
SOHO
SOLAR AND HELIOSPHERIC OBSERVATORY

SOHO
Science Operations Plan

Issue 2.1

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Contents

Preface

This document describes the concept and methodology of the SOHO science operations, including the organisation, dissemination, archiving and access mechanisms for the SOHO data products. It addresses the coordinated operation and data analysis of the SOHO investigations and will be a reference manual for that.

This issue 2.1 (March 1995) supersedes all previous issues. Changes with respect to draft issue 2.0 (May 1994) are marked with a margin bar.

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with inputs from the members of the SOHO Science Operations Working Group, both as individuals and as a group at their meetings.

Reference Documents

The SOHO Mission: ESA SP-1104
SOHO EID Part A
EID Part B of SOHO's experiments
Minutes of the SOWG meetings
Interface Control Document between SOHO, EOF, ECS and the SOHO instruments
GOLF Flight Operations Document
MDI/SOI technical facility doc.
Mission Operations Plan for the Wide-Angle White Light and Spectrometric Coronagraph: LASCO doc
SWAN Science Operations Plan
The Coronal Diagnostic Spectrometer for SOHO: Scientific Report
The SUMER Spectrometer for SOHO: Scientific Report
SOHO Inter-Instrument Flag Implementation and Utilisation Plan, Version 1.1, Dec. 1992
The SOHO Interdisciplinary Science Martix (R.A. Harrison & G. Schultz), ESA SP-348, p. 397

List of Acronyms

AIT	Atomic International Time
AIV	Assembly-Integration-Verification
AO	Announcement of Opportunity
CCSDS	Consultative Committee for Space Data Systems
CDDI	Copper Distributed Data Interface
CDF	Common Data Format (SFDU data format)
CDHF	Central Data Handling Facility
CDS	Coronal Diagnostic Spectrometer
CELIAS	Charge, ELement and Isotope Analysis
CEPAC	COSTEP – ERNE Particle Analyser Collaboration
CMS	Command Management System
Co-I	Co-Investigator
COSTEP	COmprehensive SupraThermal and Energetic Particle analyser
DDF	Data Distribution Facility
DSN	Deep Space Network
ECS	EOF Core System
ECS FRD	ECS Functional Requirements Document
EGSE	Electrical Ground Support Equipment
EIT	Extreme-ultraviolet Imaging Telescope
EOF	Experiment Operations Facility
ERNE	Energetic and Relativistic Nuclei and Electron experiment
ESA	European Space Agency
ESOC	European Space Operations Centre (ESA, Darmstadt)
Ethernet	local area network defined by ISO 802.3
FDDI	Fiber Distributed Data Interface
FDF	Flight Dynamics Facility
FITS	Flexible Image Transport System
FOT	Flight Operations Team
FTP	File Transfer Protocol
GCI	GeoCentric Inertial
GDCF/Pacor	ISTP Program Generic Data Capture Facility / Packet Processor
GGS	Global Geospace Science
GI	Guest Investigator
GISC	Guest Investigator Selection Committee
GOLF	Global Oscillations at Low Frequency
GSE	Geocentric Solar Ecliptic
GSFC	Goddard Space Flight Center
GSM	Geocentric Solar Magnetic
IDL	Interactive Data Language
IPD	Infomation Processing Division
ISTP	International Solar-Terrestrial Physics
IUE	International Ultraviolet Explorer
IWS	Instrumenter Workstation
LAN	Local Area Network
LASCO	Large Angle Spectroscopic COronagraph
MAR	Mission Analysis Room

MOR	Mission Operations Room
MDI/SOI	Michelson Doppler Imager/Solar Oscillations Imager
N/A	Not Applicable
NASA	National Aeronautics and Space Administration
NFS	Network File Services
NOAA	National Oceanic and Atmospheric Administration
NRT	Near Real-Time
NSI	NASA Science Internet
NSO	National Solar Observatory
NSSDC	National Space Science Data Center
OBT	On-Board Time
PACOR	Packet Processor
P/M	Payload Module
PI	Principal Investigator
POCC	Payload Operations Control Center
PS	Project Scientist
PSO	Project Scientist Office
PVL	Parameter Value Language
R/T	Real-Time
S/C	SpaceCraft
SDAC	Solar Data Analysis Center
SDC	Science Data Coordinator
SELDADS	Space Environment Laboratory Data Acquisition and Display System
SELSIS	Space Environment Laboratory Solar Imaging System
SFDU	Standard Formatted Data Unit
SMIP	SOHO Mission Implementation Plan
SMIRD	SOHO Mission Implementation Requirements Document
SMM	Solar Maximum Mission
SMOCC	SOHO Mission Operations Control Center
SOC	Science Operations Coordinator
SOHO	SOlar and Heliospheric Observatory
SOWG	SOHO Science Operations Working Team
SOL	Science Operations Leader
SOP	Science Operations Plan
SOT	Science Operations Team
SQL	Structured Query Language
SUMER	Solar Ultraviolet Measurements of Emitted Radiation
SWAN	Solar Wind ANisotropies
SWT	Science Working Team
TAI	Temps Atomique International
TBC	To Be Confirmed
TBD	To Be Defined
TC	TeleCommands
TCP/IP	Transmission Control Protocol / Internet Protocol
UTC	Universal Time Code
UVCS	UltraViolet Coronagraph Spectrometer
VIRGO	Variability of solar IRradiance and Gravity Oscillations
WS	Work-Station

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Chapter 1

Mission Overview

1.1 Scientific objectives

The SOHO satellite is a solar observatory to study: the structure, chemical composition, and dynamics of the solar interior, the structure (density, temperature and velocity fields), dynamics and composition of the outer solar atmosphere, and the solar wind and its relation to the solar atmosphere. To accomplish this, SOHO will carry a set of telescopes to study phenomena initiated by processes commencing below the photosphere, and propagating through the photosphere, chromosphere, and the transition region into the corona. The SOHO instruments are designed to investigate problems such as how the corona is heated and transformed into the solar wind that blows past the Earth at 400 km/s. To do so they will have spectrometers to study the emission and absorption lines produced by the ions present in the different regions of the solar atmosphere. From this information it will be possible to determine densities, temperatures and velocities in the changing structures. These measurements are complemented by the "in situ" study of the composition and energy distribution of the solar wind ions and energetic particles that emanate from the coronal structures observed by the telescopes. SOHO will thus greatly enhance our knowledge of the solar wind and its source region.

While the solar interior is the region that generates the kinetic and magnetic energy driving outer atmospheric processes, almost no direct information can be obtained about any region below the photosphere. The neutrinos generated by the nuclear reactions, taking place in the core, are the only direct radiation that reaches us from anything that is below the photosphere. A relatively new technique, helioseismology, has developed in the last two decades that allows us to study the stratification and the dynamical aspects of the solar interior. It uses the study of the acoustic and gravity waves that propagate through the interior of the Sun and can be observed as oscillatory motions of the photosphere. An analysis of these oscillations allows us to determine the characteristics of the resonant cavities in which they resonate, much in the same way as the Earth's seismic waves are used to determine the structure of the Earth interior.

To study the solar interior, SOHO will carry a complement of instruments whose aim is to study the oscillations at the solar surface by measuring the velocity (via the Doppler effect) and intensity changes produced by pressure and gravity waves. The study of such oscillations requires both high resolution imaging and long uninterrupted time series of observations. In addition, because it is paramount to understand the structure of the Sun in relation to the oscillation measurements, the total solar irradiance, or solar constant, and its variations will be measured.

Investigation	PI	Measurements	Technique	Bit rate (kb/s)
HELIOSEISMOLOGY				
GOLF	A.Gabriel, IAS, Orsay, F	Global Sun velocity oscillations (ℓ=0-3)	Na-vapour resonant scattering cell Doppler shift and circular polarization	0.160
VIRGO	C.Fröhlich, PMOD/WRC, Davos, CH	Low degree (ℓ=0-7) irradiance oscillations and solar constant	Global Sun and low resolution (12 pixels) imaging, active cavity radiometers	0.1
SOI/MDI	P.Scherrer, Stanford Univ., CA	Velocity oscillations with harmonic degree up to 4500	Doppler shift and magnetic field observed with Michelson Doppler Imager	5 (+160)
SOLAR ATMOSPHERE REMOTE SENSING				
SUMER	K.Wilhelm, MPAE, Lindau, D	Plasma flow characteristics: T, density, velocity in chrom. through corona	Normal incidence spectrometer: 50-160 nm spectral resolution 20000-40000, angular res.: 1.5"	10.5 (or 21)
CDS	R.Harrison, RAL, Chilton, UK	Temperature and density in transition region and corona	Normal and grazing incidence spectrom.: 15-80 nm, spectr. res. 1000-10000 angular res. 3"	12 (or 22.5)
EIT	J.P.Delaboudinière IAS, Orsay, F	Evolution of chromospheric and coronal structures	Images (1024 x 1024 pixels in 42' x 42') in the lines of He II, Fe IX, Fe XII, Fe XV	1 (or 26.2)
UVCS	J.Kohl, SAO, Cambridge, Mass.	Electron and ion temp. densities, velocities in corona (1.3-10 $R_\odot$)	Profiles and/or intensity of several EUV lines (Ly α, O VI, etc.) between 1.3 and 10 $R_\odot$	5
LASCO	G.Brueckner, NRL, Washington, DC	Evolution, mass, momentum and energy trans. in corona (1.1-30 $R_\odot$)	1 internal and 2 externally occulted coronagraphs, Fabry-Perot spectrometer for 1.1-3 $R_\odot$	4.2 (or 26.2)
SWAN	J.L.Bertaux, SA, Verrières-le-Buisson,F	Solar wind mass flux aniso-atropies + temporal var.	2 scanning telescopes with hydrogen absorption cell for Ly-α light	0.2
SOLAR WIND 'IN SITU'				
CELIAS	D.Hovestadt, MPE, Garching, D	Energy distribution and composition (mass, charge, ionic charge) of ions (0.1-1000 keV/e)	Electrostatic deflection system, Time-of-Flight measurements, solid state detectors	1.5
COSTEP	H.Kunow, Univ. of Kiel, D	Energy distribution of ions (p, He) 0.04-53 MeV/n and electrons 0.04-5 MeV	Solid state and plastic scintillator detector telescopes	0.3
ERNE	J.Torsti, Univ. of Turku, SF	Energy distribution and isotopic composition of ions (p - Ni) 1.4-540 MeV/n and electrons 5-60 MeV	Solid state and scintillator crystal detector telescopes	0.71

Table 1.1: SOHO payload

1.2 Instrumentation

The investigations on-board SOHO (Table 1.1) can be divided into three main groups, according to their area of research : helioseismology, solar atmospheric remote sensing, and "in situ" particle measurements.

Helioseismology

The helioseismology investigations primarily aim at the study of those parts of the solar oscillations spectrum that cannot be obtained from the ground. The required sensitivity for observing the very low modes ($l \leq 7$) and the high modes ($l \geq 300$) is difficult to achieve from the ground because of noise effects introduced by the Earth's diurnal rotation for the low modes, and the transparency and seeing fluctuations of the Earth's atmosphere for the high modes.

Solar atmospheric remote sensing

The solar atmosphere remote sensing investigations are carried out with a set of telescopes and spectrometers that will produce the data necessary to study the dynamic phenomena that take place in the solar atmosphere at and above the chromosphere. The plasma will be studied by spectroscopic measurements and high resolution images at different levels of the solar atmosphere. Plasma diagnos-

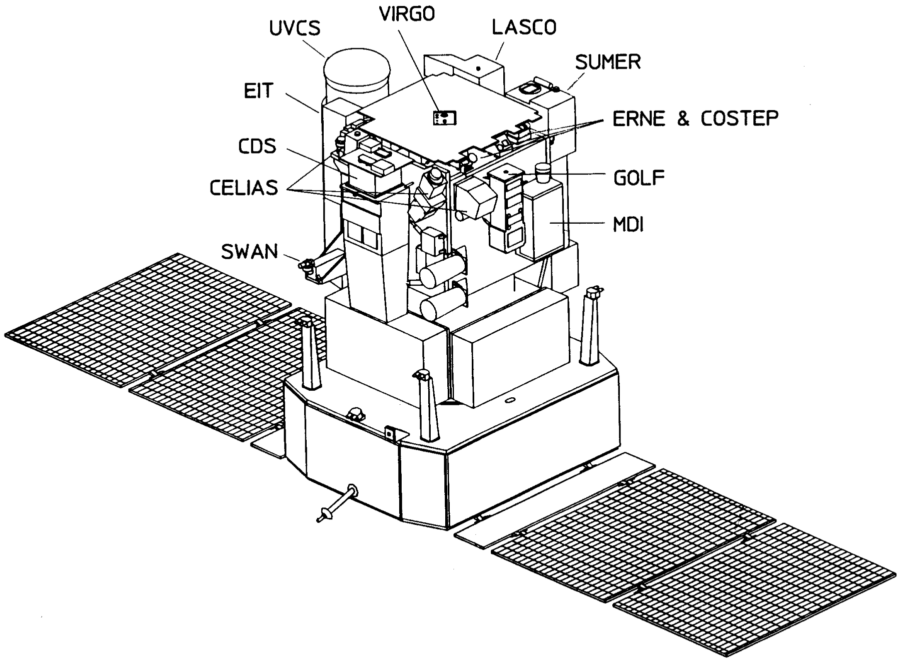

Figure 1.1: SOHO spacecraft schematic view

tics obtained with these instruments will provide temperature, density, and velocity measurements of the material in the outer solar atmosphere.

"In situ" measurements

The instruments to measure "in situ" the composition of the solar wind and energetic particles will determine the elemental and isotopic abundances, the ionic charge states and velocity distributions of ions originating in the solar atmosphere. The energy ranges covered will allow the study of the processes of ion acceleration and fractionation under the various conditions.

1.3 Spacecraft, Orbit, Attitude

The SOHO spacecraft (Fig. 1.1) will be three-axis stabilized and point to the Sun within an accuracy of 10 arc sec and have a pointing stability of 1 arcsec per 15 minutes interval. It will consist of a payload module which accommodates the instruments and a service module carrying the spacecraft subsystems and the solar arrays. The total mass will be about 1850 kg and 1150 W power will be provided by the solar panels. The payload will weigh about 640 kg and will consume 450 W in orbit.

SOHO is planned to be launched in July 1995 and will be injected in a halo orbit around the L1 Sun-Earth Lagrangian point, about 1.5×10^6 km sunward from the Earth. The halo orbit will have a period of 180 days and has been chosen because, 1) it provides a smooth Sun-spacecraft velocity change throughout the orbit, appropriate for helioseismology, 2) is permanently outside of the magnetosphere, appropriate for the "in situ" sampling of the solar wind and particles, and 3) allows permanent observation of the Sun, appropriate for all the investigations. The Sun-spacecraft velocity will be measured with an accuracy better than 0.5 cm/s.

SOHO is being designed for a lifetime of two years, but will be equipped with sufficient on-board consumables for an extra four years.

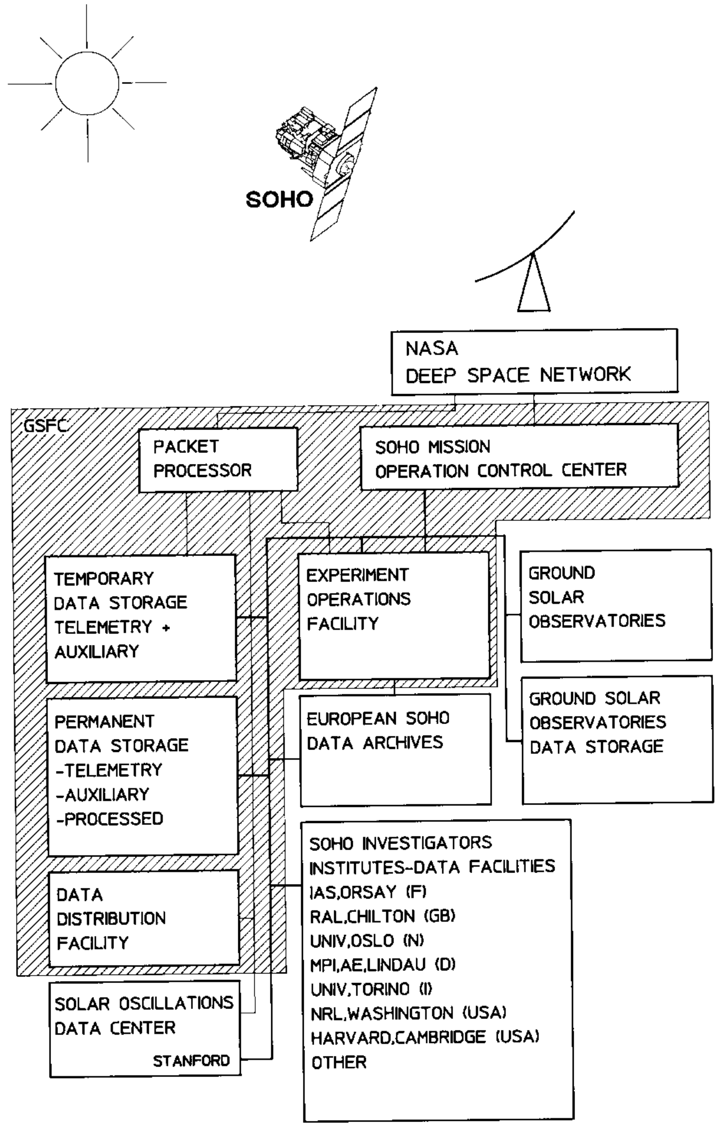

Figure 1.2: SOHO ground system: basic functions related to science operations

1.4 Operations

The diagram in Fig 1.2 shows the basic functions that will be present for the SOHO science operations. The SOHO Experiment Operations Facility (EOF), to be located at NASA Goddard Space Flight Center, will serve as the focal point for mission science planning and instrument operations. At the EOF, experiment PI representatives will receive real-time and playback flight telemetry data, process these data to determine instrument commands, and send commands to their instruments, both in near real-time and on a delayed execution basis. They will be able to perform data reduction and analysis, and have capabilities for data storage. To accomplish these ends, the appropriate experiment teams will use workstations (WS's) that will be connected to an EOF Local Area Network (LAN). Additional workstations and X-terminals will be used to support the Project Scientists (PS) and for SOHO planning and operations support staff in the EOF. There will be connections from the EOF to external facilities to allow transfer of incoming data from GSFC support elements, remote investigator institutes, other solar observatories, and ESA facilities. There will also be connections for the EOF to interact with the SOHO Mission Operations Control Center (SMOCC) and other required elements at GSFC for scheduling and commanding the SOHO flight experiments. Short term and long term data storage will be either within the EOF or at an external facility with electronic communication access from the EOF.

The Deep Space Network (DSN) will receive S/C telemetry during three short (1.6 hrs) and one long (8 hrs) station pass per day. Science data acquisition during non-station pass periods will be stored on-board and played back during the short station passes. The MDI high data rate stream will be transmitted only during the long station pass. For 2 consecutive months per year continuous data transmission, including MDI high data rate, will be supported by DSN. Whenever there is data transmission, the basic science data (40 kbits/s) and housekeepig data (15 kbit/s) will be available in near real-time at the EOF. From the EOF the SOHO investigators will control the operation of the instruments via the Payload Operations Control Center (POCC). The latter will verify and up-link the commands submitted by the experimenters.

Some SOHO instruments (CEPAC, CELIAS, VIRGO, GOLF, and SWAN) will generally operate automatically and will not need near real-time operational control except for surveillance of housekeeping data. Other instruments, those of the coronal imaging investigators, will be operated interactively every day in real (or near real-) time.

The EOF has the following functions:

a) Provides the means with which the PI teams participating in the SOHO programme can monitor and, via SMOCC, control their instruments on-board the spacecraft.

b) Is the center where the solar atmosphere investigators of SOHO will coordinate and plan the near real-time operation of their instruments, and will be the focal point on the one hand, for the overall SOHO science operations planning, and on the other, for coordinating science studies through the organisation of campaigns and data analysis workshops.

c) Provides electronic interfaces with the appropriate data bases and networks to support the WS's activities and to provide the necessary input from ground stations and other spacecraft data for the planning of the SOHO science operations.

d) Provides data storage for science, engineering and housekeeping data; common data (attitude, orbit and spacecraft housekeeping) are also stored there. Cataloging capabilities are also available.

A complete description of the EOF is found in chapter 4.

Chapter 2

SOHO Operations Policy and Requirements

2.1 Operations Plan

2.1.1 Overview

2.1.1.1 Routine operation

The SWT will set the overall science policy and direction for mission operations, set priorities, resolve conflicts and disputes, and consider Guest Investigator observing proposals. During SOHO science operations, the SWT will meet every three months to consider the quarter starting in one month's time and form a general scientific plan. If any non-standard DSN contacts are required, the requests must be formulated at this quarterly meeting. The three-month plan will then be refined during the monthly planning meetings (see 2.1.2) of the Science Operations Team (SOT), composed of those PIs or their team members with IWSs at the EOF, which will allocate observing sessions to specific programs. At weekly meetings of the SOT (2.1.3) , coordinated timelines will be produced for the instruments, together with detailed plans for spacecraft operations. Daily meetings of the SOT (2.1.4) will optimize fine pointing targets in response to solar conditions and adjust operations if DSN anomalies occur.

2.1.1.2 Responsibilities

While the Project Scientist (PS) will be responsible for the implementation of the scientific operations plan, execution of the plan will be carried out by the SOT. On a rotating basis, one of the PIs or their representatives at the EOF will serve as the Science Operations Leader (SOL). The SOL will serve for approximately 10 days, starting with the weekly planning meeting and continuing through the week of operations. The SOL will

- chair the weekly planning meeting and the daily meetings during the following week
- be responsible for the successful execution of the weekly plan.

To provide operational continuity over the course of the SOHO mission, and from one SOL's tenure to the next, a Science Operations Coordinator (SOC), who is not a member of any of the PI teams, will work daily with the SOL and SOT. The SOC's role is to

- produce and distribute an integrated science plan resulting from the daily meetings
- maintain the monthly scientific planning schedule

- insure coordination of inter-instrument operations and campaigns with other rocket, spacecraft, and ground based observatories
- advise the various planning meetings on the availability of ground- and space-based collaborations
- work daily with local PI teams to resolve inter-instrument conflicts and optimize scientific return
- coordinate commanding and problem resolution with Remote PI teams
- act as primary interface between experimenters and FOT to insure smooth planning and scheduling of all spacecraft activities
- inform the SOT of spacecraft status and DSN, SMOCC, and FDF (Flight Dynamics Facility) constraints on scheduling

There will be two full-time SOC's and two Science Data Coordinators (SDC). The SDC's role is to

- monitor data accountability of telemetry reception
- develop and maintain the SOHO archive at the EOF, i.e. update SOHO databases and catalogues with input from PI teams
- organize routine data handling activities:
  - Command History File.
  - SOHO Daily Activity Report.
  - Planning and scheduling information.
  - Time Correlation File information.
  - Predictive and Definitive Orbit File.
  - Definitive Attitude File.
  - Daily Summary Data.
  - Database/Catalogue information.
  - Images, particles and fields data.
- assemble and archive data from other observatories (both ground-based and other spacecraft) useful for planning purposes and scientific analysis
- assist users in the access and use of SOHO data and analysis software (this will start as a completely PI-team-based function, but gradually shift to a service role, reflecting experience gained during the operations phase in the use of archival data)

2.1.2 Monthly planning cycle

On a monthly time scale the SOT will meet to assess progress in achieving the scientific goals of their investigation and to discuss the objectives for operations starting in a month's time. This gives time for coordinated observations to be set up, arrangements for Guest Investigators to be made, and any deficiencies in observing sequences to be identified.

Approximately 2 weeks later a SOT meeting will discuss instrument health, solar activity and consider the operations for the month under consideration. SOL's will be appointed for each week and they will be responsible during the month for identifying any conflicts between the planned operations and the DSN schedule as they become available.

Inputs to the monthly meeting are made by each instrument team and common objectives are identified. The output of this meeting is a schedule showing when each instrument will be operating, whether

Meeting	Operational period being considered	Output
Quarterly SWT	Quarter starting in 1 month time	General plan
Monthly	Month starting in 2 weeks time	Observational priorities, schedule for month, time block allocated to specific programs, joint observations, supporting observations, guest investigators
Weekly	Week start in 3 days time	Detailed plan, time for sequences to be run, telemetry rates, flag-master/slaves, disturbances, calibrations.
	Week starting in 10 days time	Advance notice of changes to monthly schedule
Daily	Current day	Optimisation of current pointing targets. R/T instruments commands
	Tomorrow	Choice of pointing targets
	Day after tomorrow	Changes to weekly plan S/C command load

Table 2.1: Schedule for SOHO planning meetings

joint or individual observations are being made, the types of solar features being observed, ground observatory support and a backup plan if these conditions are not met. Requirements for telemetry rate switching should be identified together with any spacecraft operations which may affect the observations, for example momentum dumping and station keeping. Conflicts between instruments for resources are resolved and disturbances identified.

2.1.3 Weekly detailed planning

A weekly meeting considers the week starting in approximately three days time and this is when the detailed plans for all the SOHO instruments are synchronised. It will be convened by the SOL designated to lead that week. The intention is to lay out a definitive plan with timings, flag status, disturbances, etc., so that the daily meetings only consider deviations from the weekly plan. This meeting will have the conflict-free DSN schedule available.

The weekly meeting will also be the forum for instrument teams to give advance notice of any special operations or changes to the plan for future weeks. The DSN forecast schedule will be available for the week commencing in 10 days time and the strawman proposal will be available for the week following that.

2.1.4 Daily optimisation meeting

The daily meeting convenes to hear about the state of the Sun, discusses fine pointing targets and whether any changes are necessary in view of yesterday's operations. On the nominal timeline which follows, this meeting would take place early in the long real time contact, at approximately 10:00 GSFC local time, so that recent images from other SOHO instruments and ground observatories will be available and allow optimisation of observations, particularly pointing targets, for the current pass and also those planned for the next 24 hours. A "SOHO planning day" will start towards the end of the long real time pass, at approximately 15:00, so routine commands for the next 24 hours should

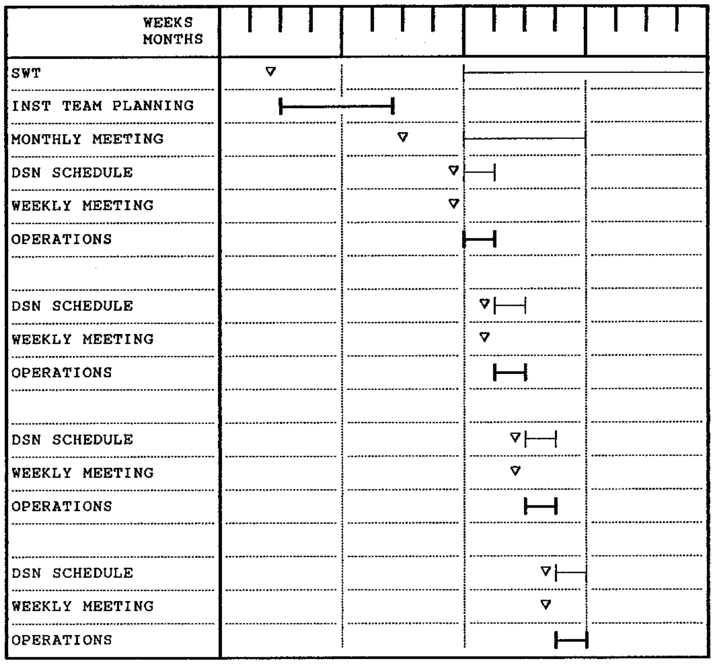

Figure 2.1: SOHO planning cycle

be uplinked by 15:00 to allow for checking and contingency. Figure 2.1 and 2.2 summarize the SOHO planning cycle activities.

2.1.5 S/C operations time line

Fig 2.2 shows the proposed overall time line of operations. The time of the long real-time operation (MDI high data rate) has been chosen to be day-light in GSFC and to overlap about half time with the Canary Islands observatories and with the USA western observatories. The 2-month continuous operation is arbitrary selected. It is expected that both the time of the day and the period of the year for the MDI high data rate will have to be adapted to DSN capabilities both for technical and scheduling reasons.

It is also expected that the Soho SWT will, on certain occasions, for correlative studies with particular ground observations or with other space missions, request modifications to the baseline operations schedule for limited periods of time.

2.1.6 Commanding schedule

During the real time operation periods the individual investigators will send their commands as needed from their workstations. It is required that the command processing time from WS to spacecraft be less than one minute. Real-time commanding rate will be typically less than 100 per hour, with peaks of about 10-20 per minute.

2.1.7 Instruments timeline: sample

This two day timeline is intended to show the degree of interaction and coordination between the instruments during a “typical” day (Fig. 2.3 and 2.4). At some times all of the instruments will be addressing a common objective, at other times joint science will be carried out by smaller number and

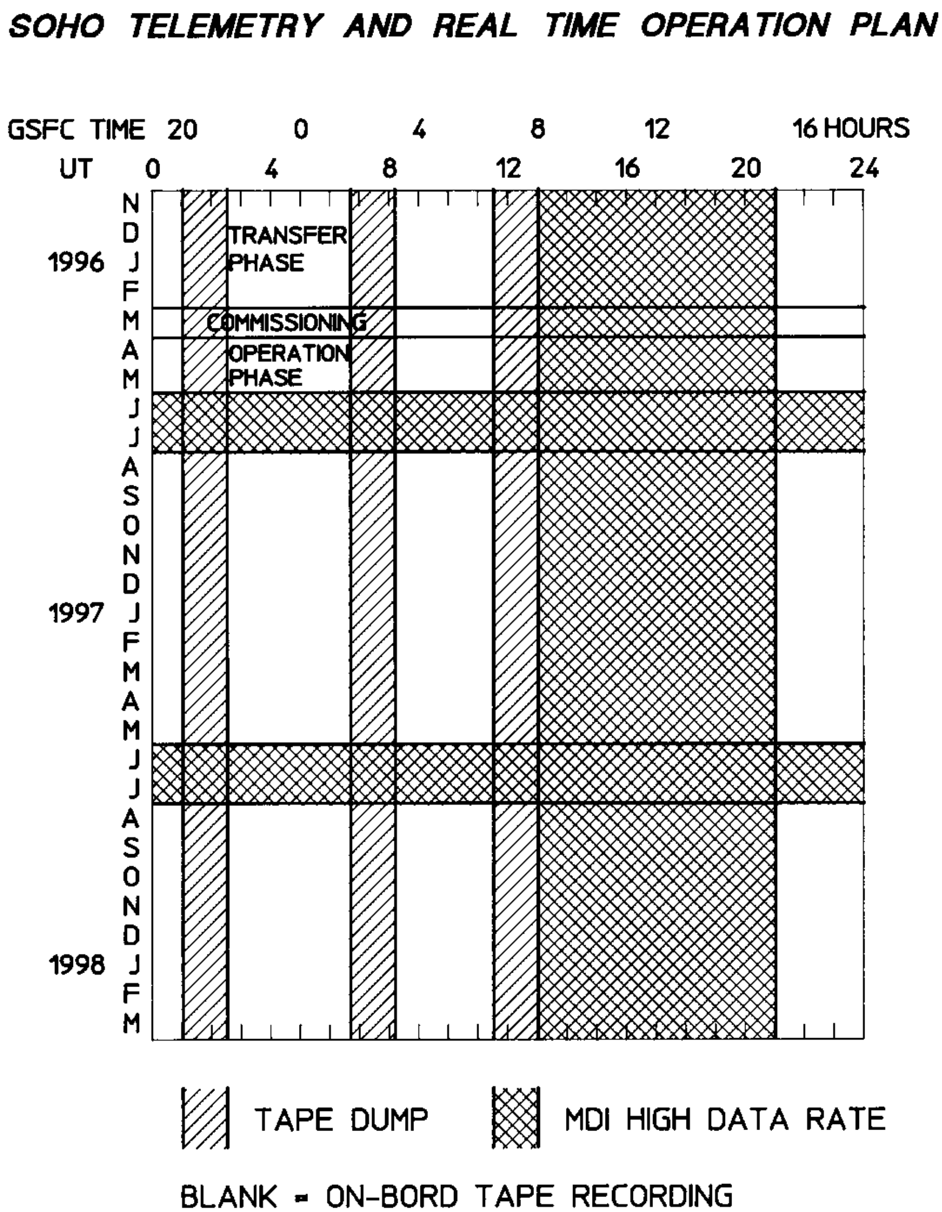

Figure 2.2: SOHO telemetry and real time operation plan

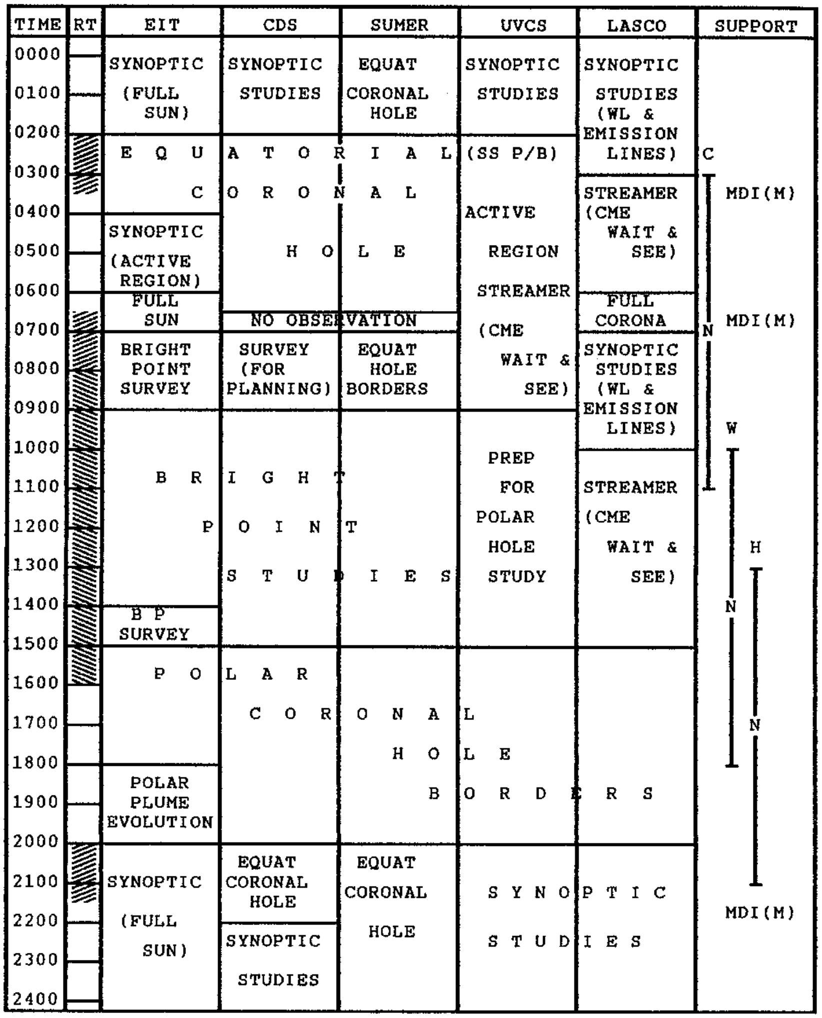

Figure 2.3: One day SOHO observing plan (Coronal instruments), Day D

there will be occasions when instruments will be working individually. Naturally there is a tremendous scope for variation.

Notes:

- TIME refers to local i.e. GSFC time. 07:00 is noon GMT.
- RT is when Real Time contact through the DSN is scheduled.
- SUPPORT: C denotes nominal observing time at the Canaries, W at the US West coast observatories and H at Hawaii. MDI (M) is when an MDI magnetogram is taken. This is scheduled for the end of the short real time passes to enable the tape recorder to be dumped first, but at the beginning of the low real time pass so that it is coincident with the EIT image.

02:00 CDS and SUMER check instrument performance and optimise observing programs (particularly pointing) for the next session. UVCS and LASCO observe a streamer which may give a CME.

03:25 MDI make a magnetogram.

07:00 Telemetry format 2 is used to enable EIT and LASCO to make full Sun images. MDI make magnetogram.

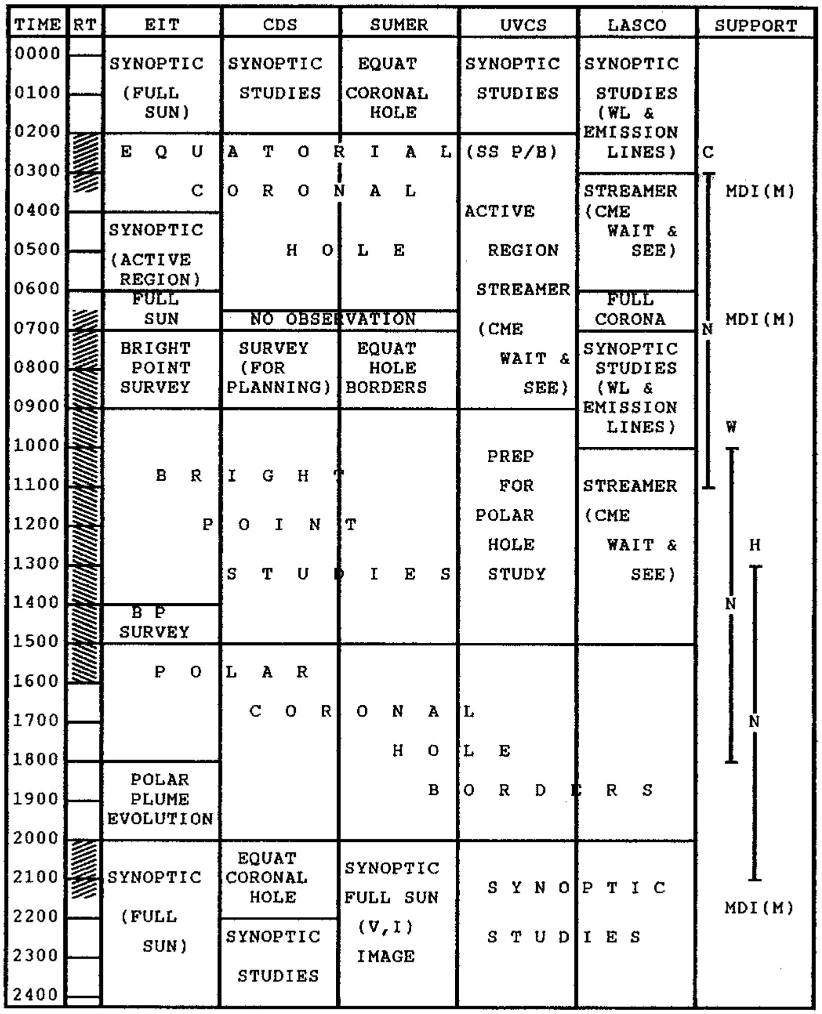

Figure 2.4: One day SOHO observing plan (Coronal instruments), Day D+1

07:30 - 09:00 CDS and SUMER make a series of short interactive observations to identify features to be studied during the rest of the real time pass and features to be studied collectively during the following SOHO day. EIT carry out a bright point survey. LASCO continue synoptic studies.

10:00 Daily SOHO meeting which optimises the plan for the day starting at 15:00 and considers the plan for the day after.

14:00 EIT repeat their bright point survey.

15:00 SOHO observing day starts. All instruments concentrating on the same area with the same objectives.

20:00 CDS and SUMER check instrument performance and optimise observing programs (particularly pointing) for the next session. Every 2 days SUMER will make a full Sun scan to give intensity and velocity maps. EIT, UVCS and LASCO start synoptic observations.

2.1.8 Coordinated campaigns

Within SOHO

During agreed periods one or several experiment teams and, if agreed, teams from other spacecraft or ground observatories will run, in collaboration, observation campaigns to address specific topics. The periods of two-months continuous near real-time observation will probably be the most convenient for campaigns that require continuous observation during more than 8 hours, or that require coordination with ground observations only feasible from particular observatories around the world. For each campaign a campaign leader will be responsible for the coordination.

Examples:

- LASCO, SWAN and SUMER
  Possible coordinated cometary observations (known or new). This should be organized on relatively short notice. Extension and magnitude of polar coronal holes. This can be done on a slower time schedule.
- LASCO, UVCS, EIT, SUMER, CDS and MDI
  A candidate structure emerges from the East limb, it is tracked by LASCO and UVCS, followed by EIT, SUMER, CDS, MDI when it transits the disk, and then LASCO and UVCS when it disappears beyond the West limb.

With ground-based observatories
If the ground-based observatory is one that has electronic links that allow near real-time imaging transmission to and from the EOF, the coordination will be no different than if the ground based observatory were one of the SOHO experiments.
If no real-time data transmission is needed or possible, the coordinated operation will be an agreed time of simultaneous observations.
Generally speaking the coordinated observations with ground observatories will need a longer time lead in their planning to insure availability of the facility and coincidence of the SOHO real-time coverage.

2.2 Conventions

The following conventions apply to facilitate the coordination of science planning, expedite the exchange of data between different instrument teams, and enhance the overall science activities.

2.2.1 Spacecraft time

The SOHO On Board Time (OBT) will use the CCSDS format, level 1 (TAI reference, 1958 January 1 epoch), as discussed in section 3.3.9 of the SOHO Experiment Interface Document Part A (Issue 1). The SOHO OBT is an unsegmented time code with a basic time equal to 1 second and a value representing the number of seconds from 1 January 1958 based on International Atomic Time. The OBT Pulse is adjusted to maintain the OBT within ± 20 ms of the ground TAI.

The SOHO OBT is used to time tag the data packets sent to the EOF and to the Data Distribution Facility (DDF). The time tags for the spacecraft and instrument housekeeping packets are generated by the spacecraft on-board data handling system. The time tags for the instrument science data packets are inserted by the instruments generating the science data. The time tags will be provided in 6 bytes; the first 4 bytes are TAI seconds (2^0 to 2^{31} seconds) and the last 2 bytes are fractions of a second with the resolution of the On Board Time Pulse (2^{-11} seconds).

The SOHO Daily Pulse is generated every 86,400 seconds, and is synchronized to the TAI with an accuracy better than ± 100 ms. The Daily Pulse will correspond to the beginning of a TAI "day", that is the Daily Pulse will occur at the zeros of TAI modulo 86,400. As of 1 January 1993, the difference between TAI midnight and 00:00 UTC was 27 seconds. Since July 1^{st} 1993 UTC - TAI = –28 sec (TBC).

The helioseismology experiments plan to center one minute observations on the TAI minute, that is where TAI modulo 60 is zero.

2.2.2 Ground time

Coordinated Universal Time (UTC) will be used as the operational time reference in the Experiment Operations Facility. The "SOHO operations day" is defined to begin at 00:00 UTC and the computer systems in the SMOCC and EOF will be synchronized to run on UTC.

2.2.3 Solar rotation axis

The solar rotation axis will be calculated using the Carrington ephemeris elements. These elements define the inclination of the solar equator to the ecliptic as 7.25 degrees, and the longitude of the ascending node of the solar equator on the ecliptic as $(75.76 + 0.01397 * T)°$, where T is the time in years from J2000.0.

The solar rotation axis used for alignment of the SOHO spacecraft will be determined from the Carrington ephemeris elements. The Experiment Interface Document Part A (Issue 1, Rev 3) lists the longitude of the ascending node of the solar equator as 75.62° and the position of the pole of the solar equator in celestial coordinates as 286.11° right ascension and 63.85° declination. This definition is consistent with a solar rotation axis determined from the Carrington elements for a date of 1 January 1990. As mentioned in the EID Part A, this information must be updated for the actual launch date.

Heliographic longitudes on the surface of the Sun are measured from the ascending node of the solar equator on the ecliptic on 1 January 1854, Greenwich mean noon, and are reckoned from 0 to 360° in the direction of rotation. Carrington rotations are reckoned from 9 November 1853, 00:00 UT with a mean sidereal period of 25.38 days, and are designated as CR_{1903} etc..

2.2.4 Inter-instrument flag reference coordinates

The spacecraft optical axes are defined with respect to the optical alignment cube of the Fine Pointing Sun Sensor, with the optical X axis (X_0) nominally perpendicular to the spacecraft launcher separation plane and pointing from the separation ring through the spacecraft. The spacecraft optical Y axis (Y_0) is along the direction of the solar panel extension with positive Y_0 pointing from the interior of the spacecraft towards the UVCS instrument.

The orientation of the SOHO spacecraft is planned to have the spacecraft optical X axis (X_0) pointing towards the photometric center of the Sun, and the spacecraft optical Z axis (Z_0) oriented towards the north ecliptic hemisphere such that the (X_0,Z_0) plane contains the Sun axis of rotation. As such the Y_0 axis will be parallel to the solar equatorial plane pointing towards the east (opposite to the solar rotation direction). ESA will be responsible for achieving this orientation with the misalignment margins defined in the EID-A.

A standard coordinate system is required for joint observations between instruments on the ground (for test purposes) and in space. This system, designated (X_{ii},Y_{ii}), will be defined as follows: On the ground, the Y_{ii} axis is parallel to the spacecraft Z_0 axis and the X_{ii} axis is anti-parallel to the spacecraft Y_0 axis. In space, the (Y_0,Z_0) system is however no longer accessible. We will therefore define a virtual system (Y_0^*,Z_0^*), which is nominally coincident with (Y_0,Z_0) and where Y_0^* is perfectly aligned with the solar equator and its origin is at the Sun centre, and define (X_{ii},Y_{ii}) in space as above using the virtual system (Y_0^*,Z_0^*).

The inter-instrument flag system (X_{ii},Y_{ii}) thus has its origin at the Sun centre, its Y_{ii} axis is in the plane containing the solar rotation axis pointing north, and its X_{ii} axis positive towards the west limb.

Each instrument participating in the flag exchange is reponsible for determining its orientation with respect to the (X_{ii},Y_{ii}) system and report the coordinates of their observations in (X_{ii},Y_{ii}) coordinates in units of 2 arcsec. Off-limb observations need special treatment if X_{ii}, $Y_{ii} > 1022$".

2.2.5 Spacecraft orbit coordinates

The Orbit data will describe the position and motion of the spacecraft, and it will be available in several coordinate systems including: geocentric inertial (GCI) coordinates for the J2000 system; geocentric solar ecliptic (GSE); geocentric solar magnetospheric (GSM) coordinates; and Heliocentric Ecliptic coordinate system.

The GSE coordinate system is defined as follows: The origin is Earth centered, with the X axis pointing from the center of the Earth to the center of the Sun; the Y axis lies in the ecliptic plane and points in the opposite direction of the Earth's orbital motion; the Z axis completes a right-handed orthogonal coordinate system and is parallel to the ecliptic pole. The Sun position is the true "instantaneous" position rather than the "apparent" (light-time delayed or aberrated) position. The ecliptic is the true ecliptic of date.

The Heliocentric Ecliptic coordinate system is defined as follows: the origin is Sun centered, with the Z axis parallel to the ecliptic pole with positive north of the ecliptic plane; the X-Y plane lies in the ecliptic plane and the X axis points towards the first point of Aries; the Y axis completes a right-handed orthogonal coordinate system.

The GCI coordinate system is defined as follows: Earth centered, where the X axis points from the Earth towards the first point of Aries (the position of the Sun at the vernal equinox). This direction is the intersection of the Earth's equatorial plane and the ecliptic plane — thus the X axis lies in both planes. The Z axis is parallel to the rotation axis of the Earth and the Y axis completes a right-handed orthogonal coordinate system. As mentioned above, the X axis is the direction of the mean vernal equinox of J2000. The Z axis is also defined as being normal to the mean Earth equator of J2000.

The GSM coordinate system is defined as follows: again this system is Earth centered and has its X axis pointing from the Earth towards the Sun. The positive Z axis is perpendicular to the X axis and paralle to the projection of the negative dipole moment on a plane perpendicular to the X axis (the northern magnetic pole is in the same hemisphere as the tail of the magnetic moment vector). Again this is a right-handed orthogonal coordinate system.

2.3 Inter-instrument flags

In crude terms, a flag is a message sent by an instrument to another instrument, which enables the latter one to respond by operating in a more efficient manner. The implication is that the data/command loop for responses via the ground would be far too long to be of use for the flagged event.

The coronal extreme ultraviolet and ultraviolet instrumentation on-board SOHO will have limited fields of view and limited telemetry streams. For this reason, one has to examine ways of increasing the efficiency of the available system. Short time scale events may best be detected by one SOHO instrument which may relay information to the others to generate operating mode changes or more precise pointing.

With SOHO we are considering a range of flags which will enable an efficient programme for observing a range of features. The inputs to this study from the various experiment teams have resulted in the list of flags given in Tables 2.2 and 2.3. For each entry we list the event-type, the time-scale needed for a response, the instrument which generates the flag, and the instruments which may wish to respond

Event type	Response time	Identified activity
Jets/Turbulent events	<Minute	Pocket of Doppler shifts
Micro/Subflares	Seconds	Brightening
Bright points Activated prominences	<Minutes Tens of minutes	Brightening Increased Doppler shifts
Eruptive prominences	Minutes	Transverse motion or detection of prominence in corona
Coronal Mass Ejection	Minutes	"Precursor" brightenings or Ejection in corona
Flares	Seconds	Extreme brightenings

Table 2.2: Transient events to be studied by the use of flags

to such a flag. Since the features being studied are not necessarily as easy to identify as a flare, we also define the nature of the activity which can be monitored in order to generate the flag.

Event type	Originator	Receiver
Jets/Turbulent events	SUMER / CDS	CDS / SUMER
Micro/Subflares	SUMER / CDS	CDS / SUMER
Bright points	EIT CDS	SUMER / CDS SUMER
Activated prominences	SUMER	CDS / LASCO / UVCS
Eruptive prominences	CDS / SUMER LASCO	LASCO / UVCS CDS / SUMER
Coronal Mass Ejection	CDS LASCO	LASCO / UVCS UVCS/ CDS / SUMER
Flares	EIT / CDS / SUMER	EIT / CDS / SUMER / UVCS / LASCO / MDI

Table 2.3: Flag generating and receiving instruments on SOHO

Timing (for flag to be read by receiving instrument):	within 16 seconds of being detected by generator.
Form of flag words:	2 x 10 bit words (X, Y location on Sun) 1 x 4 bit word (Identifier)
Notes:	all flags sent to all receiving instruments one flag generating instrument enabled at a time planned from EOF

The rules and conventions adopted in the generation and reception of flags are described in Annex C.

Chapter 3

Data

3.1 Data sets

The purpose of this section is to describe the data sets available in the EOF and at the different SOHO facilities.

3.1.1 Science data

NASA will forward real-time level 0 (=packetized) science data from the GDCF/Pacor (Generic Data Capture Facility/Packet Processor) to the EOF Core System, which will distribute it to the PI Workstations. There is no additional front-end processing performed on these data by NASA to assess the quality prior to its routing to the EOF. Playback data will be sent to the EOF in the same manner with transmission delays from DSN (approximately 3 hours) and processing delays to turn the data around (approximately 2 hours).

3.1.2 Housekeeping data

NASA will provide the level 0 housekeeping data packets obtained from the raw telemetry stream. These data are treated the same way as the science data. The SMOCC will provide the EOF with access to the SMOCC displays. The displayed data will be available in both raw counts and engineering units, and will include housekeeping parameters defined in the Project Data Base.

3.1.3 Ancillary data

Various parameters relating to the spacecraft condition will be collected together into a data set called ancillary data. Table 3.1 provides a list of the parameters that are to be included in the ancillary data set. The data set may be accessed electronically from the EOF and will be maintained for the entire SOHO mission. Some of the ancillary data parameters will be transmitted to the DDF for distribution on hard media to the PIs.

All the parameters, except for the verified attitude, will be generated by SMOCC or FDF. The verified attitude will be the responsibility of the PI teams, and will be generated from a comparison of the definitive attitude with science data. The verification process is anticipated to be a long-term process and will therefore not be included with the ancillary data set distributed by the DDF.

The Definitive Attitude file now consists of two products, (a) the Definitive Attitude File and (b) the Full Time Resolution Attitude File.

Ancillary Data Parameter	Where available	
	EOF (On-line)	DDF
Orbit predictions	X	
Orbit definitive	X	X
Attitude definitive	X	X
Attitude verified (PI responsibility)	X	
Time corrections ($\Delta t > 0.1$ sec)	X	X
DSN Schedule real-time periods	X	
Command history	X	X
SOHO Daily Report	X	X

Table 3.1: Ancillary data parameter

It is anticipated that the on-board clock may occasionally jump. Therefore corrections to the on-board clock must be accommodated and the list of "glitches" be maintained on-line and distributed by the DDF. The frequency corrections to keep the clock within 20 ms will be logged, too.

3.1.4 Summary data

The Summary Data will be used both to plan observations at the EOF and to provide an overview of the observations that have been obtained from the SOHO. Tables 3.2, 3.3, and 3.4 provide a list of the contributions from each PI team. The Summary Data will consist of three classes. The first two classes will consist of a representative image from each of the imaging experiments, and key parameters from the non-imaging experiments. The third class will be a list of observing programs and start/stop times of data sequences. Together these data will provide a synopsis of solar conditions and the science programs that have been carried out by the observatory.

The Summary Data will be available on-line from the EOF for 28 days and will be transmitted to the DDF for distribution on hard media to the PIs. Tables 3.2, 3.3, and 3.4 also include an estimate of the daily storage requirement. The total requirement is determined essentially by the number and size of the images, and is 20 Mbyte/day. If it is necessary to reduce this requirement, smaller and/or 1 Mbyte images can be considered.

The Summary Data will be the responsibility of the PI teams, and are to be generated as quickly as possible after receipt at the EOF. The data will be generated from quick-look science data and will have only preliminary calibrations performed on them. The Summary Data will therefore NOT be citable. The individual PI summaries will be transmitted by the PI to the Science Operations Coordinator's workstation (or other appropriate disk file system) either by file transfer (e.g. ftp) or by electronic mail.

An event log will be maintained in the summary data file and will be distributed by the DDF. However, the contents of the log at the EOF will be allowed to change, and will therefore be different than the one distributed by the DDF. The event log will provide a registry of events that may be of general interest. The log may also include events identified by observatories other than SOHO, but which might be relevant to the SOHO observations.

1. Each of the instruments will have an observation program summary data file even if they have only a few entries.

MDI	Full disk magnetogram, 1024 x 1024 x 2 byte (2MB) Full disk continuum, 1024 x 1024 x 2 byte (2MB)
EIT	Full disk Fe IX, 1024 x 1024 x 2 byte (2MB) Full disk Fe XII, 1024 x 1024 x 2 byte (2MB) Full disk Fe XV, 1024 x 1024 x 2 byte (2MB) Full disk He II, 1024 x 1024 x 2 byte (2MB)
UVCS	1.2-10 $R_\odot$ Corona Ly α, 256 x 256 x 1 byte (0.25 MB) 1.2-10 $R_\odot$ Coronal Temperature, 256 x 256 x 1 byte (0.25 MB)
LASCO	1.1-30 $R_\odot$ Corona White Light, 1024 x 1024 x 2 byte (2 MB) 1.1-3 $R_\odot$ Corona Fe XIV, 1024 x 1024 x 1 byte (1 MB) 1.1-3 $R_\odot$ Corona Fe X, 1024 x 1024 x 1 byte (1 MB) 1.1-3 $R_\odot$ Corona Ca XV, 1024 x 1024 x 1 byte (1 MB)

Table 3.2: Summary Data File I: Images (size per day)

VIRGO	Solar constant, SPM, LOI for each pixel (1 value/day) (0.1 kB)
SWAN	Observations sensor 1 and 2 (1.5 kB)
CELIAS	Solar wind speed, heavy ion flux (5 minutes averages) (1.5 kB)
CEPAC	17 particles flux every 5 min or 15 min (12 kB)

Table 3.3: Summary Data File II: Parameters (size per day)

SUMER	Operation modes, time, heliographic area covered (16 kB)
CDS	Operation modes, time, heliographic area covered (16 kB)
SWAN	Operation modes, area observed, start/stop time (5 kB) Operation modes, time, heliographic area covered (5 kB)
UVCS	Operation modes, sequence number, FOV, start/stop time (10 kB)
LASCO	Operation Modes, time, events (10 kB)

Table 3.4: Summary Data File III: Observation programmes (size per day)

GOLF	Time series of global velocity field
VIRGO	Times series of irradiance
MDI	Time series of full disk velocity, intensity and magnetograms images Time series of high resolution velocity, intensity and magnetograms images Time series of mode amplitudes, low resolution velocity, intensity images
SUMER	UV spectra, images (scans) and time series
CDS	EUV spectra, images (scans) and time series
EIT	Full disk EUV images, time series of selected regions
UVCS	UV spectra (Ly-α, O VI) and images of the solar corona out to 10 $R_\odot$
LASCO	Time series of coronal images (white light brightness, pB, line ratios)
SWAN	Antisolar Lyman-α intensity, Lyman-α maps of the sky
CELIAS	Composition (mass, charge, ionic charge) and energies of solar wind and suprathermal particles
CEPAC	Count rates, energy spectra, and isotopic composition of energetic particles (e, p, He – Ni)

Table 3.5: Processed science data

2. The observation program will have both a planned and an executed data file. Ideally the formats of the planned and executed files should be identical. In addition, it would speed up generation of the executed data file if it could be extracted entirely from the command history log (instead of from the instrument data streams).
3. A standard format for the observation program file will be defined for all the instruments in order to make it easier to correlate observations. The format could include Operation Mode, Start Time, Stop Time, and Observing Parameters. The Operation Mode would include instrument name, detector, and observing sequence identification. The Start and Stop Times would be in a well defined format (for example, yymmdd hh:mm.ss). The Observing Parameters could include heliographic area covered, field of view, sequence number, events, etc. and might have the format of parameter=value.
4. The observation program might be better as a database apart form the summary data. In addition, it would be a good place to start with the definition of a catalog and keywords. The disadvantage of having the observation program as a stand-alone database would be the difficulty of updating the information. This would be less of a problem if the observation program database could be generated automatically from the command history log.

3.1.5 Processed science data

Each investigation group will convert the level-0 Science data and other related data into more elaborate data files (or have the necessary software) for scientific analysis. Any processed data must have a level greater than 0 (i.e. level 1,2, etc...). Details of the archived files are to be found in the individual experiment Operations Manual. Table 3.5 gives an indication of the files to be generated.

3.1.6 Synoptic information and predictive information

The following data sets will be available at the EOF by electronic means either from SELDADS or directly from solar ground-based observatories. Among the "core support observatories" are Mitaka,

Nobeyama, Norikura (all Japan), Huairou (China), Ondrejov (Czech Republic), Pic du Midi (France), Izana (Tenerife), Huntsville, SEL (Boulder), Sac Peak, Kitt Peak, Big Bear, Mt. Wilson, Mees, and Mauna Loa (all USA).
Provided data from ground stations are:

- H-α images
- Ca K images
- Full disk magnetograms
- Helium 10830 Å images
- Radio images
- Sun map with coronal holes
- Coronagraph pictures
- Solar flares monitoring
- Zurich Sunspot number
- 10.7 cm Ottawa radio flux

Provided data from other S/C:

- X-ray images from Yohkoh (and other S/C, if available)
- GOES full Sun X-ray profiles
- Key parameters from Ulysses, WIND, CLUSTER

Provision to other projects from SOHO:

- Summary Data

3.2 Dissemination and archiving

3.2.1 Data availability

Table 3.6 indicates where and when the various data sets are to be available. The exchange of data between SOHO experimenters will facilitate the successful implementation of joint observing programs to achieve common science objectives. Electronic access to data sets remote to an individual PIs computer system provides a quick and reliable mechanism for the collaborative exchange of data. The following plan for data availability requires a submission of data from the PI teams as soon as possible after receipt, and hopefully within 24 hours. Therefore most of the inputs to the summary data should be generated by automated procedures. For example, the planned observing schedule should be generated from the planned command load.

In Table 3.6, an X indicates data availability at that facility. If a time is indicated, then the data set will be available within the time specified. The MDI High Data Rate Data will be delivered directly to Stanford University and will not go through the EOF. However the MDI magnetogram data occurring at the end of every tape recorder playback will be delivered to the EOF.

The spacecraft housekeeping shall be archived for electronic access from the EOF for 28 days after data collection. The data may be kept as digital counts, but conversion to engineering units would be preferable.

The maintenance of quick look science data is the responsibility of the PI teams. While it is desirable that the most recent 30 days be kept on-line or near on-line, it is recognized that each experiment team will have different requirements and different capabilities and no fixed requirement for on-line data retention can be imposed on the PI teams.

	Where available		
	PI WS	EOF (On-line)	DDF
Catalogs			
Ancillary Data		X	X
Summary Data		X	X
S/C Level 0 Data		X	X
Instrument Quick Look Data	X	X	
Instrument Final Data	X	X	
Ancillary Data		X	X
Definitive Orbit		1 week	1 week
Definitive Attitude		1 week	1 week
Command History		1 week	1 week
Summary Data			
Images	1 day	1 day	1 week
Parameters	1 day	1 day	1 week
Planned observations	1 day	1 day	
Executed observations	1 day	1 day	1 week
S/C Level 0 Data			
Housekeeping - real-time	<1 minute	<1 minute	
Housekeeping - playback	3.5-5 hour	3.5-5 hour	
Housekeeping - combined		4 days	X
Instrument Quick Look Data			
Housekeeping - real-time	<1 minute	<1 minute	
Housekeeping - playback	3.5-5 hour	3.5-5 hour	
Housekeeping - combined		4 days	X
Science - real-time	<1 minute	<1 minute	
Science - playback	3.5-5 hour	3.5-5 hour	
Science - combined		4 days	X
MDI			
Magnetogram	<1 minute	<1 minute	
High Data Rate (to Stanford)		1 week	X

Table 3.6: Data availability

3.2.2 Data Distribution Facility

The DDF will mail a hard copy (currently, in CD-ROM) of the respective level–0 science/housekeeping and ancilliary data to each PI within 30 days of receipt at GSFC. The PI is then responsible for further distribution to Co-Is and support institutions. In addition, such telemetry data will be available in the form of "snapshots" for limited call up to approved participating organisations. Those data, available electronically from the Central Data Handling Facility (CDHF), will represent the most recent 8 days of information.

Each PI will receive a copy of his own investigation data set, and of any other if so agreed, after 30 days of reception by DDF.

CDHF will process the key parameters for CELIAS and CEPAC to be included in the Summary Data. The Summary Data and the As-Run Plan, created and maintained on line at the EOF, is sent to CDHF for hard copy (CD-ROM) distribution. Both CDHF and EOF will keep these data online.

3.2.3 EOF

A number of SOHO participating institutes (PIs and others) will hold archives of the Science and processed science data corresponding to the experiment of their responsibility.

The central archiving facility for processed data is being developed at the EOF. This archive will hold the complete set of SOHO data with the only exception of the high data rate MDI helioseimology data set.

The following data sets will be generated for SOHO and available from the EOF archive:

- Telemetry Science Data (final level–0 distribution).
- Housekeeping Data (final level–0 distribution).
- Ancilliary Data
- Summary Data (including the As Run Plan).
- Event file
- Synoptic data (from ground-based and space-based observatories).
- Processed Data (files that are ready for scientific data analysis). Most of the data exchange between scientists and groups will be done with these data sets. The processed data will be generated at the EOF or/and the PI or collaborating institutes or observatories.

3.2.4 Databases

The various database catalogs may be accessed electronically over the EOF LAN. The catalogs will be data base tables that are linked together using standard relational data base techniques. A standard query language (SQL) is used to access the databases, but an interface program has been developed in order to use more user-friendly front ends to the EOF archive. The first interface is World-Wide-Web based and its available to anyone with Internet access. The second one is based on IDL and will be used mainly within the EOF for data analysis purposes.

The type of information stored into these database files will fall into several categories. The first category will consist of information about observing programs. For this category, a standard set of data field names and their definition has been prepared to provide uniformity in developing the individual experiment databases. Not all fields names may apply to a particular instrument, in which case that field will simply be blank for that instrument. The type of information stored in these databases will include information like identification of what type of observing program was followed, the purpose or target of the observing program, the time range of the observing program, and the heliographic area of the sun covered. Users will be able to simultaneously sample this information not only at the EOF, but worldwide. This will be accomplished maintaining a combined database incorporating this information from all the instruments on a central file server system using updates supplied by the PI teams. There will be two main datasets: the As Plan File, describing the upcoming observing plans of the instruments (will reside at ECS), and the As Run File detailing what was actually observed. This last file will be part of the Summary Data set.

The second category of database files will contain information about events that may be relevant to more than one instrument. Exactly what information will be stored in this catalog is yet TBD, but most likely it will contain the same information as found in the Observatory Log (section 3.1.4). This could consist of information about such things as spacecraft rolls, as well as information about solar events and features. Information for this file will be received from several sources: CMS (spacecraft events), ECS (global planning related events) and PI workstations. This database will also contain information about events registered by other observatories, that may be relevant to the SOHO observations. Related into this events catalog will be additional database files which will serve to logically relate the events to the individual SOHO observations, and to store information about what effect a given event had on a given observation, if any.

The third category of database will contain information about scientific data. Several tables will describe science processed, summary and synoptic observations. Access to this data sets will be unrestricted unless otherwise specified in the SOHO Science Working Team data rights agreements. Ancillary, summary, event and synoptic data will be in the public domain immediately after acquisition. The science processed data will be public after an initial period of restricted access.

There will be a way for users to attach comments to the individual entries in each of the database files. The procedure used to control this process is as yet TBD.

3.3 Standard formats

3.3.1 Overview

The specification and use of a standard format or set of formats enables data to be exchanged easily between investigators. SOHO will use the Standard Formatted Data Unit (SFDU) which is becoming more common in data archives. For example, all data in the ISTP CDHF at NASA/GSFC must be SFDU conforming data objects. Documents describing formatting standards may be obtained from:

NASA/OSSA Office of Standards and Technology
Code 933
NASA Goddard Space Flight Center
Greenbelt MD 20771
USA

3.3.2 SFDU

SFDU is an international standard that facilitates the exchange of information between users. The SFDU formalism enables a description of the data to be specified in a standard way and in a way that anyone, possibly years later, can obtain from the appropriate international agency. Such agencies are called Control Authorities, two of which are the NASA/NSSDC and ESA/ESOC. A data description that is registered with such a Control Authority is given a unique identifier that is included with the data as an SFDU label (either as a separate file or included with the data at the beginning of the data).

Thus any user of the data who is unfamiliar with the data can obtain a description by contacting a Control Authority. A FORTRAN procedure is available to generate SFDU labels.

The SOHO Science Operations Working Group has adopted the SFDU formalism for any product that is going to be distributed to the community. For example the summary data will have SFDU labels (detached) as will the orbit and attitude files.

The SFDU is described in the following documents:

- "Draft Recommendation for Space Data System Standards: Standard Formatted Data Units — Control Authority Procedures", CCSDS 630.0-R-0.2, Consultative Committee For Space Data Systems.
- "Draft Recommendation for Space Data System Standards: Standard Formatted Data Units — Structure and Construction Rules", CCSDS 620.0-R1.1, Consultative Committee for Space Data Systems.
- "Report Concerning Space Data System Standards: Space Data Systems Operations with Standard Formatted Data Units — System and Implementation Aspects", CCSDS 610.0-G-5, Consultative Committee for Space Data Systems.
- "Draft Report for Space Data System Standards: Standard Formatted Data Units — A Tutorial", CCSDS 621.0-G-1, Consultative Committee for Space Data Systems. Distillations of these documents have been included in minutes of SOWG or splinter group meetings.

The SFDU does not in itself specify the format of the data. It permits any format, either registered or not to be used. If a non-registered format is used, then the format specification needs to be included with the data. Three data formats that are registered are the Parameter Value Language (PVL), Flexible Image Transport System (FITS), and the Common Data Format (CDF), all of which will be used in SOHO files.

3.3.3 PVL

The SFDU uses PVL to specify required information. It is a generalization of the format in the header of FITS files, and is of the form "Parameter = Value". It is an international standard also and is described in the following documents:

- "Report Concerning Space Data System Standards: Parameter Value Language — A Tutorial", CCSDS 641.0 - G-1, Consultative Committee for Space Data Systems.
- "Recommendation Concerning Space Data System Standards: Parameter Value Language Specification (CCSD0006)", CCSDS 641.0-B-1, Consultative Committee for Space Data Systems.

The catalogs that will be generated by SOHO experimenters will use PVL/FITS concepts. In order to ensure that everyone is using the keywords (parameters) in a consistent way, the keywords and their definitions will be registered with a Control Authority. A draft document of the keywords has been circulated (see Annex 6 in the minutes of the 8^{th} SOWG meeting).

3.3.4 FITS

All scientific data files generated by the PI teams will be in FITS format. In particular, this applies to the summary data, and to level-1 (and higher) data files. An exception are the summary data files of the three particles experiments CELIAS, COSTEP, and ERNE which will be in CDF.

A formal description of the FITS standard can be found in "Implementation of the Flexible Image Transport System (FITS)", available as publication NOST 100-0.3b from the Office of Standards and Technology, or by anonymous ftp from nssdca.gsfc.nasa.gov (128.183.36.23), or via DECnet from NSSDCA::ANON_DIR:[FITS] (15548::).

FITS files facilitate interoperability by using a specified binary standard for encoding data values independent of the computer platform. In other words, FITS files look the same regardless of what computer the file is sitting on, and can be copied from computer to computer without modification. FITS files are also used in a wide range of astronomical applications, and are directly supported in such astronomical software packages as IRAF, and indirectly supported in some broader data analysis packages such as IDL.

Some standardized software for reading and writing FITS files are available in the public domain. The FITSIO package by William Pence is a set of FORTRAN subroutines available by anonymous ftp from tetra.gsfc.nasa.gov (128.183.8.77). There are also IDL routines available for reading and writing FITS files, as part of the IDL Astronomy User's Library. These are available via anonymous ftp from idlastro.gsfc.nasa.gov (128.183.84.71), or by DECnet copy from uit::1DUA5:[IDLUSER] (15384::).

3.3.4.1 Primary FITS files

The simplest form of FITS file consists of a single FITS header and data unit. FITS headers are a series of eighty-character card images of the form keyword=value. The keywords are restricted to a maximum of eight characters, and include a standard set of predefined keywords, some of which are required, and whatever additional keywords the experimenter wishes to define.

The data unit consists of an N-dimensional data array. The size, dimensions, and datatype of the array are described by standard FITS keywords in the header. IEEE standards are used for the binary representation of the data.

The primary FITS header and data unit can be followed by one or more FITS extensions. In that case it is not required that there be a primary data array; the number of elements can be given as zero. There are a number of different kinds of standard extension types, and there is also the possibility of defining new kinds of extensions.

3.3.4.2 ASCII tables

One standard extension type, the "TABLE" extension, allows the experimenter to store an ASCII encoded table. The format of each column in the table is defined individually. This extension could be used to store catalog-type information.

3.3.4.3 Binary tables

Similar to the "TABLE" extension, the "BINTABLE" extension allows the storage of data organized into a table with rows and columns. However, the data are stored with a binary representation (although ASCII fields are allowed), and individual items in the table can be arrays rather than scalar values.

At the moment there is no formal standard for describing the dimensions of an array. This is principally because there is no one "right' way to do this. However, there is a proposal for one way to do this, the "Multidimensional Array Facility", which is given as an Appendix in the NOST FITS document, and uses TDIMn keywords in the header to describe the dimensions. This TDIM approach should meet the needs of any SOHO instrument team that wants to use binary tables to store their data.

Binary tables represent a powerful and efficient way of associating together a number of different data variables in a single FITS file.

3.3.4.4 The IMAGE extension

The “IMAGE” extension has been proposed by the IUE (International Ultraviolet Explorer) team as a standard for storing multiple arrays in a single FITS file. Each IMAGE extension is basically of the same format as the primary FITS header and data unit.

IMAGE extensions are appropriate when the number of data arrays, and hence the number of extensions, to store together in a single FITS file is small. If the number of non-scalar variables is large, or the data structure is complex, then binary tables are more appropriate.

3.3.5 CDF

The GGS/ISTP (Global Geospace Science / International Solar-Terrestrial Physics) project has adopted the NSSDC (National Space Science Center) CDF for use in key parameters and some other data products maintained at the CDHF. The exact role of the CDHF in storing and distributing SOHO summary data still needs to be worked out, but at the very least key parameters from certain SOHO instruments will be incorporated into the CDHF database. Since that database uses CDF, and SOHO uses FITS, some conversion will be necessary.

CDF has some properties in common with FITS, in that it is self-describing, and that it allows the association of information about the data, (units, description of data axes, etc.) together with the data arrays. The underlying physical representation, and the basic data model, are different however.

The NSSDC supplies a set of standard FORTRAN and C libraries for reading and writing CDF files on VMS and Unix computers. These are available via anonymous ftp for VMS from nssdca.gsfc.nasa.gov (128.183.36.23), or by DECnet copy from NSSDCA::ANON_DIR:[CDF.CDF21- DIST] (15548::). Software for various Unix workstations are available using anonymous ftp from ncgl.gsfc.nasa.gov (128.183.10.238).

The CDHF also supplies software to aid in the generation of key parameter software in ISTP/CDF format. This software is available via DECnet from ISTP::SYS$PUBLIC:[SFDU_TOOLS.BLD_SFDU]-(15461::) or by anonymous ftp from either istp1.gsfc.nasa.gov (128.183.92.58) or from istp2.gsfc.nasa.gov (128.183.92.59) in the directory SYS$PUBLIC:[SFDU_TOOLS.BLD_SFDU].

The format used by the ISTP/CDHF is a subset of the complete CDF specification, and further specifies the format to promote uniformity between the different ISTP data sets. This uniformity extends such things as the binary representation of data (e.g. IEEE format for floating point numbers, the same as FITS), and the representation of times.

Both FITS and CDF are supported in IDL.

3.4 Use of SOHO data — data rights

3.4.1 Introduction

The objective of a coherent policy on these aspects should be to ensure the maximum exploitation of the SOHO data in order to extract the best scientific output from the mission. For this purpose, it is necessary to find a just equilibrium between the two conflicting strategies. These are :

a) to open up free access to the widest possible community, thereby making available special capabilities and expertise from outside the SOHO teams, and

b) to protect the interests of the PI teams who have invested so much personal effort, and through rewards for this effort to motivate them to continue to work for the collective scientific interest.

Leadership in applying such a policy rests with the PIs, who have a moral responsibility for maximising the science from the mission, as well as the structure and authority within their teams for applying a well-defined strategy. However, since the joint exploitation of combined data sets is a key objective of SOHO, it is important to have joint PI or SWT agreements on this policy. This section summarizes the policy that the SOHO PIs have agreed to abide by with respect to the utilization of the data generated by their instruments.

3.4.2 Definitions

3.4.2.1 Data access rights

Two types of data access rights can be envisaged:

1. **Data access for planning purposes**

   All SOHO PIs have the right to access all other SOHO data for the purpose of operations planning during the mission. They also have the right to have access to the data to survey them to evaluate their possible use for cooperative research, but *not* to carry out data analysis with a view to publication.

   Access rights defined in the above manner may serve many other useful functions, e.g. to allow potential guest investigators to verify the availability of the required data sets before finalising their proposal.

2. **Data access for analysis and research**

   This is regulated by the data rights policy of the SOHO SWT as described in this document. Specific data rights policies are defined for the SOHO Guest Investigators (GI) (see 3.4.5) and for SWT approved campaigns.

3.4.2.2 SOHO science projects

A proposed project must consist of a clear scientific objective, together with the proposed means for its accomplishment. It might or might not include the need for new observations, the definition of new observing sequences, cooperation between several SOHO instruments or with non-SOHO space or ground-based observations. It can be based upon analysis of synoptic data over long periods, recorded primarily for completely different objectives. It can involve the use of a new analysis or theoretical techniques to analyse existing data. In spite of flexibility in the form, science projects must be closely defined. Otherwise, approval to follow one research aspect could be interpreted to cover a very wide range of activities.

3.4.2.3 Responsibilities

PI individual responsibilities include :

a) To manage, in the broadest sense the attribution of science projects amongst their team scientists and CoI's.

b) To advise on the selection of Guest Investigator (GI) proposals which concern their instrument.

c) To consider how wider access with appropriate controls could help in stimulating outside (GI) participation.

d) To define, and announce publicly a Publication Policy. This should include a policy for initial publications; i.e. a declared number of early papers, formally authored, which can also give rewards for those involved in technical or engineering effort. An on-going publications policy should indicate the approval or vetting procedure (if any), authorship policy, etc.

SWT agreements and responsibilities include:

a) Data access policy, as suggested above.

b) Joint Public Relations activities

c) The establishment and managing of joint science projects.

d) Advice on the selection of GI joint science proposals.

e) To encourage a common strategy for the PI (Individual) policy.

3.4.2.4 Data levels

The SOHO data are distributed to the PIs by two channels.

1. A general line of SOHO data originates at the Data Distribution Facility (DDF):

    - **Level 0 or unprocessed data** are the data distributed by the DDF to the PIs (raw data)
    - **Level 1 or basic data** are corrected for a priori known effects such as flat fields of CCD's and other instrument inherent effects, as well as the Sun-instrument geometry (distance, radial velocity, solar disk coordinates, etc.) and they are evaluated to physical units. Level 1 data are still raw data in the sense that they do not contain corrections for e.g. degradation, which cannot be calculated right away. Level 1 data may be useful for some limited scientific analysis.
    - **Level 2 or processed (or calibrated) data** will be corrected for long term degradation and calibration changes and will contain derived parameters that will be useful for scientific evaluation in general.

2. Another line of data originates at the EOF:

    - The **real time** and the **tape dump play back** data received at the EOF by the PIs are in the same format as the level 0 data described above.
    - Out of it will be produced the **summary data** for the Summary Data File and the
    - **quick look processed** data to be used at the EOF for science operations planning.

3.4.3 SOHO science data access policy

The intent of the SOHO data access policy is to provide data to as wide a community as possible and as soon as possible. From the beginning of the operational mission, the scientific community is welcomed and encouraged to participate in the analysis of the SOHO data in collaboration with the PI teams. The goal is to make fully callibrated data available for public use through ESA and NASA archives one year after reception by the PIs.

In addition to this general policy, the following rules apply:

- For each PI team the data distribution, data rights and publication policy is defined in their Science Book.
- All the PIs have the right to access the data of the other SOHO experimenters for planning purposes in the terms defined in section 3.4.2.1.
- For this purpose, each PI will make the data available according to a mutually agreed schedule.
- The SWT will establish rules to be applied to data obtained during agreed observation campaigns.
- Exchange of data acquired during internally coordinated SOHO observations will be regulated by the cooperating teams themselves.

3.4.4 Archiving

A SOHO data archive is being developed at the EOF at GSFC for operation during the mission and for more than 10 years after nominal operations. This SOHO archive will contain copies of all the data sets referred to in section 3.1. The level 0 science, housekeeping, ancillary, summary and synoptic data will be gathered automatically. The PIs will provide the level 2 data according to an agreed schedule. It is understood that the data archived will have to be updated when improved versions of the processed data are generated. Three European institutions (IAS, Orsay, France; RAL, Chilton, England; Univ. of Torino, Italy) will host a copy of the SOHO archive at GSFC. The European and NASA archives will provide the necessary security and infrastructure facilities to ensure that access is limited according to the criteria agreed upon by the PIs.

3.4.5 Guest Investigators

3.4.5.1 General

A SOHO Guest Investigator Programme has been envisaged from the onset of the SOHO programme. To ensure the maximum exploitation of the SOHO data in order to extract the best scientific output from the mission, and to attract special capabilities and expertise from outside the SOHO teams, selected Guest Investigators (GI's) will have the opportunity to acquire and/or analyze specific data sets, or, for some experiments, to become part of the PI teams.

3.4.5.2 Nature of participation

Two types of GI participation in SOHO PI teams are foreseen, depending upon the nature of the SOHO experiment involved. For the coronal experiments (CDS, EIT, LASCO, SUMER, SWAN, and UVCS), GI participation will be of a traditional nature (like for SMM or Yohkoh): GIs will be attached to an experiment team and within that team have priority rights for the analysis of certain datasets (either newly acquired, or from the archive), or priority rights for a certain type of analysis of datasets otherwise available for study to the whole experiment team. An example of the first is the study of a specific event, for example a CME, and an example of the latter is a statistical study, say a study of the magnitude of redshifts as a function of position on the solar disc.

The data from the helioseismology (GOLF, VIRGO, MDI), and from the particle experiments (CELIAS, COSTEP, ERNE) are of a totally different nature; they do not lend themselves to being split up into 'events', observing sequences, or time intervals, each of which could be studied by different investigators. Hence the mode of participation of GIs attached to these instruments will be different. It is envisaged that, possibly for a limited period of time, approved GIs will be included as members of the PI teams and share the rights and obligations of the team members, according to the team-specific rules. Approval of proposals for these SOHO experiments will depend on whether the proposed work adds to the expertise existing within the SOHO experiment team – an example could be the implementation of a statistically superior method of analyzing time series for a helioseismology instrument.

3.4.5.3 Mechanics of selection

The first cooperative ESA/NASA Announcement of Opportunity (AO) will be issued on 1 Dec 1995, about 1 month after SOHO launch, and prospective GI's are required to react with a letter of intent by 1 Feb 1996. Proposals will be due on 1 May 1996. Proposals received at the due date by the Project Scientist Office (PSO) will be forwarded to the SOHO PI teams proposed for attachment. These PIs will comment on the proposals in writing, and forward their comments to the for consideration in the Guest Investigator Selection Committee (GISC). PIs can object to proposals that

- duplicate their declared major objectives
- demand excessive PI group resources
- interfere with other PI programmes for technical reasons

A Guest Investigator Selection Committee (GISC) will be nominated by ESA and NASA after recommendation by the SOHO SWT, ESA's SSWG, and its NASA equivalent. The GISC will rate the GI proposals according to the evaluation criteria, and rank them in order. Those proposals will be selected that meet an absolute quality standard t.b.d. by the GISC, and rank within the cutoff defined by 30% cumulative observing time for the coronal instruments, or the maximum number of GIs for the particle and helioseismology instruments, set in advance by the PI teams.

The GISC will produce a referee report for each proposal. The referee report, the absolute rating of the proposal according to the criteria, and the notification of selection or rejection, will be forwarded to the GIs approximately 1 Sep 1996. For US proposals, the same will be forwarded to NASA for consideration for funding.

Selected GIs from other countries can forward their proposals and their GISC evaluations to their national, or to international agencies for funding. The 6 month time span between the announcement of the GI selection (1 Sep 1996) and the start of the GI investigations (1 Jan 1997) leaves time for the selected GIs to secure this funding.

3.4.5.4 Implementation

After selection of their proposal, approved GIs will be assigned a point of contact within the relevant SOHO PI team, who will work with the GI until completion of the investigation.

Initial scheduling of the new observations from accepted GI proposals will take place at the last quarterly SWT meeting before the start of the GI investigations (1 Jan 1997). Selected GIs approach their point of contact before this meeting (i.e. at least three months before the start of the GI investigations) to discuss the need for their presence during their observations, and the times of their availability. GIs that are required to assist with obtaining their observations, and that do not show up at the mutually agreed scheduled time, may lose their rights, at the determination of the SWT.

Approved GIs who have requested data from the SOHO archive should contact the Project Scientist at the EOF at least two weeks before the start of their guest investigation. They will be given network access to the approved data only in the SOHO data archive, and to the general SOHO software for visualisation and data analysis. If necessary, data can also be forwarded on tape, or by other media, but network transfer is the preferred means.

In case of accepted Guest Investigations which do not require new SOHO observations, or have to secure additional funding, the starting date of the investigation can be moved forward in consultation with the Project Scientist and the relevant SOHO PI Teams.

Selected GIs for the coronal instruments will have a priority right to carry out the research described in their proposal, and/or the data identified in their proposal, for 12 months after the receipt of the data in usable form, or from access to the archive. After this time the relevant SOHO PI team in consultation with the GI will decide on how to proceed. Approved SOHO GIs will have access to data from other SOHO experiments, in the same manner as SOHO Co-I's for the subject for which they have been selected.

Approved GIs for the helioseismology and particle experiments will become members of the relevant SOHO PI team. They may have to attend PI team scientific meetings, and otherwise will have to comply with the team rules on division of tasks, reporting, and authorship of publications. In general they will be the lead authors on publications of the direct results from the specific new research identified in their proposals.

The guest investigation ends 12 months after access to the data, or, in case of theoretical investigations, 12 months after the formal start of the guest investigation (on 31 Dec 1997). However, this period can be extended in mutual agreement with the SOHO PI team that the GI is attached to. A final report on the guest investigation is due within one month after the end of the investigation period. The final report shall briefly summarize the main results and list all publications resulting, or partially resulting, from the guest investigation, and have copies of these publications attached. After the final report has been submitted, the GI will provide the relevant SOHO PIs and the PS with copies of any further publications resulting from the guest investigation.

It is intended that the AO for the SOHO GI programme will be renewed every year, until several years after the end of the mission, with a similar review cycle each time.

Chapter 4

EOF Functional Requirements

This chapter is intended to provide a framework for the configuration of the SOHO Experiment Operations Facility (EOF). A more complete description of requirements for the NASA-supplied elements of the EOF can be found in the SOHO EOF Core System Functional Requirements Document (ECS FRD; edition of April 1992 and subsequent revisions). Data exchange and command interfaces are described in detail in the ECS-Experimenter Interface Control Document (January 1994 and subsequent revisions).

4.1 EOF/EAF Overview

The requirement for NASA to provide suitable space for the SOHO experimenters is being implemented by two separate facilities at Goddard Space Flight Center - –the Experiment Operations Facility (EOF) and the Experiment Analysis Facility (EAF).

The operations area (EOF) will consist of approximately 3200 square feet of space in Building 3. This space is contiguous to the SoHO Mission Operations Control Center where the Flight Operations Team works. The EOF is composed of a large Common Area with conference table where planning meetings and joint operations can occur, and individual office space for the following groups: Project Scientists, Science Operations Coordinator and ECS hardware, EIT, LASCO, UVCS, SUMER, CDS, and MDI-GOLF.

The EOF is the location for:

- Daily Planning Meetings
- Monitoring telemetry from the instruments
- Real-time commanding (individual or joint)
- Campaign coordination

Because there is insufficient space in the EOF to house all of the personnel for the resident experiment teams, additional space in Building 26 has been provided to SOHO. Modular workspace will be available for resident PI team members and for visiting scientists and engineers. The Building 26 space will be shared with the Solar Data Analysis Center (SDAC) and with other elements of the ISTP program, and it will include a conference area. A high capacity data communications link between the EOF and the EAF is being implemented, but real-time experiment operations will not take place from the EAF.

The EAF is the location for:

- Weekly and Monthly Planning Meetings

- Data analysis and reformatting activities
- Scientific interchange

4.2 Workstation requirements

Three types of workstations are envisioned at the EOF: the workstations of resident, and in some cases nonresident, PI teams (Instrumenter Workstation or IWS), the Project Scientists' workstation, and the Science Operations Coordinator's workstation.

The Science Operations Coordinator's workstation is an EOF-resident workstation for use by SOHO science operations personnel, under the direction of the Science Operations Coordinator. This workstation will be used to receive and display data used in planning (e.g. from ground-based observatories), to resolve conflicts in instrument operations so as to produce weekly science operations schedules, and maintain various databases (such as the key parameters) to be transmitted to DDF and ISTP CDHF.

The Project Scientists' workstation is an EOF-resident workstation specifically for the use of the Project Scientists, but can also be used as a temporary backup to the Science Operations Coordinator's workstation in the event of unavailability. A PI team that has made arrangements with the Project Scientists to implement IWS software on the Project Scientists' workstation will have a similar backup capability in case of IWS failure. Non-resident investigators will coordinate their operational commanding activities via one of the EOF resident workstations, normally the Science Operations Coordinator's workstation. Commands from remote sites are to be submitted in a format ready for verification and validation before they are relayed to the SMOCC. Software to perform such functions on the EOF-resident workstation is to be furnished by each PI team requiring this capability.

All EOF workstations will support agreed upon standard software (Motif or Motif-compatible implementations of the OpenLook toolkit, IDL, SQL) and formats (FITS) to facilitate the exchange of catalog, scientific, engineering, and planning data. The only exceptions can be specific platforms which are not capable of supporting a subset of the agreed standards (e.g. certain PC Unix implementations for which IDL is not available, but which can open Motif windows on other EOF systems with IDL).

Each EOF resident investigation team will provide a sufficient number of dedicated workstations to acquire incoming data, process and/or monitor those data as required, and prepare schedules and command sequences for submission to the SMOCC.

Each EOF workstation will provide its own capabilities for interfacing with the GSFC EOF Local Area Network (LAN), including provisions for any special additional data interfaces.

Each EOF workstation will provide its own capability for storage of instrument data and resident databases, and for data display and hardcopy, unless specifically stated otherwise herein or in the ECS FRD.

Each EOF workstation will provide its own capability to obtain data from a variety of databases, with elements on a common file server as well as on individual teams' workstations. The individual instrument databases should be accessible to other SOHO users at the EOF. Each PI team will develop and maintain a catalog of accessible files for that instrument. This catalog will also be readable through the EOF LAN interface.

Security provisions to ensure that command transmissions from remote sites over public networks do in fact originate with the authorized PI team and have been received intact are to be installed on the remote and EOF resident workstations.

All EOF workstations will be compatible with standard U.S. power (60 Hz, 110 V) and receptacles.

4.3 LAN requirements

The EOF LAN will provide a high speed (e.g. FDDI or copper FDDI) connection between resident systems to allow the exchange of catalogs, scientific data (including large-format images), engineering data, and planning data among the instrument and flight operations teams. All EOF resident workstations will use the EOF LAN to communicate with the Core System and other resident workstations.

The EOF LAN is a collection of Ethernet sub-segments, joined together in a high speed router. The ECS sub-LAN is to be CDDI.

The EOF LAN will provide a secure interface (e.g. a multiprotocol-filtering bridge or router) that will protect the secure elements of the LAN (the IWSs used for commanding, the ECS elements used for connecting those workstation with the SMOCC, and the interface with the SMOCC) from unauthorized access from the public elements of the LAN (i.e., those elements connected to public networks). This interface will nonetheless allow data transfers from public LAN elements to secure IWSs when initiated by the latter, as required for planning, particularly in near real-time.

The EOF LAN will support all protocols required to interface the EOF to GSFC support facilities and remote investigator institutions.

The EOF LAN will be compatible with the LAN used to conduct SOHO spacecraft AIV (Assembly-Integration-Verification) tests at the spacecraft integrations contractor's facility. The EOF LAN will have the capability to receive SOHO real-time telemetry (formats VC0, VC1, VC2). The ECS does not accept VC4 (tape recorder playback) telemetry. Those data come from the GSFC Information Processing Division (IPD) as a quicklook file.

The EOF LAN will have the capability to interface with the SMOCC for instrument command loads, real-time instrument commands, DSN schedules, and command history files.

The EOF LAN will interface with the GSFC Centerwide LAN, through which the EOF resident workstations will be able to access and utilize existing GSFC facilities such as the ISTP CDHF, supercomputing facilities, and mass storage facilities.

The EOF LAN will be capable of network access to the following:

- The online SOHO predictive and definitive orbit and attitude files updated weekly by the FDF.
- The SELDADS computer network for data regarding current solar activity.
- Ground-based observatories' computer systems for the coordination of observing programs.
- PI-specific communications links to remote PI institutions.
- NSI/DECnet (SPAN) and NSI/Internet for communication with remote investigator institutions, other research institutes, and other sources of solar data such as NOAA SELSIS.

4.4 Incoming data requirements

Realtime data captured by Pacor, including normal scientific data, MDI magnetogram data, and spacecraft housekeeping data, will be routed to the EOF with minimum processing delay following receipt at the ground station, and transferred to the Investigator workstations.

Playback data will be captured by the GSFC Pacor data processing facility and routed to the EOF within two hours of their receipt by that facility. These data will include both scientific data packets and spacecraft housekeeping packets, but will not include all of the preprocessing and quality checking operations performed by the DDF in producing Level-0 distribution data products.

The real-time data and playback data will be stored for up to 7 days after their time of origin. A map of received data packets will be maintained to allow IWS to determine whether to initiate downloads of recently arrived data.

Retransmissions will be arranged for playback data lost due to problems with the network, Pacor, or ECS elements; the resulting delay will be determined by the location and severity of the problem, as well as the availability of network bandwidth.

Experiment data files including the Level-0 scientific and housekeeping data packets from both real-time and playback telemetry, definitive orbit and attitude data files, command history files, and summary data of daily key parameters will be available to the EOF as distribution data. The DDF-produced data products will be distributed to each Project-approved Investigator and Institution on a regular basis (frequency to be determined).

POCC page displays will be provided to the EOF via dedicated display systems. In order for PI teams to be able to monitor instrument performance in near real-time, these remote displays will include all POCC housekeeping display pages and a display of the POCC command buffer page. In addition, a message window facility will allow error-free communication of command requests between the EOF and the FOT in the POCC.

Data from other observatories, both ground-based and space-based, will be received by the EOF and subsequently stored for access by the Investigators.

4.5 Commanding requirements

The EOF will establish an interface with the SMOCC that supports both near real-time commanding, the scheduled uplink of commands for the following day, and the "background" uplink of long memory loads sent to the EOF from remote PI institutions. Delayed loading capability will include the ability to specify an earliest and latest time of uplink.

A prioritization scheme will be established for uplinking commands.

In cases of instrument anomalies, the SMOCC will support emergency reloads with best available turnaround.

The PI groups will develop procedures for the verification and validation of their own processor loads.

To produce daily and weekly schedules of observations and other spacecraft activities, the Science Operations Coordinator and his/her staff will resolve scheduling conflicts, with the aid of rule-based software if such proves feasible by the time of the SOHO launch.

During real-time contact with the spacecraft, Investigator teams may issue commands for near real-time initiation of command sequences and/or the reconfiguration of instrument operational modes. Issuance of critical or so-called "spacecraft" commands will have to be coordinated with the FOT. Any IWS used for commanding will be provided with the status of each command group being handled by the ECS and SMOCC.

The ECS will implement special provisions for accepting command requests from remote institutions, verifying and validating the requests, and then relaying the requests to the SMOCC.

4.6 Data storage requirements

Online storage in the EOF will be provided for the real-time and playback housekeeping and science telemetry data for 7 days. Then the data are stored off-line for an additional 21 days, the nominal turnaround time for DDF to produce the Distribution data.

Summary Data will be stored for real-time access for the most recent 28 days. These data will be provided daily by the investigator teams to the SOC, who will assemble and transmit them daily to the CDHF.

4.7 Support requirements

EOF staff will normally support a 10-hour operating day, during both regular and campaign (i.e. 24-hour real-time contact) periods. Normal operations will be synchronized with local daytime at NASA Goddard. Sufficient staff should be available to support 7-day-a-week operations.

Four classes of support staff are required for the operation of the EOF: science operations, SMOCC coordination, computer administration, and EOF administration.

The SOC who is not a member of any instrument team will be responsible for ensuring the success of the scientific operation of the SOHO mission by executing the decisions of the PS, the SWT, and the regular SOT planning meetings chaired by the SOL.

A system administration team will ensure around-the-clock operation of ECS systems, including interfaces with the IWSs, SMOCC, Pacor, DDF, etc.; telecommanding and telemetry capabilities for the PI teams; EOF-wide e-mail facilities; and EOF-wide time service. In addition, the system administration team will ensure the operation of the PS's and SOC's WS; maintain the various databases and catalogs on the ECS file server; manage any other common ECS hardware elements (e.g. shared hardcopy capability); be responsible for maintenance calls on all ECS hardware and software elements, routine backup and recovery, and system configuration documentation.

An administrative assistant to the PS will aid the personnel working at the EOF in clerical support, access to GSFC resources, security (especially for international visitors), travel arrangements, and interfacing with Project, GSFC, and NASA administration.

Sufficient office support facilities are required to support the EOF. This includes a dedicated voice/data line to the SMOCC, data communications links with external networks, telephone and fax support with international direct dialing capability at all times, copying machine, and dedicated conference room with projection equipment.

Appendix A

Institutions involved in data processing and analysis

GOLF

Primary data processing and distribution:	
Institut d'Astrophysique Spatiale Orsay	Alan Gabriel (PI), Patrick Boumier
Initial science analysis:	
Institut d'Astrophysique Spatiale Orsay	Patrick Boumier
Universite de Nice	Gerard Grec
Service d'Astrophysique, CE-Saclay	Sylvaine Turck-Chieze
Instituto de Astrofisica de Canarias, Tenerife	Teo Roca Cortes
University of Southern California, Los Angeles	Roger Ulrich

VIRGO

Primary data processing and distribution:	
IAC, La Laguna, Tenerife	T. Roca Cortes, A. Jimenez, F. Gomez
Science analysis (PI, Co-I's, AS):	
PMOD/WRC, Davos	Claus Fröhlich (PI), J. Romero, C. Wehrli
IRMB, Bruxelles	Dominique Crommelynck
ESA Space Science Department	T. Appourchaux, V. Domingo, T. Toutain
Observatoire de la Cote d'Azur Nice	P. Delache, G. Berthomieu, J. Provost
Norwegian Space Center	Bo Andersen
University of Cambridge, England	Douglas Gough
National Solar Observatory, Tucson	Andrew Jones
Stanford University, CA	Todd Hoeksema
University of Southern California, Los Angeles	Werner Däppen
Jet Propulsion Laboratory	J. Pap, R. Willson

SOI/MDI

Primary data processing and distribution:	
Stanford University	Philip Scherrer (PI)
Co-Investigators – science analysis:	
Lockheed Palo Alto Research Labs	Alan Title
Lockheed Palo Alto Research Labs	Theodore Tarbell
NCAR High Altitude Observatory	Timothy Brown
Aarhus Universitet, Denmark	Joergen Christensen-Dalsgaard
Institute of Astronomy, Cambridge, England	Douglas Gough
Michigan State University	Jeffrey R. Kuhn
National Solar Observatory, Tucson	John Leibacher
California Institute of Technology	Kenneth Libbrecht
Smithsonian Astrophysical Observatory	Robert Noyes
University of Southern California	Edward Rhodes, Jr.
JILA University of Colorado	Juri Toomre
University of California at Los Angeles	Roger Ulrich
University of Colorado	Ellen Zweibel

SUMER

Primary data processing and distribution:	
IAS Orsay	Philippe Lemaire
Science Analysis:	
MPAe Lindau	K. Wilhelm (PI), E. Marsch, U. Schühle
IAS Orsay	P. Lemaire, J.-C. Vial, A. Gabriel
GSFC	S. Jordan, A.I. Poland, R.J. Thomas
HAO Boulder	D. Hassler
Astronomishes Institut Tübingen	M. Grewing
ESA Space Science Department	M. Huber

CDS

Primary data processing and distribution:	
Rutherford Appleton Laboratory	Richard Harrison (PI)
	Jeff Payne (Ground System Eng.)
	David Pike (Software Leader)
Science Analysis:	
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Mullard Space Science Laboratory	Len Culhane
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Appendix B

Data formats and software

	Data formats				Software packages	
	SFDU	FITS	CDF	Others	IDL	Others
GOLF	Yes	Yes	No	-	No	Fortran
VIRGO	Yes	Yes	No	-	Yes	-
MDI	Yes	Yes	Yes	-	Yes	-
SUMER	Yes	Yes	No	-	Yes	-
CDS	Yes	Yes	No	-	Yes	-
EIT	Yes	Yes	No	Yohkoh	Yes	-
UVCS	-	Yes	No	-	Yes	-
LASCO	Yes	Yes	No	-	Yes	-
SWAN	To be defined				Yes	-
CELIAS	Yes	No	Yes	-	Yes	-
CEPAC	Yes	Yes	Yes	ASCII	Yes	-

Appendix C

Inter-Instrument Flags

Flags are used to transfer information from one instrument to another, on the same platform, to enable immediate modifications to be made to operations, in a pre-programmed manner. The exchange of information on board is much faster than the sum of the downlink, manual decision and uplink times, and thus the use of a flag system can allow the efficient observation of a whole class of transient solar phenomena.

The operation of the coronal payload on SOHO will be performed in three layers. Standard operations will involve planning sessions at the EOF with targets and operating sequences fixed one or more days prior to the operation. This is adequate for most solar targets. The second layer involves developments in solar activity that may demand changes in operation overriding previous planning, and this can be done by commanding from the ground during real time passes. For the shortest time-scale transient activity, such as the build-up of a bright point, the onset of a flare or eruption, the EOF real-time interruption is not quick enough. Therefore, the third layer of operation requires the use of an inter-instrument flag.

Multiple Flag Policy

The operation of the SOHO scientific payload is extremely flexible and the likely solar targets are many. This demands the use of multiple flags. Such a system dictates a great need for care in planning, operation and responses to flags as the potential for error is great. We avoid much complexity and potential clashes by enabling only one flag at a time. Thus, at any one time, only one pre-defined instrument may flag an event in response to a specified observation, and this will only have one potential reaction by the receiving instruments. The "flag enabled" instrument will be known as the Master and the receiving instruments known as the Receivers. Not all experiments will want to receive a particular flag. Thus, for each flag-type there will be a differing number of Receivers. The contents of the flag message will include the co-ordinates of the solar event and some identification data. The Master and Receivers are assigned from the ground, an individual experiment cannot define its own role.

On receiving a flag, an instrument in a Receiver status will terminate the current operating sequence and run a new, pre-defined sequence centred on the co-ordinates given. An instrument may choose to ignore the flag if the co-ordinates are inappropriate (e.g., require significant re-pointing).

One issue that must be addressed is the flexibility of the order of the flag receivers. It is useful to have differing orders for different flags since particular flags will be of greater interest to different experiments.

The Inter-Instrument Process

The Inter-Instrument Data Exchange Protocol is described in Section 3 of the SOHO EID A (Page 92, 25 March 1991). The flag data exchange will be controlled in a cyclic manner by a COBS software task running in the On Board Data Handling (OBDH). Two 16 bit words will be sampled every 16 seconds from the Master. The words contain a validity bit which, if set to 0, dictates that the X,Y solar co-ordinates of the solar event be sent by block command to each Receiver. From the acquisition of the flag from the Master, it takes 2 seconds to be relayed to the first Receiver, another 2 seconds to the next and so on.

The OBDH block header 16 bit word is defined as follows. Bits 2-5 are the destination address as defined in the table below. Bits 6-10 are the command identifier where 00100 corresponds to Master/Receiver Selection, and 00110 corresponds to Inter-Instrument Data Exchange. If the command identifier is 00100 the block length, given as bits 11-15, is 00010 since the data field will only contain the mode selection word and the checksum dat word (defined in the EID A). The mode selection word is 0000 0000 0000 0000 for Standy by, 1111 1111 1111 1111 for Master mode, and 1010 1010 1010 1010 for Receiver mode.

Instrument Identification Codes

CDS	0100
EIT	0111
LASCO	1001
SUMER	1011
UVCS	1101
MDI	1010

If the command identifier is 00110 the block length is 00011. This is followed with the two 16 bit words from the Master and the checksum data word from the OBDH. In the first word, bits 1-4 are the instrument ID, bit 5 is set to 0, and bits 6 to 15 are the X co-ordinate of the solar event. For the second word, bits 1-4 are the solar event ID, bit 5 is set to 1, and bits 6-15 are the Y co-ordinate of the solar event. Bit 0 is the validity bit for both words, set to 0 for a valid message and 1 for an invalid message.

The inter-instrument communication process can be in an active or disabled state. In the latter, all instruments are set to the stand-by flag state.

Event Identification

The first problem is the identification of a solar event to be flagged. Such an event would presumably be identified by a change of circumstances, be it a significant rise or fall in brightness at a specific wavelength or a Doppler shift. A Doppler shift can be thought of as a brightening if one is monitoring intensities just off line-centre from a specific spectral line. A further event-type would be transverse motion which would have to be identified through differencing of successive images.

An example of a flag is given below, along with a method of identification, the Master and Receiver instruments and event ID for use in the flag word (see above).

Solar Event: Flare
Event ID: 0001
Master(s): EIT/CDS/SUMER

Receivers: CDS/SUMER/UVCS/LASCO/MDI
Method for Event Recognition: Identify excessive brightenings either in the EIT image or in a hot CDS(NIS)/SUMER spectral line (e.g. Fe XVI 335.40Å, 360.76Åor Si XII 520.67Å) during a large raster scan over an active region. The intensity threshold must be set to a relatively high level.

Other potentially useful flags are, e.g., Bright Point, Microflare, High Velocity Events, Tranverse Velocity Events, Activated Prominence, Eruptive Prominence, Coronal Mass Ejection, and Precursor Activity.

Many flags can only be set through experience. For example, the setting of thresholds must remain flexible since we do not have an accurate feeling for expected intensities for some events. Furthermore, while the crossing of intensity thresholds is clear cut, the idenitication of transverse motions through image comparisons, on board, is not straightforward and may require much development and tuning. As a result, we cannot expect to have a complete, finely tuned system from day one.

Schedule

The mechanism for the flag generation and processing should be set up as the OBDH and instrument CDHS systems are developed. That is, the instruments should adhere to the instructions in the EID-A as described above.

Specific codes should be written into the instrument CDHS for each potential Master and Receiver to generate and respond to flags 0001 and 0010 as described above. These are the simplest flags. Threshold figures should be estimated.

The flag system will not be among the highest priority operations at the start of the mission and will most likely not be used for some weeks after arriving at the L1 point. Initial scientific operations will include the onset of basic synoptic programmes and "look and see" spectral scans and rasters. However, it is recommended that the flag system be brought into operation within a month of the start of scientific operations at the L1 point.

Once the go ahead is given to initiate the flag campaigns, the experience gained will be used to adjust the flag thresholds and to fine tune the responses to the flags. And later, more complex flags will be implemented.

Appendix D

The SOHO Interdisciplinary Science Matrix

The goals of SOHO require comparison and analysis of data-sets from very different experiments. Such interdisciplinary studies require careful planning, prior to the observations, and involve complex analysis procedures. In recognition of this, the SOHO Coronal and Particle Working Group (SCPWG, now merged to the Science Planning Working Group, SPWG) initiated a study to provide an overview of the nature of such activities.

The underlying goal of the ESA Solar Terrestrial Science Programme (STSP) is to develop an understanding of the activity of the Sun and its influence on the Earth. SOHO and the Cluster spacecraft fleet were designed to provide the backbone of such a study. Even with such a co-ordinated effort, it is difficult to correlate solar and space plasma events and structures. Complexites arise because of time delays and the uncertainty of propagation paths, as well as the linking of observations made with fundamentally different instruments, such as spectrometers and particle detectors.

At the SCPWG meeting in the Spring of 1991, attempts were made to bring the scientific discussion to focus on operations. As part of this an overall picture of interdisciplinary operations was developed by constructing a matrix which describes each experiment's activities during certain campaigns.

Studies

Several scientific studies or campaigns which involve inter-experiment operations on SOHO are presented in matrix form. The entries are limited to those schemes suggested by people who responded to the call for input. Most are derived from detailed schemes, with specific operations for each instrument.

Included here are only studies which involve many instruments, and especially those involving instruments belonging to more than one of the experiment groups (see Table 1.1 in Chapter 1). For the present, we are concentrating on the interdisciplinary aspects of the solar atmospheric and space plasma observations and will not consider the operations of the GOLF, VIRGO and MDI experiments.

The studies fall into three categories:

- E = Event driven study. For this, a specific feature may be tracked through different regimes by the experiments, e.g. tracking a mass ejection from the Sun to 1AU.

- C = Campaign.
- R = Regular or periodic observation.

The participation of an instrument in each study is noted by the letters x, w or d. Non-participation is denoted by a '-'. An x entry simply denotes that the experiment is participating. A w entry means that the instrument is waiting for an event, probably operating in a "sit and stare" mode until a flag is triggered. A d denotes some time delay during an event driven study (E) from the onset of the event observation in the first instruments. For example, a flare seen in CDS, which was operating in a w mode, might generate a stream of particles seen in ERNE some 10 min later.

Each study is denoted by a three letter identifier:

FIL = Filament eruption study.
CME = Coronal mass ejection study.
HOL = Coronal hole study.
ION = Ion abundance study.
ELE = Element abundance study.
FIN = Fine scale structure study.
STR = Streamer study.
FLA = Flare study.
COR = Coronal evolution study.
SCT = Sector boundary study.
SHK = Development and propagation of shocks.
BRT = Bright point study.

Most of the studies are of a campaign nature. This will probably be the most productive interdisciplinary approach. These will be relatively easy to operate since they do not attempt to make direct links between observed features, the observations can be easily defined and plans may be made well ahead of the campaign.

The event driven studies involve some of the coronal instruments "waiting" in a pre-event "sit and stare mode". This may be wasteful. Once an event has occurred, we are very dependent on it's path of propagation to receive signals in the high coronal or in situ devices.

Most of the studies require specific ground-based input, and will, most likely require supporting satellite data. Good information exchange and communication between SOHO and ground based and other satellite instrument groups is essential.

One way ahead is for the SPWG to extend the Matrix by filling in the detailed operation for each instrument for each entry in the Matrix. From that point one may input a schematic event, such as a simple mass ejection, to produce dummy data. Methods for comparing the different signatures may be discussed, then, for a known input.

The Flare Study

SOHO is not a flare mission, but discussion of how we would hunt a flare provides one extreme in potential operations. The sequence of events could be as follows:

(i) Some weeks prior to the observation, at the EOF planning meetings, the details of a FLA campaign is discussed. The plan is to observe a flare within a region 30-60 degrees from the western limb, so we may observe low coronal structure with CDS and SUMER, and the high coronal response with LASCO and UVCS. EIT and MDI would be involved. The particle instruments are informed, in case flare generated particles arrive at the spacecraft.

(ii) Having identified a candidate active region crossing the eastern hemisphere, in the preceding week, contacts are made to ground based observatories to ensure good Hα monitoring, vector magnetogram data on the relevant region, and to the receipt of coronameter data. Similarly, approaches are made to relevant spacecraft teams.

(iii) CDS is chosen to be the inter-instrument flag Master. An intensity threshold in a particular hot line is chosen as the flag generation mechanism. Flags will be used by SUMER, to home in on the flare region, and by UVCS and LASCO to change mode to scan the overlying corona. The other instruments will not change mode during the operation.

(iv) At the specified time CDS points to the identified active region. The other instruments may continue other observations or also view the active region or overlying corona.

(v) A flare occurs and a flag is sent. Automatic repointing and mode changing is immediately performed by the other instruments, as specified during the planning, to enhance the observation. There is no time for control by ground contact; this is flag driven. The operation continues for a specified time.

(vi) A team has been appointed to co-ordinate the analysis of the data-set. In practice, this should be individuals from the involved experiment groups and would include someone from each of the other non-SOHO instruments. The SOHO data-sets should be processed and forwarded to the team, as should other space-based and ground-based data. An initial report on the success of the campaign (i.e. the operational aspects such as the performance of the flag, the delay in getting data, the loss of any data due to weather, drop outs etc.) should be reported to the SPWG within a month of the campaign. This provides the experience for improving future campaigns. The analysis of the data-set and the publications should be co-ordinated by the team over the following months.

The Matrix

The columns 2-10 represent the SOHO instruments and column denoted G-B includes comments on ground-based support.

Study	SUM	CDS	EIT	UVC	LAS	SWA	CEL	COS	ERN	G-B
FIL/E	w	w	w	d(30m)	d(30m)	d(1hr)	d(1d)	d(10m)	d(1hr)	1,2,3
CME/E	w	w	w	w	w	d(1hr)	d(1d)	d(10m)	d(1hr)	1,2,3
HOL/R	x	x	x	x	x	x	x	x	x	4
ION/C	x	x	-	-	-	-	x	x	x	-
ELE/C	x	x	-	-	-	-	x	x	x	-
FIN/C	x	x	x	-	-	-	x	x	x	-
STR/R	x	x	x	x	x	x	-	-	-	2
FLA/E	w	w	w	-	-	-	d(1d)	d(10m)	d(1hr)	3
COR/C	-	-	x	x	x	x	-	-	-	2
SCT/C	-	-	x	x	x	-	x	x	x	1
SHK/E	w	w	w	d(m)	d(m)	d(hr)	d(1d)	d(10m)	d(1hr)	5
BRT/C	x	x	x	x	-	-	x	x	x	1,3

The suggested ground-based support is taken from the following list:
1 - Magnetograph (e.g. Marshall Space Flight Cente)
2 - Mauna Loa Solar Observatory (coronagraph and Hα limb monitor)
3 - Hα (e.g. Big Bear Solar Observatory)
4 - He I 10830Å (e.g. Kitt Peak).
5 - Metric radio observations (Type II)

Interface Control Document
Between
the Solar and Heliospheric Observatory (SOHO)
Experimenters Operations Facility (EOF)
Core System (ECS)
and the SOHO Instrumenters

Revision 1

October 1995

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ABSTRACT

locument describes the interface between the International Solar-Terrestrial Physics (ISTP) Solar and Heliospheric vatory (SOHO) Experimenters' Operations Facility (EOF) Core System (ECS) and the SOHO Instrumenters. Section ides an introduction to this document. Section 2 presents an overview of the interface. Section 3 defines the format of ıta exchanged over the interface. Section 4 defines the communications protocols and lower level layers of the ace.

ords: Experimenters' Operations Facility (EOF)
EOF Core System (ECS)
Solar Heliospheric Observatory (SOHO)
Interface Control Document (ICD)

PREFACE

s the first revision of the Interface Control Document (ICD) between the SOHO ECS and the SOHO Instrumenters.

nterface between the ECS and the instrumenters for the commanding functions is widely based on a proposal oped by Dr Van Ballegooijen, following an action item from the November 1991 Science Operations Working Group G) splinter meeting. A preliminary outline of the ICD was presented to the instrumenters during the May 1992 er meeting. A draft version of the document was produced in July 1992 and discussed at the September 1992 SOWG ng. The review copy (April 1993) was presented at the June 1993 SOWG meeting and at the ECS Critical Design w. The final approved version is dated January 1994. Integration testing with the instrument teams and several l system tests have shown that modifications to the ICD were necessary and those are incorporated in the present on of the document. Revision 1 provides a final definition of the data to be exchanged in support of the mission ing functions. It also includes a revised file naming convention (see appendix A) for better compatibility with the) archive.

CD is under the configuration management of the Mission Operations Division (MOD) Configuration Control Board). Proposed changes to this document shall be submitted to the MOD CCB, along with supportive material justifying ange. Changes shall be made by document change notice (DCN) or by complete revision.

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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).

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10. Deleted

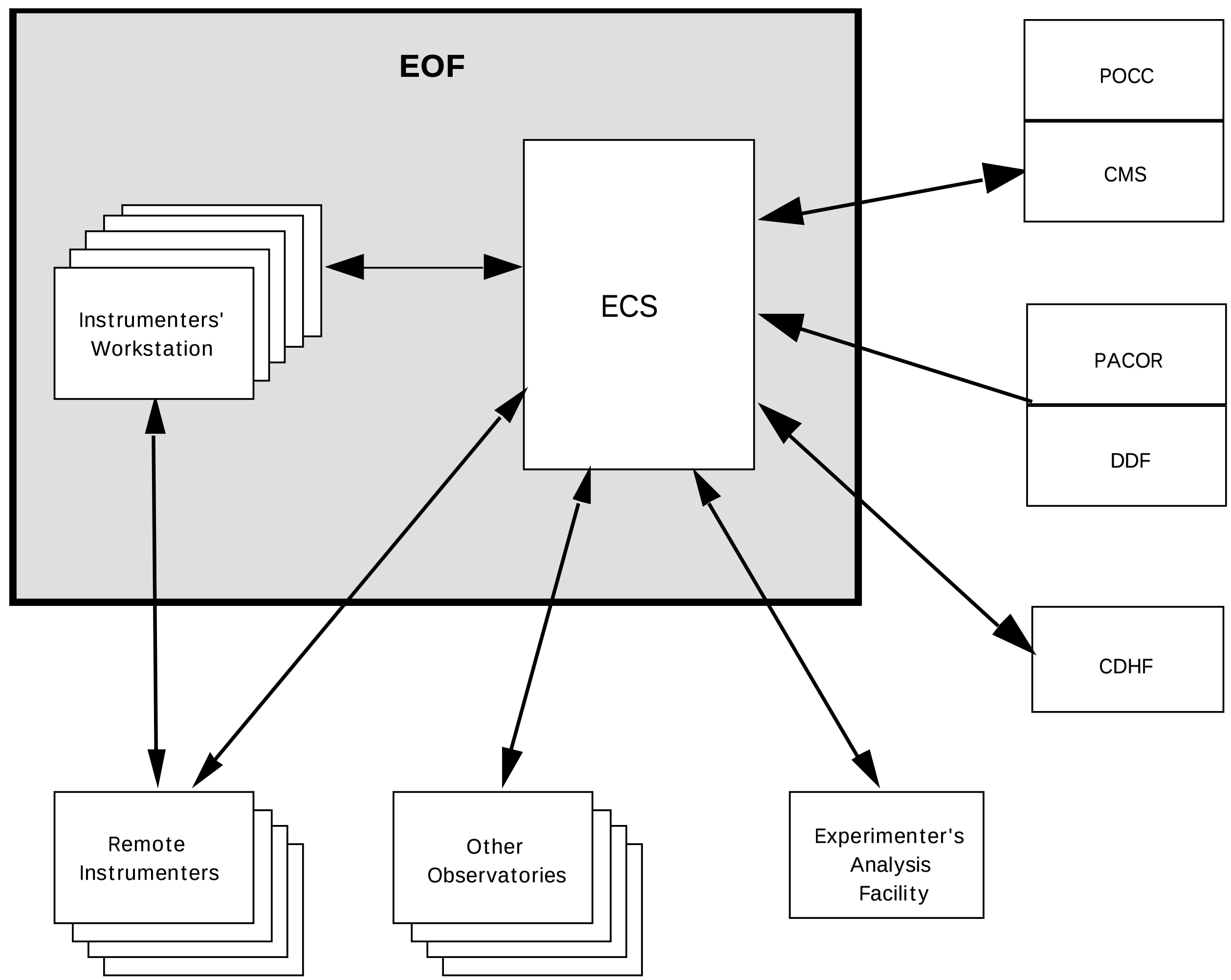

Figure 1.1. ECS/IWSs Context Diagram

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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
TPOCCTransportable Payload Operations Control Center
UDP User Datagram Protocol
UTC Coordinated Universal Time
UVCS Ultraviolet Coronagraph Spectrometer
VC Virtual Channel
VIRGOVariability of Solar Radiance and Gravity Oscillations

SECTION 2. INTERFACE OVERVIEW

2.1 DATA EXCHANGED

The subsections below provide a description of the various data items exchanged over the interface between the ECS and the instrumenters. Several modes of data transfer will be used:

1) Data stream: transfer data in real-time over sockets.
2) File transfer: transfer large and less time-sensitive data using File Transfer Protocol (FTP).
3) Remote graphic displays: graphical interface to interactive ECS processes via X.11.
4) Mail services: address text messages to a specific user to be read later using Simple Mail Transfer Protocol (SMTP).

Table 2.1 provides a list of the main types of data exchanged between the ECS and the instrumenters and, for each type, it identifies the mode of data transfer used.

Table 2.1. Data exchanged over the ECS/instrumenters interface

DATA TRANSFERRED:	DIRECTION	TRANSFER MODE
Session Control messages	Bidirectional ECS / IWSs	Data stream
Near-real-time commanding data	IWSs to ECS	Data stream
Commanding status messages	ECS to IWSs	Data stream
Informational messages	Bidirectional ECS / IWSs	Data stream / Mail services
Commanding and telemetry status windows	ECS to IWSs	X.11 remote graphic display
Delayed commanding data	Instrumenters to ECS	File transfer
Background-queue commanding data	Instrumenters to ECS	File transfer
Delayed command validation reports	ECS to Instrumenters	File transfer
Background-queue cmd validation reports	ECS to Instrumenters	File transfer
Real-time telemetry data	ECS to IWSs	Data stream
Real-time TLM distribution control messages	ECS to IWSs	Data stream
Quicklook / Archived TLM data	ECS to Instrumenters	File transfer
Activity plan	ECS to Instrumenters	File transfer
Instrumenter input to activity plan	Instrumenters to ECS	File transfer
Summary data	ECS to Instrumenters	File transfer
Instrumenters input to the Summary Data	Instrumenters to ECS	File transfer
Orbit and attitude data	ECS to Instrumenters	File transfer
Command history data	ECS to Instrumenters	File transfer
Time correlation log	ECS to Instrumenters	File transfer
SOHO Daily Report	ECS to Instrumenters	File transfer
As-Run Database	Instrumenters to ECS	File transfer
Synoptic data	ECS to Instrumenters	File transfer
Project data base	ECS to Instrumenters	File transfer
Project data base update requests	Instrumenters to ECS	Mail services
Time services	ECS to Instrumenters	Data stream

2.2 COMMANDING PROCESS OVERVIEW

There are two primary commanding modes differentiated by the delay between the time the commands are transmitted by the instrumenters and the time they are uplinked: the near-real-time commanding mode and the delayed commanding mode. In both modes, all instrument commands are routed to the instruments as soon as they are received by the spacecraft, since the instrumenters may not use the spacecraft time-tagged buffer. The actual execution of a command once it is received by an instrument processor is not relevant to this classification.

A third commanding mode is defined to accommodate the case where instrumenters need to utilize spacecraft commands or critical commands: the FOT-coordinated commanding mode. The instrumenters must coordinate the issuance of these commands with the FOT operator who will send the commands requested by the instrumenters. This commanding mode may also be utilized in case of contingency. A particular case of this commanding mode will be used to command the VIRGO instrument.

The commands are submitted either in binary or in mnemonic format by the instrumenters who have the basic responsibility of command validation. The role of the ECS is limited to verifying that the commands originate from an authorized source, and does not include a check against the command definitions in the PDB. This check is done by the CMS. However, commands that will be submitted in the binary format will not be checked against the PDB. In particular, critical commands cannot be flagged. The instrumenters have the choice of disallowing commanding in binary format and they may do so by contacting the SOC. From then on and until the request is revoked by the originating instrumenter, ECS will reject commands in binary format for that instrument.

2.2.1 NEAR-REAL-TIME COMMANDING

The near-real-time commanding data is submitted by the IWS to the ECS as a series of "messages", the functional protocol being, as much as possible, similar to the protocol used with the Central Checkout System (CCS) in the Assembly, Integration and Validation (AIV) environment. Modifications have been necessary to support the operational environment.

2.2.1.1 Throughput Mode

The overall ground system requirement for this mode is that commands generated by an instrumenter in the EOF will be received by the spacecraft within 60 seconds. More specifically, ECS shall make a single near-real-time command available for transmission to the SMOCC within 10 seconds of reception from an IWS. This mode is only available to the instrumenters who are resident in the EOF. Its primary goal is science monitoring and control of experiments as dictated by changes in solar activities. Thus, full processor reloads would normally not be done in this mode, although the uplink of large loads might be negotiated among the experiment teams resident at the EOF.

The throughput mode may be interrupted or ended in three different ways:

1) Pause: In order to allow POCC or FOT activities to take place, the throughput mode is temporarily interrupted. At that time, ECS stops accepting near-real-time commands from the instrumenters but all near-real-time command queues in ECS and in the SMOCC are maintained. When the throughput mode resumes, near-real-time commanding resumes without any data loss.

2) Stop gracefully. This is the normal ending for the throughput mode. SMOCC sends a warning that the throughput mode will be ended shortly. All the near-real-time commanding data in the ECS queues and in the SMOCC queues are processed, uplinked and acknowledged before the throughput mode is ended.

3) Stop immediate. In cases of emergency, SMOCC will terminate the throughput mode without a warning. In this case, all the near-real-time commanding queues in the SMOCC and in the ECS will be flushed.

If an error is detected in a near-real-time command group, both the ECS and SMOCC will reject all near-real-time command groups addressed to the same instrument following the group where the error was found. The originating IWS must submit an Instrument Reset message. Commanding will resume after proper reception by ECS and SMOCC of the Instrument Reset message. All near-real-time command groups for the same instrument between the group in error and the reset message will be discarded by ECS and the CMS. The operation of the throughput mode for the other instruments is not affected by this process.

2.2.1.2 Reserved-time Commanding

This mode allows one or more instrumenter teams to have exclusive use of the throughput mode during a reserved period of time. At least one operational day in advance, an instrumenter requests a reserved time slot, and indicates the command volume expected. The request may be included in the planning process, it is negotiated among the EOF instrument teams, and if accepted, the requested time window is reserved for that instrument. The SOC will manually control the start and end of a reserved-time session. This mode can be used when an instrument requires a larger amount of commands or when the command uplink needs to be timed in a very precise manner.

2.2.2 DELAYED COMMANDING

In this mode, the commanding data will be uplinked to the spacecraft by the FOT within a time window specified by the instrumenter. The delayed commanding mode applies to individual command groups which need to be uplinked during a rather precise time window. It is available to all instrumenters, EOF resident or not.

A command group is submitted in a file, the header of which specifies the desired uplink window. Under normal operational conditions, the file should be submitted to the EOF at least 8 hours be fore the start of the operational day during which the commands will be uplinked. When received by ECS, the command group is submitted to the CMS for validation. CMS will return a command validation report which will be transmitted back to the originating instrumenter. If the group is valid and the requested uplink time does not create any scheduling conflict, it will be uplinked by the FOT during the specified window.

The width of the requested uplink window should be on the order of one hour. This would avoid scheduling conflicts and too frequent interruptions of the throughput mode since the uplink of delayed commands necessitates pausing the throughput mode for near-real-time commands. There also will be times outside of the throughput mode reserved for payload-related activities by the FOT; these time windows will be specified in the ECS activity plan and should be used as much as possible for the uplink of delayed commands. CMS cannot ensure the ordering of individual command groups that would have the same or overlapping uplink windows. In order to avoid sequencing problems, the following is suggested: for a given instrument, all delayed command groups should have non-overlapping uplink windows. As long as the maximum number of commands contained in a single file does not exceed the allowed limit, a single larger group should be used instead of several smaller groups with the same requested uplink window.
ECS is informed of a successful uplink via an informational message generated in the POCC. This informational message is forwarded to the IWS commanding this instrument if a NRT session is open at that time. In order to accommodate remote instrumenters, ECS will also send the same message via E-mail to two addresses agreed upon between the instrument team and the ECS.

2.2.3 BACKGROUND-QUEUE COMMANDING

This mode is primarily intended to deal with large command groups which do not need to be uplinked in a time-critical manner. In particular, this mode will be used for large amounts of commanding data (e.g., large table loads) which could block the commanding link for a long period of time. To avoid this, the instrumenters must package the commanding data into "chunks" no larger than 0.5 Kbytes. Just like for delayed commanding, ECS submits the command groups to the CMS which returns a command validation report that will be transmitted back to the originating instrumenter. If no errors were found, the command groups are put in the SMOCC "background queue". The individual groups are uplinked in the order submitted by the instrumenter, by interleaving them into the real-time command stream as soon as some space becomes available. However, ECS and SMOCC understand that there is no need to uplink the individual chunks in any specific order. Background-queue commands have the lowest priority among all commanding data. The originating instrumenter may optionally specify an uplink window. If not specified, the chunks are uplinked whenever possible without a time limit. If specified, CMS would reject all the chunks that could not be uplinked during the requested uplink window. It is recommended that the width of the requested uplink window be at least on the order of one week.

Note that for both delayed and background-queue commands, once the validation report has been received and until uplink confirmation, there is no electronic method for an instrumenter to determine the status of the submitted file. This information may be requested from the FOT through the SOC.

2.2.4 FOT-COORDINATED COMMANDING MODE

This mode allows the instrumenters to request the execution of spacecraft commands or critical commands. This is implemented using either a Remote Command Request (RCR) or a Remote Procedure Request (RPR). When originating from an IWS, these requests are received by the ECS and forwarded to the FOT via the SMOCC in a format similar to the NRT command messages. These requests identify the originating instrumenter and contain the name of a Predefined Command Sequence (PCS) in the case of an RCR, or the name of a STOL procedure in the case of an RPR. The PCSs and STOL procedures are defined directly between the instrumenters and the FOT. The FOT maintains a list of PCSs and STOL procedures that have been approved and can be invoked in RCRs or RPRs respectively. The throughput mode can be set to either allow RCRs or not. If RCRs are disallowed, ECS will reject them. If RCRs are allowed, ECS forwards them to the CMS / POCC. If an instrumenter's RCR is valid, the PCS will be automatically executed in the POCC and incorporated into the uplink transmission. Critical commands are not allowed via RCRs. If an instrumenters' RPR is valid, the FOT operator will initiate its execution. The throughput mode will have to be paused during the execution of an RPR. ECS will always acknowledge the receipt of an RCR or RPR via a NRT response message. For RPRs, the originating IWS will receive an informational message containing text defined in conjunction with the FOT as part of the procedure itself (last line of the procedure).

This mode of commanding may only be used by EOF-resident instrumenters while the near-real-time throughput mode is enabled. For remote instrumenters, it will require communication with the SOC (E-mail or fax) to request the intervention the FOT operator.

2.2.5 COMMANDING PRIORITY SCHEME

The ECS has a requirement to prioritize the commanding data it receives from the instrumenters. To that effect, different levels of priority are implemented at the instrument level.

Near-Real-Time Commanding
Two priority levels apply:

> **1) High Priority.** This level is intended for emergency situations. It may only be granted by the SOC for near-real-time commands originating from a given instrument or a given set of instruments. It may even be a single-user mode where all commanding activities for all other instruments are stopped.
>
> **2) Normal Priority**. This is the normal level of priority for near-real-time commanding. However, ECS provides several levels within the normal priority (instruments can be prioritized on an individual basis). These levels will be negotiated by the instrument teams during the daily planning meeting, but they can be changed at any time by the SOC. This will allow the instrumenters to control, and modify when needed, the allocation of relative priorities regarding near-real-time commanding.

Delayed and Background-Queue Commanding

All delayed commanding data is assigned a lower priority for transmission to the SMOCC. Within the SMOCC, delayed commands are guaranteed an uplink time. Background-queue commands are assigned the lowest priority level and are only transmitted when the uplink channel is free.

2.3 TELEMETRY DISTRIBUTION

ECS receives, archives and distributes real-time telemetry data (house-keeping, science and MDI-M data) to the resident instrumenters. ECS receives and archives tape recorder playback data.

2.3.1 REAL-TIME TELEMETRY DISTRIBUTION

The real-time telemetry data is comprised of housekeeping and science data (VC0 and VC1), as well as MDI-M data (VC2). ECS receives that data from the Information Processing Division (IPD) Packet Processor (PACOR) as a stream of packets identified by an Application Process Identifier (APID). ECS distributes these packets in real-time to the IWSs.

During a given real-time pass, the IWSs request the APIDs they wish to receive, each APID being requested individually. An IWS may request more than one APID for simultaneous distribution (for example, housekeeping and science from different sources). A given IWS is not limited to telemetry from the instrument it primarily controls, and it may request telemetry from other instruments. The maximum number of APIDs that may be requested simultaneously depends on the system capacity and utilization: if during the pass, the requests for telemetry distribution exceed the system capacity, the instrumenters will have to negotiate and modify the distribution scheme.
The IWSs receive the telemetry packets they requested in individual messages, one packet per message. PACOR provides quality and accounting information associated with each packet. The instrumenters may select to either receive or not receive this information on a session basis. Under normal conditions, ECS will stop distributing the telemetry to a given IWS either following an interrupt-packet-transfer message from that IWS, or at the end of the real-time pass.

2.3.2 ARCHIVED TELEMETRY DATA

The telemetry data archived within ECS consists of all VC0, VC1 and VC2 packets received either as real-time telemetry or as quicklook data, including the tape recorder dumps and retransmissions of real-time telemetry in the case of a transmission loss. The archived telemetry data are sorted by APID and by time: each file contains approximately 2 hours worth of data for a single APID. The tape recorder dump data are available to the instrumenters at ECS within approximately 2 hours of downlink. The telemetry data are kept on-line for 7 days and off-line for 21 days.

The archived telemetry data are organized among several system directories and specific naming conventions are used. That data may be retrieved by the instrumenters via file transfer. To access the data, the instrumenters utilize the telemetry file naming conventions and search the system directory. They may also submit to the SOC a request to receive the telemetry data for a given set of APIDs and ECS will automatically send the requested data via FTP as soon as the files are available.

2.4 MISSION SUPPORT DATA

2.4.1 SUMMARY DATA

These data provide a synopsis of solar conditions and SOHO science programs. They include three classes of data: images from the imaging instruments, parameters from non-imaging instruments, and a list of observation programs which is information extracted from the As-run database. Table 2.2 describes the various components of the summary data.

Table 2.2. SOHO Summary Data.

Instrument	Images	Key Parameters	Observation Program
GOLF		X	X
VIRGO		X	X
MDI	X		X
SUMER	X		X
CDS	X		X
EIT	X		X
UVCS	X		X
LASCO	X		X
SWAN		X	X
CELIAS		X (CDHF)	X
CEPAC		X (CDHF)	X

MDI, EIT, UVCS and LASCO are expected to provide ECS with daily images. SUMER and CDS are also expected to provide images, but possibly not on a daily basis. Key parameters will be calculated for CELIAS and CEPAC by CDHF, and will be kept on-line in that facility. Parameters are expected to be provided to the SOC in the ECS by GOLF, VIRGO, and SWAN. A daily observation program report will be compiled by the SOC based on input from the instrumenters (see As-run database).

The average size of the instrumenter input to the summary data is 20 Mbytes per day. ECS stores these data (images, instrumenter-generated parameters, and observation program report) for on-line access by the instrumenters for 28 days. Input to the summary data is submitted to ECS by the individual instrumenters. Under the control of the SOC, it is merged and stored in the ECS where the instrumenters can access it. Once all the instrumenter input has been received and approved, the SOC transmits the daily summary data to CDHF.

2.4.2 PREDICTIVE AND DEFINITIVE ORBIT DATA

The orbit data describes the translational motion of the spacecraft relative to an inertial reference system. Definitive orbit refers to the measured past translational motion of the spacecraft; predictive orbit refers to the calculated future translational motion of the spacecraft. That data consists of a series of state vectors describing the position and velocity of the spacecraft at 10-minute intervals. The orbital data is generated weekly or biweekly by FDF, sent electronically to CDHF and forwarded to EOF. The definitive data describes the previous week (7 days), and the predicted data refers to the upcoming 5 weeks (42 days). ECS stores 5 weeks of predictive and 28 days of definitive orbit data on-line. With 10-minute intervals between data points, the average daily volume of orbit data is on the order of 1.0 MB.

2.4.3 DEFINITIVE ATTITUDE DATA

Definitive attitude data describes the past rotational motion and pointing stability of the spacecraft relative to an inertial reference system. It contains pitch and yaw offsets from Sun-center, and roll angle offset from the projection of the Sun north pole.

Two attitude products are available in the EOF:

- the "full-time resolution" data contains pitch and yaw values at 10 samples per seconds and roll values at one sample per second.
- the "definitive attitude" data contains pitch, yaw and roll values averaged over 10-minute intervals.

The attitude data is generated by CDHF and forwarded to the EOF. ECS stores 28 days of attitude data.

2.4.4 COMMAND HISTORY

This data is provided by the SMOCC and contains a time-ordered list of POCC activities and all the command groups uplinked to the spacecraft during a given operational day. This is a fixed-format report, where each entry contains a time field and a description of the activity. Instrument commanding activities are keyed by instrument name and command group ID uniquely identifying each command group. CMS will append to that report activities that are specific to the CMS, such as the background queue processing.

2.4.5 SYNOPTIC DATA

This data is comprised of images and science reports obtained from other missions and other observatories. It is presently estimated that ECS would receive approximately 50 Mbytes per day of solar-related data for planning purpose. It is obtained by the SOC, and stored for 7 days within the ECS, for access by the instrumenters.

2.4.6 TIME CORRELATION LOG

This information describes the on-board clock drift rates and resets. This data is created from information received from the SMOCC in the command history report. It will be kept within the ECS in a data set containing the times and description of procedures run in the POCC affecting the spacecraft clock.

2.4.7 PROJECT DATA BASE

The PDB is maintained by the POCC. ECS will obtain the original version of the PDB from the POCC. Later on, when new versions of the PDB are issued, the POCC distributes the entire updated PDB to the interested entities.

The POCC provides the PDB to the ECS via tape or possibly electronically, as a series of ASCII files. ECS will make these files available for the instrumenters to retrieve them via file transfer. These files are in the format provided by the POCC, that is the format defined in the Data Format Control Document (DFCD) which is produced by the POCC (reference 14). ECS does not modify or reformat them. An E-mail message will inform the instrumenters of the reception of a new PDB.

2.4.8 PROJECT DATA BASE UPDATE REQUESTS

When instrumenters need to request an update to the existing PDB (for example modification of command or telemetry parameter definitions), they must send an E-mail message to the FOT operator describing the desired change. FOT will approve or reject this request. If accepted, it will be incorporated into the operational data base which is the POCC working copy of the PDB. Recreating an operational data base is usually a cumbersome process and is done infrequently. Changes to the PDB require approval by the Configuration Control Board and there may be a rather long delay between the time a PDB update is requested by an instrumenter and the time it is actually implemented.

2.4.9 SOHO DAILY REPORT

FOT sends this report to ECS via E-mail, typically within 24 hours of the operational day being reported. It gives a high level status of the spacecraft and each instrument (ON / OFF) for that day. The report provides descriptions and times of anomalies or contingencies in the spacecraft or any instrument. The SOHO Daily Report contains the times of any unrecoverable data gaps. It will be stored in one file per operational day, each file being uniquely named for that calendar day. It will remain available on-line in the EOF for the most recent 30 days. It is also transmitted electronically to CDHF where it is stored on-line for 30 days for access by remote instrumenters and other interested researchers. The SOHO Daily Report will be included by DDF in the distribution data on hard media.

2.4.10 TIME SERVICES

The ECS will obtain the Universal Time using the Network Time Protocol (NTP). The ECS system clocks will be synchronized to that time to allow for uniform time tagging. Using the appropriate utilities on their own systems, the instrumenters will be able to access that time service and synchronize their own system clocks.

2.4.11 DISPLAYS

Two main types of displays are made available to the instrumenters:

1) Commanding Status and Telemetry Distribution Monitoring displays. These displays are primarily designed and implemented to support the SOC with ECS monitoring functions. They are made available to the EOF-resident instrument teams that have X.11 capabilities. ECS will make available to the instrumenters ANSI C code to support these displays on their workstations. The format and general content of these displays are provided in Appendix B.

2) POCC Telemetry Displays. Two POCC terminals will be located in the EOF. POCC telemetry pages will be displayed on these terminals for viewing by the instrumenters within the EOF.

2.5 PLANNING PROCESS OVERVIEW

The planning process enables the instrumenters to incorporate their science activities with pre-existing constraints such as DSN contacts or commanding time slots reserved by the FOT for special spacecraft activities. Planning can be done on a quarterly, monthly, weekly or daily basis. The long term planning is mainly based on science programs, whereas the shorter term planning is more detailed and incorporates DSN schedules and FOT planned activities.

In order to initially set-up the planning process, a set of activities needs to be defined. The definition of activities also includes specifying associated priorities and scheduling strategies. For the shorter term planning (monthly or less), the instrumenters are expected to submit their activity requests to ECS who merges them. ECS identifies and resolves conflicts when possible. If conflicts remain, the instrumenters are notified, and they should modify and resubmit their requests. This process is repeated until all conflicts are solved. The final conflict-free plan is referred to as the schedule.

2.5.1 ECS ACTIVITY PLAN

The ECS Activity Plan (EAP) consists of a list of activity requests or notifications. The following is provided to the instrumenters as part of the activity plan:

1) DSN Contacts. This provides DSN contact start and end times, and the associated ground station. This information is incorporated into the activity plan as soon as the ECS receives it from the SMOCC. Each transmission covers one week of confirmed schedule and up to 3 weeks of forecast and FDF predicts schedule. Long-term predictions may be incorporated if and when available. This information is transmitted by the SMOCC every week on a fixed day, 3 days before the start of the confirmed week.

2) FOT-controlled Events. This indicates the start and end times of events and activities controlled by the FOT. For instance, it includes time windows for planned near-real-time commanding and time windows reserved by the FOT for special activities such as spacecraft commanding, maneuvers and instrument maintenance. It also provides start and end times for events such as tape recorder dumps, MDI-M transmission to the EOF and planned telemetry modes.

3) Reserved Times for Activities Coordinated with Other Observatories. This indicates the start and stop times of science programs and special campaign activities.

2.5.2 INSTRUMENTERS INPUT TO THE ACTIVITY PLAN

The Instrumenters Input to the Activity Plan (IAP) consists of a list of statements, each statement defining a specific activity request or notification. These statements may be classified as follows.

1) Science Plan and Program Notifications. The Science Plan entries describe the planned science plans, their goals and objectives. They specify the first level of science planning information, i.e. the overall plan as developed during the monthly or weekly science planning meetings and refined during the daily meetings. The Science Program entries describe the specific programs that each instrument team would run to satisfy the scientific objectives of the corresponding Science Plan: for each Plan entry, there will be a sequence of Program entries that represent the details of the Science Plan.

2) Notification for Special Activities. This is used to indicate when an instrument will perform an activity that may affect the operation of other instruments. This will include requests for near-real-time commanding for a specified period of time, requests for a reserved time slot for near-real-time commanding for a given instrument, or uplink window for a group of delayed commands. It may also include notifications of planned execution of STOL procedures and maneuvers that may cause vibrations and affect the overall pointing stability of the spacecraft.

3) Instrument Mode Change Notifications. Examples of possible requests are:

- Change in telemetry sub-modes
- Change in the inter-instrument flag configuration
- Change in instrument mode of operation (specific to each instrument).

Specific requests may be defined by the instrument teams for activities which are of interest to or affect the operation of other instruments.

2.5.3 AS-RUN DATABASE

This information is provided by the instrumenters to the ECS. It describes the science programs that were actually executed on the previous day. It is electronically transferred to the ECS as ASCII files and the SOC is responsible for incorporating it into the Summary Data that will be sent to the CDHF for later distribution to the instrument teams. The design and implementation of the As-run database are not the responsibility of the ECS development task and further details on the nature and format of that data are not included in this ICD.

SECTION 3 - DATA FORMAT SPECIFICATION

3.1 GENERAL DATA FORMAT SPECIFICATION

3.1.1 ECS MESSAGES

This section describes various messages exchanged between the ECS and the instrumenters as data streams over sockets.

3.1.1.1 General Format of an ECS Message.

A message exchanged over the ECS/IWS interface consists of a 4-byte standard header followed by a data field of variable length as illustrated in Table 3.1.

Table 3.1. General ECS Message Format.

Field	Bytes	Description
Type/Message ID	2	Standard Header
Length	2	
User data dependent on the message type.	variable	Data field

The standard header is comprised of a 2-byte "type field" followed by a 2-byte length field.

(1) The 2-byte type field is defined as:
first byte is
X'01' for messages to control a communication session
X'02' for messages related to telemetry distribution
X'03' for messages related to telecommanding
X'04' for informational messages
second byte identifies the messages within these 4 categories.

(2) The 2-byte length field contains the length in bytes of the message that follows, excluding the 4-byte standard header.

The data field is specific to each type of message and is of variable length.

3.1.1.2 ECS Messages Description.

As much as possible, the ECS/instrumenters functional protocol was kept similar to the protocol implemented between CCS and the Experiment Ground Support Equipment (EGSE) in the AIV environment. Modifications were necessary to apply the AIV protocol to the operational environment, mainly to support the commanding functions. Also, a bi-directional Informational message has been added. Table 3.2. defines the messages used within the EOF.

Table 3.2. ECS Messages.

Message Name	Direction	Standard Header		Data Field	
		Type	Length	Bytes	Description
Session Init	ECS to IWS	X'0101'	X'0004'	Int 4	Endian check block data
Session Init Response	IWS to ECS	X'0102'	X'0015'	ASCII 16 Int 1 Int 4	ORIG_ID Endian check result Endian check block data
Session End	ECS to IWS	X'0103'	X'0001'	Int 1	Reason code
NRT Command	IWS to ECS	X'0301'	var	Int 2 ASCII 6 ASCII var	Request ID Instrument name Command data
Response to NRT Command	ECS to IWS	X'0302'	var	Int 2 ASCII 6 Int 2 Int 2 ASCII var	Request ID Instrument name Response code Reason code Response to command (text)
NRT Command Authority Request	IWS to ECS	X'0303'	X'000A'	Int 2 ASCII 6 Int 2	Request ID Instrument name Request code
NRT Authority Status	ECS to IWS	X'0304'	var	Int 2 ASCII 6 Int 2 ASCII var	Request ID Instrument name Status code Status description (text)
Remote Command Request	IWS to ECS	X'0305'	var	Int 2 ASCII 6 ASCII 20 ASCII var	Request ID Instrument name PCS name Instructions/Comments
Remote Procedure Request	IWS to ECS	X'0306'	var	Int 2 ASCII 6 ASCII 20 ASCII var	Request ID Instrument name STOL Procedure name Instructions/Comments
TM Packet Distribution Request	IWS to ECS	X'0201'	var: X'0005' or X'0006'	Int 1 Int 2 Int 2 Int 1	Spacecraft ID APID Request ID Optional: Q&A capsule Flag
TM Packet Distribution Response	ECS to IWS	X'0202'	X'0004'	Int 2 Int 1 Int 1	Request ID corresponding to Request Response Code Reason Code
Start of TM Packet Distribution	ECS to IWS	X'0203'	X'0005'	Int 1 Int 2 Int 2	Spacecraft ID APID Request ID
Telemetry Packet	ECS to IWS	X'0204'	var	Int 2 Binary 6 bytes	Request ID TM source packet Q&A capsule
Interrupt TM packet transfer	IWS to ECS	X'0205'	X'0002'	Int 2	Request ID
End of TM Packet Transfer	ECS to IWS	X'0206'	X'0003'	Int 2 Int 1	Request ID Status code
Informational Message	ECS to IWS IWS to ECS	X'0400'	var	ASCII var	Free form text

3.1.2 ECS FILES

Files exchanged between the ECS and the instrumenters have a standard transfer format consisting of a file header followed by a file body. The file header uses keywords to provide information about the file and is in the general format "KEYWORD = value". Each Keyword is followed by '=' and each record is ended by a New Line (X'0A'). The file body contains ASCII character data that is specific to each type of data contained in the file. See Appendix B for examples of file formats.

3.1.2.1 System Directory Organization for Files

The ECS files are organized among various system directories, one directory being provided for each type of file, and sub-directories being provided as needed in each case. The ECS main system directories for the data exchanged with the instrumenters are listed and described in Appendix B.

3.1.2.2 File Naming Conventions

Each file is referenced by a unique name representative of the type of data it contains. Several file naming schemes are necessary in the EOF to better describe the data contained within each file or to satisfy already existing naming conventions with other ECS external interfaces. The specific conventions are described in Appendix A.

3.1.2.3 File Header Format

All file headers described in this document have the same general format: a series of records of ASCII characters, each record being of the form "KEYWORD = value", the last character being a New Line (NL).

3.1.3 TIME FIELD FORMAT

All time fields, unless specified otherwise in individual cases, will contain both the date and time in a single 19 character format as follows:

YYYY/MM/DD HH:MM:SS
where:
YYYY/MM/DD is the date:
YYYY represents the year (for example 1995)
MM represents the month (01 for January to 12 for December)
DD represents the day of the month (01 to 31)
HH:MM:SS is the time:
HH represents the hours (00 to 23)
MM represents the minutes (00 to 59)
SS represents the seconds (00 to 59)
The date and time fields are separated by an ASCII blank.

Except where specifically mentioned otherwise, all times mentioned in this document are in reference to GMT.

3.1.4 INSTRUMENT NAME FIELD FORMAT

Unless specified otherwise, all fields specifying the Instrument name are 6 ASCII characters in length, and must be one of the following, left-justified and padded with ASCII blanks if necessary:

CDS
CELIAS
CEPAC
EIT
GOLF
LASCO
MDI
SUMER
SWAN
UVCS
VIRGO

3.2 COMMANDING DATA SPECIFICATION

3.2.1 OBDH BLOCK COMMAND

The routing and formatting of the command data from the instrumenters to the spacecraft is illustrated in figure 3.1. The basic unit of command input provided by an instrumenter is an OBDH block command as illustrated in figure 3.2. Each OBDH block command consists of a series of 16-bit words of data as follows:

- one word representing the block header
- up to 30 words of data
- one word containing the checksum of the preceding words (header and data).

The block header is 16 bits long and of the form:

XXYYYYZZZZZLLLLL

where:

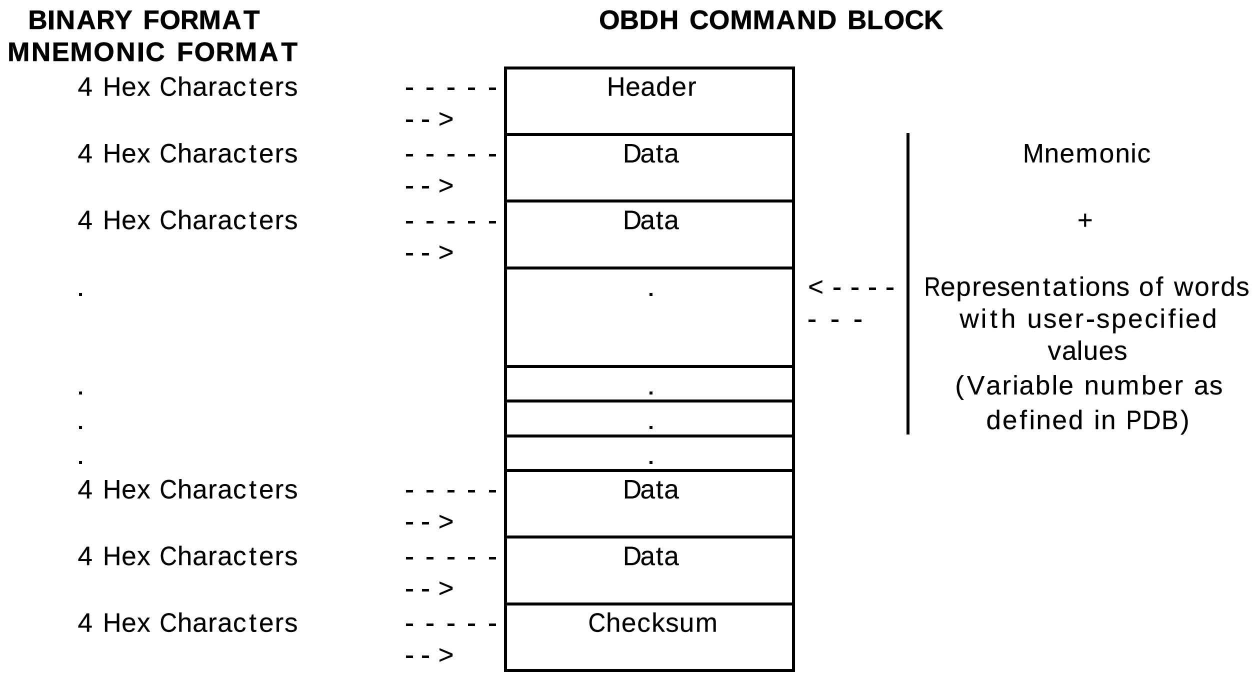
XX	bits 0 and 1	Reserved
YYYY	bits 2 through 5	Destination address 0100 for CDS 0101 for CELIAS 0110 for CEPAC 0111 for EIT 1000 for GOLF 1001 for LASCO 1010 for MDI 1011 for SUMER 1100 for SWAN 1101 for UVCS 1110 for VIRGO
ZZZZZ	bits 6 through 10	Command identifier
LLLLL	bits 11 through 15	Block length (1 to 31): number of 16-bit words in the block, excluding the checksum.

3.2.2 INSTRUMENT COMMAND INPUT

The method and format for submitting instrument commands described in this section are based on the following understanding:

Figure 3.1. SOHO Command Formatting.

REPRESENTATION OF AN OBDH BLOCK COMMAND



Mnemonic representation:

```
MNEMO1,0x77AF;     /* one parameter in hexadecimal */
MNEMO1,123;        /* one parameter in decimal */
MNEMO1,0777;       /* one parameter in octal */
```

Binary representation:

```
BINARY 0x1203,0x2401,0x77AF,0xADB3;   /* Only hexadecimal allowed */
```

Figure 3.2. Instrumenters Command Specification.

- The instrumenters can only use OBDH block commands when commanding their instruments through the ECS. However this does not apply to VIRGO.

- A mnemonic for an instrument command uniquely defines a single OBDH block command.

- For each such mnemonic, the PDB provides the binary equivalent of the OBDH block command header (including destination address, command identifier and number of data words associated with this command).

- For each mnemonic, the PDB also provides the binary equivalent of each 16-bit data word in the OBDH block command. Some data words may contain variable bits that the user must specify. These parameters specifications can be done using ASCII characters representing their decimal, octal or hexadecimal value.

The content of an OBDH block command may be represented in one of two general formats: binary format and mnemonic format as described in the following sections. Note that a procedural language such as STOL or ELISA is not used in the EOF.

3.2.2.1 Binary Format

In the binary format, the commanding data consist of a series of ASCII hexadecimal representations of all the 16-bit binary words contained in one OBDH block command including header and checksum:

1) The keyword "BINARY" indicates the start of an OBDH block command. It must be in upper case.

2) The content of an OBDH block command is represented as a series of up to 32 4-character hexadecimal words:
   - The first hexadecimal word represents the 16-bit OBDH block header.
   - The following words represent up to 30 16-bit data words.
   - The last word represents the 16-bit checksum of the header and data words.

3) Hexadecimal words are separated by a comma.

4) The end of the OBDH block command is indicated by a semicolon.

5) Comments in the form "/* text */" are allowed after the semicolon.

Example: BINARY 0x1203,0x2401,0x77AF,0xADB3; /* optional comment */

3.2.2.2 Mnemonic Format

Each mnemonic specification defines a single OBDH block command. It consists of a mnemonic optionally followed by ASCII representations of the data words which have been defined as user-specified in the PDB.

1) The mnemonic is followed by up to 30 user-specified parameters. The mnemonic must be defined in the telecommand description files of the PDB and the number of user-specified parameters must correspond to the number of user-defined values defined in the PDB. All command mnemonics must be specified in upper-case characters to conform to the PDB definition.

The user-specified 16-bit words are defined using ASCII character representations:

hexadecimal:	0xhhhh	'0x' followed by hexadecimal digits
octal:	0oooooo	'0' followed by octal digits without leading zeros
decimal:	ddddd	decimal digits without leading zeros

2) The representation of data words are separated by a comma.

3) The end of the command specification (mnemonic and optional data words) is indicated by a semicolon.

4) Comments in the form "/* text */" are allowed after the semicolon.

Examples:

```
CBEFILI,0x77AF;     /* in this command, only one word has user-defined values */
CBEFILI,073657;     /* same command using octal representation */
CBEFILI,30639;      /* same command using decimal representation */
```

Note: The checksum is not provided by the instrumenters in the case of the mnemonic format. It will be calculated by the CMS.

3.2.3. NEAR-REAL-TIME COMMANDING DATA SPECIFICATION _

The general format of the messages exchanged over the interface is defined in section 3.1.1. These messages all contain a 4-byte standard header followed by a data field. This section defines the specific functions and the content of the data field for the messages exchanged for near-real-time commanding.

3.2.3.1 <u>Session-Init</u> (ECS to IWS). This message is used to initiate a communication session between the ECS and a given IWS.

Data field content:

Integer*4	Endian check block data X'01020304' used to insure that the data transmitted by the ECS will correctly be interpreted by the IWS. The ECS uses the big endian format.

3.2.3.2 <u>Session-Init-Response</u> (IWS to ECS). This message is used to acknowledge a Session-Init message and to identify the entity with which the session is established.

Data field content:

Character*16	IWS Identification padded with ASCII blanks.
Integer*1	Endian check result indicating whether the endian check block included in the session-init message was correctly interpreted by the IWS: X'00': successful X'01': unsuccessful If the check is not successful, ECS will consequently terminate the session.
Integer*4	Endian check block data X'01020304' used to insure that the data transmitted by the IWS is compatible with the endian characteristics of ECS.

3.2.3.3 <u>Session-End</u> (ECS and IWS). This message is used to terminate a session, either immediately after the reception of a Session-Init-Response if a problem was found or to end an on-going session.

Data field content:

Integer*1	Reason Code X'00': normal end X'01': invalid ORIG_ID (IWS identification in Session-Init-Response) X'02': endian check error X'03': unsuccessful session-init-response or no Session-Init-Response received X'04': error reading/writing to socket

X'05': invalid IWS message received
X'06': lost connection to CMS

3.2.3.4 NRT-Command (IWS to ECS). This message is used to transfer the near-real-time command data. The message data field for a near-real-time command message is illustrated in Table 3.3.

Data field content:

Integer*2	Request ID generated by the IWS to uniquely identify this command message. ECS and SMOCC use the combination "instrument/request ID" to uniquely identify all NRT-Command messages and NRT-Command-Authority-Request messages. ECS uses the value X'FFFF' for special purposes (see section 3.2.3.7)
Character*6	Instrument name
Character var	The command data as defined in section 3.2.2. Each message will contain one and only one OBDH block command definition, that is one mnemonic definition or one "BINARY" keyword.

Table 3.3. Near-Real-Time Command Message Format

Field	Bytes	Description
Standard Header	4	Type (X'0301') and length
Request ID	2	2-Byte integer uniquely identifying this message
Instrument Name	6	Instrument commanded
Command data	var	Command data in mnemonic or binary format. See Section 3.2.2

3.2.3.5 Response-to-NRT-Command (ECS to IWS). This message is used to answer a NRT-Command message. There is one response for each NRT-Command message to indicate its processing status. If an error is detected either by the ECS, the CMS or the POCC, the Response-to-NRT-Command is sent immediately back to the IWS currently commanding the instrument, with a description of the error. Otherwise, an OK status will be sent once the successful uplink status is received from the POCC. This may represent a few seconds delay between the reception of the NRT-command and the response.

Data field content:

Integer*2	Request ID identical to the request ID in the corresponding NRT message.
Character*6	Instrument name
Integer*2	Response Code 00 NRT command message OK 01 NRT command message was rejected
Integer*2	Reason Code (see table 3.4)
Character var	Text explaining reason code (see table 3.4). Also indicates if the instrument error flag has been set, resulting in the need for an instrument reset (described in section 3.2.3.6).

Table 3.4. Response-to-NRT-Command Format Definition

Response Code	Reason Code	Reason Text
01	1	Rejected- throughput mode is disabled (ERROR FLAG SET)
01	2	Rejected - syntax error found in this command group (ERROR FLAG SET)
01	3	Rejected - mnemonic not found in PDB (ERROR FLAG SET)

01	4	Rejected - format error found in message received (ERROR FLAG SET)
01	5	Rejected - duplicate request ID for this instrument (ERROR FLAG SET)
01	6	Rejected - binary format disallowed for this instrument (ERROR FLAG SET)
01	7	Rejected- reserved time commanding in progress
01	8	Rejected - message received had invalid message type
01	9	Rejected - invalid instrument for this socket (ERROR FLAG SET)
01	10	Rejected- start command request not received for instrument
01	11	Rejected- instrument disabled by FOT or previous error
01	12	Uplink failed BARM verification (ERROR FLAG SET)
01	13	Uplink failed - NASCOM link is down (ERROR FLAG SET)
01	14	RCR rejected - RCR processing disabled (ERROR FLAG SET)
01	15	RCR rejected - was not on the approved list (ERROR FLAG SET)
01	16	RPR rejected - STOL procedure not found (ERROR FLAG SET)
01	17	Rejected - invalid first character in name (ERROR FLAG SET)
01	18	RCR terminated - contained invalid command (ERROR FLAG SET)
01	19	RCR terminated - contained critical command (ERROR FLAG SET)
01	20	RCR rejected - not found (ERROR FLAG SET)
00	0	OK - command group successfully uplinked
00	- 1	OK - command group uplinked without BARM verification
00	- 2	RPR notify - FOT has been notified to start the requested RPR

The Response-to-NRT-Command is also used to notify an instrumenter of the processing status of RCRs and RPRs. This message may indicate one of the following:

- the request was rejected
- the FOT has been notified to start the requested procedure
- the uplink status of the requested PCS

For RPR's, the final status is not systematically made available by the POCC and will not be sent to the instrumenters via this message. An informational message defined between the instrumenters and the FOT may be incorporated into the procedure itself.

Data field content for RPR's and RCR's:

Integer*2	Request ID as provided by instrumenter in the RPR or RCR message.
Character*6	Instrument name
Integer*2	Response Code 00 RPR/RCR message OK 01 RPR/RCR message was rejected
Integer*2	Reason Code (see table 3.4)
Character var	Text explaining reason code (see table 3.4). Also indicates if the instrument error flag has been set, resulting in the need for an instrument reset (described in section 3.2.3.6).

3.2.3.6 <u>NRT-Command-Authority-Request</u> (IWS to ECS). This message identifies the commanding functions to be performed by a given IWS. It allows the ECS to verify that only one IWS is commanding a given instrument at a given time. This message can be used to start commanding, to stop commanding, or to reset commanding after an error for an instrument.

Data field content:

Integer*2	Request ID generated by the IWS to uniquely identify this message.
Character*6	Instrument name. ECS and SMOCC use the combination "instrument/request ID" to uniquely identify all NRT-Command messages and NRT-Command-Authority-Request messages. ECS uses the value X'FFFF' for special purposes (see NRT-Authority-Status messages, section 3.2.3.7).

Integer*2 Request code (see table 3.5)

Table 3.5. NRT-Command Authority Request Format Definition

Request Code	Description Text
00	Start commanding the instrument specified
01	Stop commanding the instrument specified
02	Reset after error: commanding for this instrument to restart with the near-real-time command message immediately following.

3.2.3.7 <u>NRT-Authority-Status</u> (ECS to IWS). This message is used to respond to a NRT-Command-Authority-Request, or to notify an IWS of changes affecting the commanding session. The possible values for the status code transmitted via this message are defined in table 3.6.

Data field content:

Integer*2	Request ID corresponding to ID in NRT-Command-Authority-Request, when applicable. ECS will use a fixed value of X'FFFF' for status codes 3, 5, 6, 7, 8, 9, 10, and 11.
Character*6	Instrument name
Integer*2	Status code (see table 3.6)
Character var	Text explaining status code (see table 3.6)

Table 3.6. NRT-Authority-Status Format Definition

Status Code	Description Text
- 1	Command Authority Request denied - duplicate request ID (ERROR FLAG SET)
- 2	Start commanding request denied - instrument already commanded
- 3	Command Authority Request denied - instrument specified incorrect (ERROR FLAG SET)
- 4	Start commanding request denied - session not properly established (incorrect Session-Init response)

Table 3.6. NRT-Authority-Status Format Definition (Cont.)

- 5	Command Authority Request denied - IWS not currently commanding instrument specified
- 6	Reset denied - instrument not in error
1	Start commanding request granted
2	Stop commanding request granted
3	Received SOC request to cancel this session (1)
4	Reset accepted
5	Throughput mode status = enabled / RCRs allowed (1) (2)
6	Throughput mode status = enabled / RCRs disallowed (1) (2)
7	Throughput mode status = disabled (1) (2)
8	Throughput mode status = paused (1) (2)
9	Warning: Throughput mode shutdown soon (1) (2)
10	Reserved time commanding has ended (1) (2)
11	Warning: reserved time commanding will begin soon (1) (2)
12	Reserved time commanding now in effect for this session (1)
13	Reserved time commanding no longer in effect for this session (1)

(1) Request ID is not applicable and will have a fixed value of X'FFFF'
(2) Message sent to all IWSs with open commanding sessions

3.2.3.8 <u>Remote Command Request and Remote Procedure Request</u> (IWS to ECS).

For RCRs, the message data field identifies the name of a Predefined Command Sequence (PCS); For RPRs, the message data field identifies the name of a STOL procedure.

Data field content:

Integer*2	Request ID generated by the IWS to uniquely identify this message.
Character*6	Instrument name
Character*20	The name of the predefined command sequence or the STOL procedure, in lower case characters, left-justified and padded with ASCII blanks if necessary. The first character of the name must be as follows: c for CDS f for CELIAS h for CEPAC e for EIT g for GOLF l for LASCO m for MDI s for SUMER n for SWAN u for UVCS v for VIRGO
Character var	Comments and execution instructions in the form /* text */, maximum of 256 characters, are allowed for RPRs.

3.2.3.9 <u>Informational Message</u> (Bi-directional).

This message is supplied for the exchange of free text between the ECS and the IWSs. For instance, it will be used by ECS to provide execution status for RPRs. The SMOCC passes an informational message to ECS that contains a text defined between the instrumenters and the FOT as part of the definition of the STOL procedures. ECS will forward that message to the IWS currently commanding the instrument.

Data field content:

Character var   ASCII Free text (maximum of 256 characters)

3.2.4 DELAYED COMMANDING DATA SPECIFICATION

The delayed commanding data is received by the ECS as files. Each file is comprised of a file header followed by a file body that contains the command data as specified in section 3.2.2. The maximum number of OBDH block commands that can be included in a single delayed command file is 1000. If this number is exceeded, ECS will reject the file and indicate so in the command validation report. The file header is described in Table 3.7. It specifies the earliest and latest uplink times.

Table 3.7. File Header Format for Delayed Commanding.

KEYWORD	DESCRIPTION
DATATYPE	"DELAYED"
FILENAME	Name of this file: iiicccccccccc.DEL (see Appendix A)
INSTRUME	Instrument (full name) being commanded
ORIG_ID	ID of originating entity (IWS ID or remote host). No embedded blanks allowed.
OBSERVER	Person who generated this file
DATE_CRE	Date file was created YYYY/MM/DD HH:MM:SS (GMT)
NUM_CMDS	Number of commands (OBDH Block commands) in this file.
EARLIEST	Earliest uplink time YYYY/MM/DD HH:MM:SS (GMT)
LATEST	Latest uplink time YYYY/MM/DD HH:MM:SS (GMT)
COMMENT	Free text. May contain special instructions (i.e., contingency, end-item verification, etc...). This keyword may be repeated to allow several comment lines
END	

3.2.5 BACKGROUND-QUEUE COMMANDING DATA SPECIFICATION

The file header is defined in Table 3.8. It specifies the total number of commands contained in the file and an optional uplink window. The uplink window may be specified when it is critical to uplink the data by a given time. However, SMOCC does not guarantee uplink within that window and would only reject the data that has not yet been uplinked by the specified latest uplink time. In most cases the window will not be specified, and the data will be uplinked whenever possible.

The file body contains the commanding data which consists of a series of command specifications either in binary format or mnemonic format as specified in section 3.2.2. The command data, once expanded into the binary form of OBDH block commands, should be less than 0.5 Kbytes in length.

Table 3.8. File Header Format for Background-Queue Commanding.

KEYWORD	DESCRIPTION
DATATYPE	"BACKGROUND"
FILENAME	Name of this file: iiicccccccccc.BCK (see Appendix A)
INSTRUME	Instrument being commanded
ORIG_ID	ID of originating entity (IWS ID or remote host). No embedded blanks allowed.
OBSERVER	Person who generated this file
DATE_CRE	Date file was created YYYY/MM/DD HH:MM:SS (GMT)
NUM_CMDS	Number of commands (OBDH Block commands) in this file.
EARLIEST	Optional. Earliest uplink time YYYY/MM/DD HH:MM:SS (GMT)
LATEST	Optional. Latest uplink time YYYY/MM/DD HH:MM:SS (GMT)
COMMENT	Free text. May contain special instructions (i.e., contingency, end-item verification , etc...). This keyword may be repeated to allow several comment lines
END	

3.2.6 COMMAND VALIDATION REPORTS

These reports are generated by the CMS as soon as CMS receives and processes a delayed command group or a background-queue command group. They contain an echo of the original commanding data: list of mnemonics or binary specification, and error messages when applicable. There will be one validation report for each group (one uniquely named file) of delayed or background-queue commanding data generated by the instrumenters.

Table 3.9. File Header Format for Command Validation Reports.

KEYWORD	DESCRIPTION
DATATYPE	"COMMAND VALIDATION REPORT"
FILENAME	Name of this file: (see Appendix A) iiicccccccccc.DRP for Delayed command validation reports iiicccccccccc.BRP for Background queue validation reports
INSTRUME	Instrument commanded in original delayed or background command group
ORIGFILE	Filename of delayed/background command group this report applies to. iiicccccccccc.DEL or iiicccccccccc.BCK
DATE_CRE	Date this file was created YYYY/MM/DD HH:MM:SS (GMT)
NUM_CMDS	Number of commands (OBDH Block commands) covered in this report
COMMENT	Free text. This keyword may be repeated to allow several comment lines
END	

3.2.7 SPECIAL COMMANDING FOR THE VIRGO INSTRUMENT

The VIRGO instrument requires special commanding data specifications. At the present time, VIRGO sends time-tagged commands as delayed command files. These files are rejected by CMS as invalid and are then processed manually by the CMS operator. A final process to be used during operations still needs to be defined and accepted by CMS.

3.3 TELEMETRY DATA SPECIFICATION

3.3.1 REAL-TIME TELEMETRY

The general format of the messages exchanged over the interface was defined in section 3.1.1. They all contain a 4-byte standard header followed by a data field. This section defines the specific functions and the data field content of the messages exchanged for real-time telemetry distribution.

The Session-Init message (ECS to IWS), the Session-Init-Response message (IWS to ECS) and the Session-End messages (ECS and IWS) are identical to the messages used for NRT commanding, defined in section 3.2.3.

3.3.1.1 Telemetry-Packet-Distribution-Request (IWS to ECS). This message is used by an IWS to indicate what type of telemetry packets (i.e., what APID) it wants to receive. There must be one such message for every APID to be transmitted. This message contains an optional field that allows an instrumenter to choose to receive the Quality and Accounting capsule at the end of each telemetry packet for a given APID. If the flag is not specified, the Quality and Accounting capsule will not be provided at the end of the telemetry packets.

Data Field content:
- Integer*1 Spacecraft ID (X'00').
- Integer*2 APID to be received.
- Integer*2 Request ID: non-negative number generated by IWS to uniquely identify this telemetry exchange. It will be found in all the messages related to this TM distribution request.
- Integer*1 Optional: flag indicating if the Q&A capsule should be included (01) or omitted (00) after each telemetry packet for this APID for this telemetry exchange.

3.3.1.2 Telemetry-Packet-Distribution-Response (ECS to IWS). This message is used to indicate the result of the telemetry-packet-distribution-request:

Data Field content:
- Integer*2 Request ID corresponding to request ID in TM Packet Distribution Request message.
- Integer*1 Request Response Code
  - X'00' successful
  - X'01' unsuccessful
- Integer*1 Reason Code giving an explanation for success or failure
  - X'00' Success
  - X'01' Bad APID
  - X'02' APID already requested
  - X'03' Duplicate Request ID
  - X'04' Request ID in TM-packet-distribution-request is missing
  - X'05' TM data not available
  - X'06' ECS system capacity exceeded
  - X'07' to X'0F' other reasons

3.3.1.3 Start-of-Telemetry-Packet-Distribution (ECS to IWS). This message is used to indicate the start of telemetry transmission.

Data Field content:
- Integer*1 Spacecraft ID (X'00').
- Integer*2 APID of telemetry packets included in this distribution
- Integer*2 Request ID corresponding to request ID in TM Packet Distribution Request message.

3.3.1.4 Interrupt-Telemetry-Packet-Transfer (IWS to ECS). This message is used by an IWS to ask for immediate termination of the current telemetry transfer.

Data Field content:

Integer*2 Request ID corresponding to request ID in TM Packet Distribution Request message

3.3.1.5 End-of-Telemetry-Packet-Transfer (ECS to IWS). This message is sent by ECS to confirm the fact that the telemetry transfer is terminated. This may happen either upon receipt by ECS of an interrupt-telemetry-packet-transfer message, in the case of a system problem, or at the end of the real-time contact period.

Data Field content:

Integer*2 Request ID corresponding to request ID in TM Packet Distribution Request message

Integer*1 Status code
- X'00' Canceled by IWS
- X'01' Canceled by ECS
- X'02' Telemetry transfer interrupted by PACOR
- X'03' to X'0F' other reasons.

3.3.1.6 Telemetry-Packet (ECS to IWS). This message is used to transmit the real-time telemetry data, that is one complete telemetry source packet corresponding to the APID requested. Additional data may be included, such as the Quality and Accounting (Q&A) capsule. If requested by the receiving instrumenter in the Telemetry-Packet-Distribution-Request message, a 6-byte Q&A capsule will be appended to the end of each telemetry packet associated with this Request ID.

Data Field content:

Integer*2 Request ID corresponding to request ID in TM-Packet-Distribution-Request.

Binary data Telemetry data packet, including packet header as defined in table 3.10. Note that for some APIDs, the packets do not contain a time field.

Integer*6 (Optional, supplied only if requested in Telemetry-Packet-Distribution-Request) Real-time Q&A capsule, as provided by PACOR (see Reference 9) and defined in table 3.11.

Table 3.10. Telemetry Data Packet

PACKET HEADER							PACKET DATA FIELD	
Packet ID				Sequence Control		Packet length	Time field (OBT or LOBT)	Source data
Version No.	Packet type	Data field header flag	APID	Segment flags	Source sequence count			
3 bits	1 bit	1 bit	11 bits	2 bits	14 bits	16 bits	48 bits	variable
(2 bytes)				(2 bytes)		(2 bytes)	(6 bytes)	variable

Table 3.11. Real-Time Quality and Accounting Capsule

Field Name	Length	Description
Virtual Channel ID	1 byte	Virtual channel the packet was transmitted on
Data Type Flag	1 byte	PACOR uses each bit is a flag indicating the data type: 00010000 for real-time and 00001000 for test telemetry
Sequence Continuity Flag	1 byte	00 (hexadecimal) no sequence discontinuity 01 (hexadecimal) sequence discontinuity
Reed-Solomon Error Flag	1 byte	00 (hexadecimal) no Reed-Solomon correction 01 (hexadecimal) Reed-Solomon error corrected.
Data Fill Location	2 bytes	Location of the start of fill in the source data unit. A value of 0000 hex indicates there is no fill.

3.3.1.7 Informational Message (Bi-directional).

This message is supplied for the exchange of free text between the ECS and the IWSs. For instance, ECS sends an informational message to an IWS when a telemetry session is canceled by the ECS operator. ECS displays the informational messages it receives from the IWSs on the ECS event page.

Data field content:
Character var ASCII Free text (maximum of 256 characters)

3.3.2 ARCHIVED TELEMETRY DATA

The telemetry data is stored in the ECS for retrieval by the instrumenters. The archived telemetry is sorted by APID and by time. Each file contains approximately 2 hours of telemetry and contains a header followed by the file body. The telemetry data is organized among several system directories, one directory per APID. Under each directory, each file contains packets consecutively received by ECS for the given APID. The instrumenters can obtain the archived telemetry data via file transfer. In order to select the files they want to retrieve, the instrumenters will use the file naming conventions described in Appendix A or will formulate a standing request with the SOC to receive files corresponding to a given APID as soon as these files are available within ECS.

3.3.2.1 Archived Telemetry File Header.

Table 3.12 defines the format of the file header.

3.3.2.2 Archived Telemetry File Body.

The file body contains the telemetry packets followed by quality and accounting information as illustrated in table 3.13. The format of the file body is illustrated in Appendix C. It was kept as much as possible identical to the format of the production data as defined in the ICD between the SDPF and the SOHO Consumers (Reference 9).

Table 3.12. Archived Telemetry File Header

DATATYPE	"ARCHIVED REAL-TIME TELEMETRY" or "ARCHIVED RETRANSMITTED REAL-TIME TELEMETRY" or "ARCHIVED TAPE RECORDER DUMP TELEMETRY"
FILENAME	As defined in Appendix A
APID	APID of the telemetry packet (see Appendix A)
DATE_CRE	Date file was created by ECS YYYY/MM/DD HH:MM:SS (GMT)
NUM_PACK	Number of telemetry packets stored in this file
STARTIME	Start of period covered (Time stamp of first packet) YYYY/MM/DD HH:MM:SS when applicable. Othewise, time of reception by ECS of the first data packet.
ENDTIME	End of period covered (Time stamp of last packet) YYYY/MM/DD HH:MM:SS when applicable. Othewise, time of reception by ECS of the last data packet.
COMMENT	Free text. When applicable, will indicate if the file name is based on the ECS system time (time of first packet not available)
END	

Table 3.13. Archived Telemetry File Body

Source Data Units	Series of telemetry packets: Telemetry packet 1 Telemetry packet 2 . . . Telemetry packet n
Quality and Accounting List Length	Length in bytes of the Quality and Accounting List
Quality and Accounting List	Series of Quality and Accounting Capsules: Quality and Accounting capsule for first packet in error Quality and Accounting capsule for second packet in error . . . Quality and Accounting capsule for m^{th} packet in error
Missing Data Units List Length	Length in bytes of the Missing Data Units List
Missing Data Units List	Series of Missing Data Units Entries: Offset, "From" packet and "To" packet . . .

3.3.3 TELEMETRY GAP REPORT

The ECS generates a Telemetry Gap Report for each operational day. This report is generated from the archived telemetry Selective reports for shorter time ranges can be generated by SOC. Appendix B contains an example of the Telemetry Gap Report.

3.4 MISSION SUPPORT DATA SPECIFICATION

3.4.1 SUMMARY DATA

The summary data received by ECS from the instrumenters is in FITS format. There may be one or more input files for each instrument and each day (some instruments may provide more than one file for the same day, while other instruments may not provide a file for every day). The SOC is responsible for gathering the instrumenters' input before sending it to CDHF which requires detached SFDU headers.

The instrumenters submit their input to ECS in FITS format optionally with detached SFDU headers. The file naming convention used for the summary data will comply with the CDHF conventions (see Appendix A).

3.4.2 ORBIT AND ATTITUDE DATA

Orbit and attitude data are received by the ECS from CDHF at a frequency that will be defined within the EOF and operationally agreed upon with CDHF. These data are received in files in CDF format with detached SFDU headers. Each file contains data for one operational day.

That data is provided to the instrumenters in CDF format with detached SFDU headers, and the CDHF file naming conventions described in Appendix A are used.

The files will be organized among system directories in the ECS. The data files and the corresponding SFDU header files are contained in the same directory.

3.4.3 COMMAND HISTORY

The command history file covers one operational day. ECS receives a file from the SMOCC typically at the end of every DSN contact. The ECS merges the individual files into a single file per day. It then generates an SFDU header before transmitting the final report to CDHF.

The command history is available to the instrumenters as an ASCII text file with a detached SFDU header. See Appendix B for an example of the command history file format as proposed by the SMOCC (ASCII text with fixed fields).

3.4.4 TIME CORRELATION LOG

The time correlation log is an ASCII text file containing a cumulative log of all SOHO spacecraft clock time offsets since the start of the mission. Once each day that the spacecraft clock is adjusted, ECS updates the time correlation file by appending the new information at the end. ECS extracts the time correlation information from a command history file by recognizing commands that were used to reset the spacecraft clock.

The time correlation log is made available to the instrumenters as an ASCII text file with detached SFDU header.

3.4.5 SYNOPTIC DATA

The format of that data is not defined in this ICD. The synoptic data will be gathered by the SOC and will reside in a dedicated ECS file directory from where the instrumenters will be able to retrieve it. The management of the synoptic data is not an ECS function.

3.4.6 PROJECT DATA BASE

The ECS will make the PDB available to the instrumenters as ASCII files in the Data Format Control Document (DFCD) format as supplied by the POCC.

3.4.7 PROJECT DATA BASE UPDATE REQUEST

The format of this free-form text E-mail message exchanged between the instrumenters and the FOT is not described in this ICD.

3.4.8 SOHO DAILY REPORT

The SOHO Daily Report is an ASCII text file with detached SFDU header. Each file covers one operational day. The files are named according to the CDHF file naming conventions described in Appendix A. The format of the SOHO Daily Report will be defined in an operational agreement between the FOT and the Instrumenters.

3.5 PLANNING AND SCHEDULING DATA SPECIFICATION

There are two types of data related to the planning functions: the ECS activity (EAP) plan which ECS sends to the instrumenters and the instrumenters' input to the activity plan (IAP). These data are in a file format as described in the following sections.

3.5.1 INSTRUMENTERS INPUT TO THE ACTIVITY PLAN

The IAP is a file used by each instrument team to specify their activity requests. One input file relates to a single instrument and covers an entire operational day. When updates and modifications are necessary, the IAP for the entire operational day must be re-submitted to the ECS. In order to allow for greater flexibility in the input, the "keyword=value" format is used for the IAP files.

3.5.1.1 Input to the Activity Plan File Header

The IAP file header is defined in table 3.14.

Table 3.14. File Header for the Instrumenter Input to the Activity Plan

KEYWORD	DESCRIPTION
DATATYPE	"INSTRUMENTER INPUT TO THE ACTIVITY PLAN"
FILENAME	Name of this file: iiicccccccccc.IAP (see Appendix A)
INSTRUME	Instrument for which this IAP is submitted (see section 3.1.4)
ORIG_ID	E-Mail address where a validation report on the IAP will be sent
OBSERVER	Person who generated this file
DATE_CRE	Date file was created YYYY/MM/DD HH:MM:SS (GMT)
STARTIME	Start time of period covered YYYY/MM/DD HH:MM:SS (GMT) ECS will assume that HH:MM:SS is 00:00:00
ENDTIME	End time of period covered YYYY/MM/DD HH:MM:SS (GMT) ECS will assume that HH:MM:SS is 00:00:00 for the day following the start time
COMMENT	Free text. This keyword may be repeated to allow several comment lines
END	

3.5.1.2 Input to the Activity Plan File Body Format

The file body is in the keyword format. It contains a list of statements, each statement consisting of a series of fields of the form KEYWORD = value. A list of keywords that may be used in the IAP is provided in Appendix B.

Notes:

- Comment lines may be inserted anywhere in the IAP file. They consist of the keyword COMMENT= followed by free text.

- Typically, the duration of an activity is specified using the STARTIME= and ENDTIME= keywords, followed by a time field.
  All time fields are in the standard format YYYY/MM/DD HH:MM:SS.

- The originator ID (ORIG_ID) must be a valid E-Mail address where a validation report on the IAP will be sent. When it receives the IAP, the ECS planning software validates it and generates a report indicating errors if any are found. This report is sent in the form of an E-mail message to the address indicated in the ORIG_ID field. This address will also be used to send availability notifications for the EAP.

3.5.2 ECS ACTIVITY PLAN

The ECS Activity plan (EAP) is a file containing information provided by the SMOCC such as DSN contacts and FOT-reserved times as well as the merged activity requests that were specified by the instrumenters in the IAP files. The activity plan file is made available in two different formats: the fixed-field format which provides more readability but limits the amount of information provided, and the keyword format which offers more flexibitity.

3.5.2.1 ECS Activity Plan File Header

The activity plan file header is defined in table 3.15.

Table 3.15. File Header for the ECS Activity Plan

KEYWORD	DESCRIPTION
DATATYPE	"ECS ACTIVITY PLAN"
FILENAME	Name of this file: (see Appendix A) ECSYYYYMMDDvvv.EAP for files in the fixed-field format ECSYYYYMMDDvvv.KAP for files in the keyword format
OBSERVER	Person who generated this file
DATE_CRE	Date file was created YYYY/MM/DD HH:MM:SS (GMT)
STARTIME	Start time of period covered YYYY/MM/DD HH:MM:SS (GMT) where HH:MM:SS is 00:00:00 for a given day DD
ENDTIME	End time of period covered YYYY/MM/DD HH:MM:SS (GMT) where HH:MM:SS is 00:00:00 for day DD+1
OUT_FORM	Format indicator KEYWORD for the keyword format FIXED_FIELD for the fixed field format
COMMENT	Free text. This keyword may be repeated to allow several comment lines
END	

3.5.2.2 ECS Activity Plan Fixed-field Format

In the fixed-field format, the file body for the ECS activity plan is an ASCII-text formatted report. Each line corresponds to the description of one activity and contains the fixed-length fields defined in table 3.16.

Table 3.16. ECS Activity Plan Fixed-field Format

FIELD NAME	Byte Number	Length (Bytes)	DESCRIPTION
Activity	1	20	Name of the activity or resource (see Appendix B)
Blank-fill	20	2	
Activity Qualifier	22	6	Instrument performing the activity or Ground station ID for DSN contacts or Originating entity for the activity such a FOT or

Blank-fill	28	2	
Start Time	30	19	Start time of the activity in the format YYYY/MM/DD HH:MM:SS
Blank-fill	49	2	
End Time	51	19	End time of the activity in the format YYYY/MM/DD HH:MM:SS
Blank-fill	70	2	
Duration	72		Duration of the activity in the format HH:MM:SS
Blank-fill	80	2	
Description/Comment (optional)	82	80	Textual description of or remarks applying to the activity
New-line separator	162	1	X'0A'

3.5.2.3 ECS Activity Plan Keyword Format

In the keyword format, the file body for the ECS activity plan is ASCII text. Refer to Appendix B for a list of valid keywords and their format specification.

SECTION 4. COMMUNICATIONS PROTOCOLS

4.1 COMMUNICATIONS OVERVIEW

The workstations for the EOF-resident instrumenters (IWSs) will be connected to ECS and among themselves using Ethernet. Upgrades to provide higher capacity to some instrumenters' teams may be implemented if necessary (for instance, upgrade to CDDI). The communications among the IWSs may use either TCP/IP or DECNET. Additionally, TCP/IP will be routed to Internet and DECNET to SPAN. Communications between the ECS and the IWSs will take place using a subset of TCP/IP services and protocol as illustrated in Figure 4-1. Internet connections from remote instrumenters will be routed through NASA GSFC. All instrumenters, resident or not, may access ECS through FTP and SMTP. The IWSs may additionally use sockets, NTP, X11 and rlogin to access various resources on ECS.

4.1.1 FILE TRANSFER

FTP is used to support file transfers between the ECS and all instrumenters' teams (resident or remote). As described in the following paragraphs, four different methods may be used to exchange files between the ECS and the instrumenters. The method selected depends on the type of data exchanged.

1) Files that ECS needs to send to specific instrumenters' teams (i.e., command validation reports).
ECS maintains a list of designated computer addresses where each type of file is to be forwarded, typically two addresses per instrument team. As soon as a file becomes available, ECS initiates an FTP session with the computers designated to receive that type of file for that particular instrument, and writes the file to that computer. ECS must maintain a list of Internet addressees for all the instrumenters' teams. ECS must also have an account on each of these instrumenters' computers and maintain a list of current account names and passwords. In the case where ECS would be unable to connect to any of the receiving computers, the SOC will notify the addressees via E-mail, and ECS will keep the files for a certain period of time for possible manual retransmission by the SOC.

2) Files generated by ECS and retrieved by the instrumenters when needed (i.e., Activity Plan).
These files are deposited by ECS on specific system directories. Read access is available to instrument teams and members of the scientific community with a valid FTP account: the ECS system administrator will maintain a list of these valid account and passwords. Anonymous FTP is not allowed.

3) Commanding files generated by the instrumenters. The transfer of these files (delayed command files and background-queue files) requires the use of a SecureID card. The instrumenters initiate these FTPs and write the files to specified ECS systems directories. When performing the FTP, the originating instrumenter must be in possession of a SecureID card and enter the proper numeric code. These FTPs must also be done on a specific port number different from the default FTP port number.

4) Other files generated by the instrumenters (e.g., input to the summary data or input to the activity plan). These FTPs will be initiated by the instrumenters and performed using account name and password on the default port number. The instrumenters write their files to specified ECS systems directories. The ECS system administrator maintains a list of authorized computers and account information.

	FTP RFC-959	SMTP RFC-821	X 11	SOCKET I/F	NTP RFC-123
Communication Protocols and Application Level Services	TCP RFC-793				UDP RFC-768
	IP/ICMP RFC-791 RFC-792				
	ETHERNET Link Level RFC-826 RFC-894				
Physical Interface	ETHERNET IEEE 802.3				

Note: The Requests for Comment (RFCs) listed above are the specifications for the various protocols for Internet. The full listing of each RFC is available via anonymous FTP on various Internet computers (i.e., NIC.DN.MIL).

Figure 4.1. SOHO/ECS Communication Architecture

4.1.2 E-MAIL

SMTP mail utility will be used to exchange non-time-critical information between ECS and the instrumenters. ECS must obtain and maintain a list of Internet addresses and user-names where to send mail. Similarly, ECS must supply the instrumenters with the ECS Internet address, user-name and password.

4.1.3 XWINDOWS

X11 will be used by the IWSs (i.e., EOF-resident) to view ECS displays such as the commanding status window or telemetry distribution monitoring display. ECS will make 'C' language software available to the instrumenters to allow the display of these Motif windows.

4.1.4 REMOTE LOGIN

Rlogin will be used by the IWSs to initiate an X11 session. ECS will maintain a list of network addresses and user-names of these IWSs allowed to do remote login.

4.1.5 TIME SERVICES

NTP will be used to supply standard time to the instrumenters. This protocol allows the synchronization of the internal clock of each served computer to a time server computer. No special hardware or software is needed on the instrumenter computers: NTP is part of the suite of software distributed with almost all implementations of TCP/IP. The time server computer provides the Coordinated Universal Time (UTC). Using NTP, the instrumenters can synchronize the system clock of their computers to within 20 milliseconds of UTC. Then, they can obtain UTC by using system utilities to read their system clock. System clocks are generally readable down to milliseconds and sometimes microseconds.

4.1.6 SOCKETS

Sockets are used for the transmission of real-time data streams (primarily, near-real-time commanding and telemetry distribution) between the IWSs and the ECS. The IWSs will serve the necessary sockets and ECS will connect to them when data need to be transferred (for instance, at the beginning of a pass when real-time telemetry is received by ECS or when the NRT throughput mode is enabled). ECS has reserved a group of port numbers for the sockets to be served by the IWSs (see Table 4.1 below).

- For telemetry data, 4 sockets are available to each IWS, one of these being reserved for the transmission of MDI-M data. This could allow a given IWS to receive telemetry simultaneously on up to 3 separate sockets for non-MDI data, and a fourth socket for MDI-M data. It is envisioned that operationally, an IWS will not use more than one or two sockets at one time. However, this is provided to allow separate processes to run and accept different types of telemetry on a single IWS. ECS will maintain a list of 'default IWS-socket pairs' which are the sockets over which telemetry is expected to be distributed during a real-time pass. At the beginning of the pass, ECS will attempt to initiate a session with each of these 'default IWS-socket pairs'. Additional connections may be requested at any time via the SOC.

- For commanding data, 11 sockets are available to each IWS, each socket corresponding to one instrument. Each IWS will use the port socket(s) it needs to command the instrument(s) it intends to command. ECS will maintain a list of 'default IWS-instrument pairs'. When the throughput mode is enabled, ECS attempts to initiate a session with each 'default IWS-instrument pair'. It is expected that an IWS will not serve a socket for an instrument it is not authorized to command or an instrument it will not command during the current NRT session.

Table 4.1 Port number assignments for NRT sockets.

FUNCTION		**PORT NUMBER**
Telemetry	Connection	
	First	20100
	Second	20101
	Third	20102
	Fourth	20103

Commanding	Instrument	
	CDS	20200
	CELIAS	20201
	CEPAC	20202
	EIT	20203
	GOLF	20204
	LASCO	20205
	MDI	20206
	SUMER	20207
	SWAN	20208
	UVCS	20209
	VIRGO	20210

4.2 ECS HARDWARE CONFIGURATION

The current ECS hardware configuration is illustrated in figure 4.2. It is only included in this document for informational purpose and may be modified during the life of the mission. The ECS hosts are RS/6000 workstations running AIX. The hardware configuration has been in part dictated by the interface with MODNET an by security considerations. The description of specific security measures, policies and procedures are not within the scope of this ICD. The following section outlines the main characteristics of the security implementation within the ECS.

1) The filtering capability of the routers will be utilized to limit external access to the EOF. Only packets with specific combinations of source address, destination address and IP port number or DECNET packet type will be allowed to pass.

2) Only specific services (e.g., E-mail, or FTP) on specific ECS hosts will be available to external users. The ECS itself will support only TCP/IP. The use of the SecureID card is required for FTP of commanding data.

3) Host protection measures will remain the primary security measures. They vary from host to host, depending on the capabilities of the various operating systems. It is recommended that remote logins not be allowed on a given IWS while this IWS supports an active near-real-time commanding session.

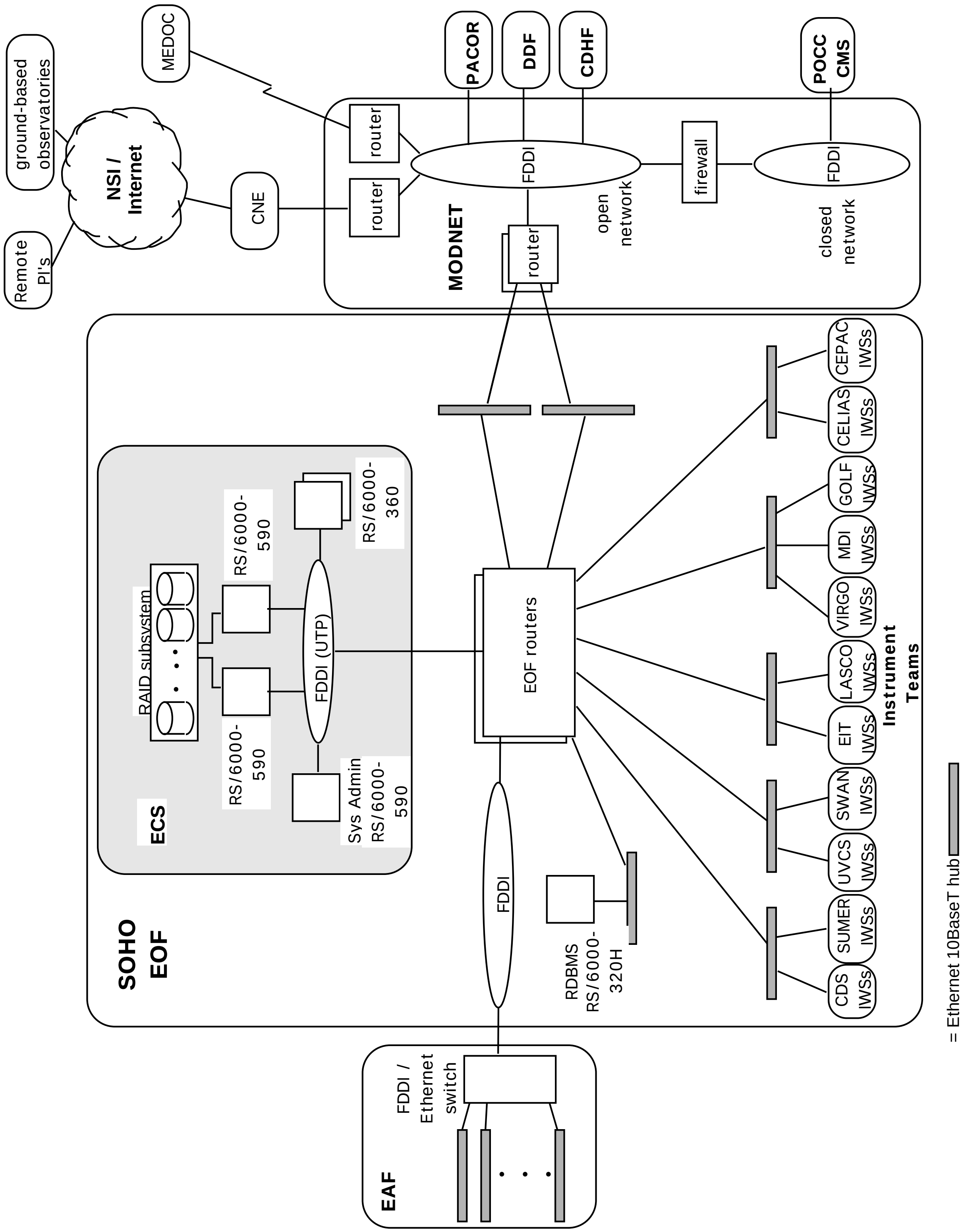


Figure 4.2. SOHO/EOF Hardware Architecture

APPENDIX A. FILE NAMING CONVENTIONS

A.1 "ORIGINATOR/ID" SCHEME

In this scheme, the first 3 characters of the identifier represent the originator of the file. The file name extension is three-characters long and is used to indicate the type of data contained in the file.

A file name is of the general form: **iiiccccccccccc.EXT** where:

iii: 3-letter abbreviation of the file originator name (upper-case)

CDS	for CDS	CEL	for CELIAS
CEP	for CEPAC	EIT	for EIT
GOL	for GOLF	LAS	for LASCO
MDI	for MDI	SUM	for SUMER
SWA	for SWAN	UVC	for UVCS
VIR	for VIRGO	ECS	for ECS

ccccccccccc: alphanumeric characters to uniquely identify this file

A suggestion for this field is to use 11 characters: YYMMDDHHvvv where:
YYMMDDHH represents the year, month, day and hour, and
vvv uniquely identifies this file.

For the activity plan, ECS uses the convention YYYYMMDDvvv.

For delayed and background-queue command files, this field should be limited to 9 characters since this is the maximum number of characters that the POCC and CMS software can handle. Any longer file name would be truncated. In order to avoid duplicate file names after truncation, the instrumenters are required to limit the names of delayed and background-queue files to 12 characters. For example, iiiYYMMDDHHv.DEL and iiiYYMMDDHHv.BCK are valid file names.

The validation reports for delayed and background-queue commands keep the same name as the corresponding .DEL or .BCK file with a different extension (.DRP and .BRP respectively).

.EXT: 3-letter field defining the data type contained in the file (upper case)

DEL	for delayed commanding data
BCK	for background-queue commanding data
IAP	for instrumenter input to the activity plan
EAP	for the ECS activity plan in fixed-field format
KAP	for the ECS activity plan in keyword format
DRP	for delayed command validation report
BRP	for background queue command validation report

A.2 "TELEMETRY FILE" SCHEME

This scheme is used for archived telemetry files. It includes a representation of the APID followed by a date representative of the data contained in the file.

A file name is of the general form: **apid_yymmdd_hhmmss.EXT** where:

apid: up to 6 alphanumeric characters (upper case) as described in table A1

yymmdd_hhmmss: a unique time stamp for this file (year, month, day, hours, minutes and seconds)

.EXT: 3-letter field defining the data type contained in the file (upper case)

.REL for ECS-archived real-time telemetry data

.QKL for ECS archived tape recorder files or retransmitted real-time telemetry data.

If the time-stamp of the first packet in the file contains a valid OBT or LOBT time, the file name will represent the time stamp in UT of the first packet in the file.

If the first packet of the file does not contain a valid time-stamp, the file name will represent the system time when the file was created. For example, this will apply to VIRGO telemetry packets which do not contain a time-stamp. It will also apply when an instrument is turned off. This difference in the naming process will be indicated by using the character X at the end of the file name.

File name examples:

apid_yymmdd_hhmmss.EXT

for telemetry files when the first telemetry packet contains a valid OBT or LOBT time

apid_yymmdd_hhmmssX.EXT

for telemetry files when the first telemetry packet does not contain a valid time stamp

Table A.1. SOHO APID Abbreviations

Packet Name	APID	Abbreviation
SVM HK1	8803	SVMHK1
SVM HK2	8805	SVMHK2
SVM HK3	8806	SVMHK3
SVM HK4	8809	SVMHK4
AOCS HK1	8833	AOCHK1
AOCS HK2	8835	AOCHK2
ATTITUDE 1	8836	ATTIT1
ATTITUDE 2	8839	ATTIT2
S/W	880A	SW
OBT	8000	OBT
Low Rate EXPERIMENT HK	8860	EXPHK
CDS HK	8863	CDSHK
CELIAS HK	8865	CELHK
CEPAC HK	8866	CEPHK
EIT/LASCO HK1	8869	ELAHK1
EIT/LASCO HK2	886A	ELAHK2
EIT/LASCO HK3	886C	ELAHK3
GOLF HK	886F	GOLHK
MDI HK1	8893	MDIHK1
MDI HK2	8895	MDIHK2
SUMER HK	8896	SUMHK
SWAN HK	8899	SWAHK
UVCS HK	889A	UVCHK
VIRGO HK	889C	VIRHK
CDS Science Low Rate	88A3	CDSSCL
CDS Science Medium Rate	88A5	CDSSCM
CDS Science High Rate	88A6	CDSSCH
CELIAS Science	88A9	CELSC1
CEPAC Science	88AA	CEPSC
EIT/LASCO Science Low Rate	88AC	ELASCL
EIT/LASCO Science High Rate	88AF	ELASCH
GOLF Science	88C3	GOLSC
MDI Science	88C5	MDISC
SUMER Science Low Rate	88C6	SUMSCL
SUMER Science High Rate	88C9	SUMSCH
SWAN Science	88CA	SWASC
UVCS Science	88CC	UVCSSC
VIRGO Science	88CF	VIRSC
MDI M	80C4	MDIHR
IDLE	87FF	IDLE

A.3 CDHF CONVENTION

This naming convention used for files that are exchanged between the ECS and CDHF is defined in the ICD between CDHF and the EOF (Reference 11). It applies to:

- Summary data
- As-Run plan
- Command history report
- Time correlation log
- SOHO daily report
- Orbit data
- Attitude data

The general file name is:
mission_datatype_descriptor_date_version.extension where:

• The logical file identifier is a concatenation of 5 fields:

mission SO for SOHO

datatype: identifies the type of data.

Valid datatypes for SOHO are:

AN	for ancillary data
AR	for as-run plan
AT	for attitude data
CH	for command history report
OR	for orbit data
SU	for summary data

descriptor: further qualifies the type of data.

Valid descriptors for SOHO are:

CDS	for CDS
CEL	for CELIAS
CEP	for CEPAC
EIT	for EIT
GOL	for GOLF
LAS	for LASCO
MDI	for MDI
SUM	for SUMER
SWA	for SWAN
UVC	for UVCS
VIR	for VIRGO
TCF	for Time Correlation File
SDR	for SOHO Daily Report
FTR	for full resolution attitude data
DEF	for definitive data
PRE	for predicted data
NUL	when this field does not apply (e.g, command history report)

date YYYYMMDD

version Vnn where nn = 01 to 99

• The file extension may be

.SFDU	for an SFDU file
.DAT	for a generic data file
.CDF	for a CDF file
.Snn	where nn=01 to 99, for files with several segments (e.g., summary data for a same instrument and same day)

File name examples

Summary data

Several files for the same instrument and the same day SO_SU_EIT_19960523_V01.SFDU
SO_SU_EIT_19960523_V01.S01
SO_SU_EIT_19960523_V01.S02
SO_SU_EIT_19960523_V01.S03
Single file for a given instrument on a given daySO_SU_VIR_19960523_V01.SFDU
SO_SU_VIR_19960523_V01.DAT

Command history report

SO_CH_NUL_19960523_V01.SFDU
SO_CH_NUL_19960523_V01.DAT

As Run Plan

SO_AR_UVC_19960523_V01.SFDU
SO_AR_UVC_19960523_V01.DAT

Time correlation file

SO_AN_TCF_19960523_V01.SFDU
SO_AN_TCF_19960523_V01.DAT

SOHO Daily report

SO_AN_SDR_19960523_V01.SFDU
SO_AN_SDR_19960523_V01.DAT

Definitive attitude data

SO_AT_DEF_19950523_V01.SFDU
SO_AT_DEF_19950523_V01.CDF

Full-time resolution attitude data

SO_AT_FTR_19950523_V01.SFDU
SO_AT_FTR_19950523_V01.DAT

Predictive orbit data

SO_OR_PRE_19930523_V01.SFDU
SO_OR_PRE_19930523_V01.CDF

Definitive orbit data

SO_OR_DEF_19930523_V01.SFDU
SO_OR_DEF_19930523_V01.CDF

APPENDIX B. EXAMPLES OF ECS DATA SETS AND REPORTS

B.1 NEAR-REAL-TIME COMMAND DATA EXAMPLE

B.1.1 BINARY FORMAT

```
X'03010023'        (4 binary bytes for message type and length)
X'1010'            (Request ID)
CDS                (6-Char, padded with blanks)
BINARY 0x1203,0x2401,0x77AF,0xADB3; /* OBDH block with header, 2 data
                                       words and checksum */
```

B.1.2 MNEMONIC FORMAT

```
X'03010033'        (4 binary bytes for message type and length)
X'A001'            (Request ID)
LASCO        (6-Char, padded with blanks)
MNEMO1,0x1AB,0x1234;  /*command with 2 variable words in hex format */.
```

B.2 DELAYED COMMAND GROUP

This example contains commands in mnemonic format. The binary format could also have been used. The example also contains errors in the command data to illustrate the validation report format in section B.3.

```
DATATYPE=   DELAYED
FILENAME=   CDS0126001.DEL
INSTRUME=   CDS
ORIG_ID=    CDS_OPS_1
OBSERVER=   Ricky Ricardo
DATE_CRE=   1996/01/25 15:27:30
NUM_CMDS=   3
EARLIEST=   1996/01/26 18:00:00
LATEST=     1996/01/26 18:30:00
COMMENT=    In case of contingency, notify PI team by telephone
COMMENT=    This example contains errors as illustrated in the associated validation report
END
CDSMNEMO1;  /* first command, no argument */
LASCOMNEMO, 10;  /* 2nd command, argument in decimal */
CDSMNEMO2,01AB,1234;  /* 3rd command, first argument in octal, second in decimal*/
```

B.3 DELAYED COMMAND VALIDATION REPORT

NOTE: This is an example of the report which is produced by CMS and is described in Reference 8.

```
DATATYPE=   COMMAND VALIDATION REPORT
FILENAME=   CDS0126001.DRP
INSTRUME=   CDS
ORIGFILE=   CDS0126001.DEL
DATE_CRE=   1996/01/26 15:37:53
NUM_CMDS=   3
COMMENT=    "Errors in input file"
END


SOHO CMS INPUT VALIDATION REPORT FOR CDS GROUP CDS0126001.DEL
  Started At Thu Jan 25 20:30:51 1996

Original Header:
INSTRUME=   CDS
FILENAME=   CDS0126001.DEL
ORIG_ID=    CDS_OPS_1
OBSERVER=   Ricky Ricardo
DATE_CRE=   1996/01/25 15:27:30
NUM_CMDS=   3
EARLIEST=   1996/01/26 18:00:00
LATEST=     1996/01/26 18:30:00
COMMENT=    "CDS Calibration"
END

CDSMNEMO1;  /* first command */

LASCOMNEMO, 10; /* 2nd command */

***  IV_MNEMON    Invalid mnemonic.

CDSMNEMO2,01AB,1234;  /* 3rd command */

***  MAX_ARGS    Improper number of arguments for a fixed length command.



***  Command Group Is Invalid  ***
```

B.4 BACKGROUND-QUEUE COMMAND GROUP

This example contains

```
DATATYPE=   BACKGROUND
FILENAME=   MDITBL0001.BCK
INSTRUME=   MDI
ORIG_ID=    MDI_IWS_2
OBSERVER=   C. Moi
DATE_CRE=   1996/01/25 15:27:30
NUM_CMDS=   8
EARLIEST=
LATEST=
COMMENT=    This will be uplinked by SMOCC as soon as possible.
END
BINARY 0x1000,0x1,0x2,0x3,0x4,0x5,0x6,0x7,0x8,0x9,0xA,0xB,0xC,0xD,0xE,0xF,
0x0,0x1,0x2,0x3,0x4,0x5,0x6,0x7,0x8,0x9,0xA,0xB,0xC,0xD,0xE,0x1234;
BINARY 0x2000,0x1,0x2,0x3,0x4,0x5,0x6,0x7,0x8,0x9,0xA,0xB,0xC,0xD,0xE,0xF,
0x0,0x1,0x2,0x3,0x4,0x5,0x6,0x7,0x8,0x9,0xA,0xB,0xC,0xD,0xE,0x1234;
BINARY 0x3000,0x1,0x2,0x3,0x4,0x5,0x6,0x7,0x8,0x9,0xA,0xB,0xC,0xD,0xE,0xF,
0x0,0x1,0x2,0x3,0x4,0x5,0x6,0x7,0x8,0x9,0xA,0xB,0xC,0xD,0xE,0x1234;
BINARY 0x4000,0x1,0x2,0x3,0x4,0x5,0x6,0x7,0x8,0x9,0xA,0xB,0xC,0xD,0xE,0xF,
0x0,0x1,0x2,0x3,0x4,0x5,0x6,0x7,0x8,0x9,0xA,0xB,0xC,0xD,0xE,0x1234;
BINARY 0x5000,0x1,0x2,0x3,0x4,0x5,0x6,0x7,0x8,0x9,0xA,0xB,0xC,0xD,0xE,0xF,
0x0,0x1,0x2,0x3,0x4,0x5,0x6,0x7,0x8,0x9,0xA,0xB,0xC,0xD,0xE,0x1234;
BINARY 0x6000,0x1,0x2,0x3,0x4,0x5,0x6,0x7,0x8,0x9,0xA,0xB,0xC,0xD,0xE,0xF,
0x0,0x1,0x2,0x3,0x4,0x5,0x6,0x7,0x8,0x9,0xA,0xB,0xC,0xD,0xE,0x1234;
BINARY 0x7000,0x1,0x2,0x3,0x4,0x5,0x6,0x7,0x8,0x9,0xA,0xB,0xC,0xD,0xE,0xF,
0x0,0x1,0x2,0x3,0x4,0x5,0x6,0x7,0x8,0x9,0xA,0xB,0xC,0xD,0xE,0x1234;
BINARY 0x8000,0x1,0x2,0x3,0x4,0x5,0x6,0x7,0x8,0x9,0xA,0xB,0xC,0xD,0xE,0xF,
0x0,0x1,0x2,0x3,0x4,0x5,0x6,0x7,0x8,0x9,0xA,0xB,0xC,0xD,0xE,0x1234;
```

B.5 FORMAT FOR THE INSTRUMENTER INPUT TO THE ACTIVITY PLAN (IAP)

The IAP will be in the keyword format only. (Fixed format is no longer used)
Note that the keywords as listed below can be specified in any order. However, they must be used as described, and they are case sensitive.

SCIPLAN

The SCIPLAN entry specifies the first level of science planning information, i.e. the overall plan as developed during the weekly and daily science planning meetings. The xyz field which follows SCIPLAN_ should be descriptive of a specific science plan. It can be up to 10 alphanumeric characters long, no blanks embedded, but underscores are allowed. This field will be used to specify the occurence of Joint Operations Procedures (JOP). For example, SCIPLAN_JOP_3. All fields described as "strings" contain a maximum of 50 alphanumeric characters, blanks, commas and underscores being allowed.

SCIPLAN_xyz

STARTIME=	Start time of the special activity
ENDTIME=	End time of the special activity
INSTRUME=	Instrument or group implementing the planned activity
SCI_OBJ=	Scientific objective, e.g. "Bright Point Studies". (1)
SCI_SPEC=	(Optional). More specific scientific objective, e.g. "Density Profile". (1)
OBJECT=	Generic name for the object planned to be observed, from a limited list of possible objects, e.g., "Bright point". (1) (5)
OBJ_ID=	(Optional). Unique identifier for the object to be observed. Up to 6 alphanumeric characters, no blank embedded, e.g. BP. (5)
XCEN=Center of the instrument field-of-view along the solar X-axis (2) (3) (4)	
YCEN=Center of the instrument field-of-view along the solar Y-axis (2) (3) (4)	
NOTES=	(Optional). May include references to specific studies or rasters to be run. (1) (2)
PROG_ID=	(Optional). An ID number specifying that this observation is part of a continuing series. Up to 6 numeric characters.
CMP_NO=	(Optional). ID number of the coordinated observing program this observation supports. Up to 6 numeric characters.
DISTURB=	(Optional). Description of any possible disturbances. (1).
DATE_MOD=	(OPtional). Last date modified.

Notes :

(1) String.
(2) This field can be repeated if nercessary. The value can be an array of n elements: elements separated by a comma, no blanks embedded.
(3) Units are arc-seconds from Sun center for coordinates and degrees from Solar North for angles.
(4) Optional. Applies to coronal instruments only.
(5) The list of objects is provided at the end of this section.

PROGRAM

The PROGRAM entry is used to describe the specific programs that the instruments would run to satisfy the scientific objectives of the corresponding SCIPLAN activity: for each SCIPLAN entry, there will be a sequence of PROGRAM entries that represent the details of the SCIPLAN. The _xyz which follows PROGRAM is the name of the activity that the instrumenter provides. It can be up to 10 alphanumeric characters long, with no embedded blanks, but underscores are allowed.

PROGRAM_xyz

STARTIME=	Start time of the special activity
ENDTIME=	End time of the special activity
INSTRUME=	Instrument or group implementing the planned activity
OBS_PROG=	The observing program that will be run
SCI_OBJ=	Scientific objective, e.g. "Bright Point Studies". (1)
SCI_SPEC=	(Optional). More specific scientific objective, e.g. "Density Profile". (1)

OBJECT=	Generic name for the object planned to be observed, from a limited list of possible objects. (5)
OBJ_ID=	(Optional). Unique identifier for the object to be observed. Up to 6 characters. (5)
XCEN=	Center of the instrument field-of-view along the solar X-axis. (2) (3) (4)
YCEN=	Center of the instrument field-of-view along the solar Y-axis. (2) (3) (4)
ANGLE=	Rotation angle of vertical axis of instrument field-of-view relative to solar north. (2) (3) (4)
IXWIDTH=	Maximum width of the instrument field-of-view in the instrument X axis, i.e. the direction perpendicular to the vertical axis as used in keyword ANGLE. (2) (3) (4)
IYWIDTH=	Maximum width of the instrument field-of-view in the instrument Y axis, i.e. the direction perpendicular to the vertical axis as used in keyword ANGLE. (2) (3) (4)
PROG_ID=	(Optional). ID number specifying that this observation is part of a continuing series
CMP_NO=	(Optional). ID number of the coordinated observing program that this observation supports
DISTURB=	(Optional). Description of any possible disturbances
JITTER_LIMIT=	(Optional). Maximum amount of jitter allowable for this program and this instrument (in 1/10 arc-seconds)
STATUS=	Acceptance status (6)

Notes :

(1) String. The list of objects is provided at the end of this section.
(2) This field can be repeated if nercessary. The value can be an array of n elements: elements separated by a comma, no blanks embedded.
(3) Units are arc-seconds from Sun center for coordinates and degrees from Solar North for angles.
(4) Optional. Applies to coronal instruments only.
(5) The list of objects is provided at the end of this section.
(6) This keyword will only be present in the KAP. If present in the IAP, it will be ignored by the ECS. The possible values are REQUESTED, CONFIRMED, DENIED.

ACTIVITY

The ACTIVITY entry is used to specify predefined activities that the ECS planning system knows about, that is that have been entered in the knowledge base. These activities typically have constraints associated with them that are checked by the scheduling system. The xyz which follows ACTIVITY is the name of the predefined activity.

ACTIVITY_xyz (1)

STARTIME=	Start time of the special activity
ENDTIME=	End time of the special activity
INSTRUME=	Instrument or group implementing the planned activity
AMOUNT=	(Optional). Should be specified for certain activities such as jitter (1)
STATUS=	Acceptance status (2)

Notes :

(1) Example: specify the amount of jitter generated by this activity estimated in 1/10 arc-seconds.
(2) This keyword will only be present in the KAP. If present in the IAP, it will be ignored by the ECS. The possible values are REQUESTED, CONFIRMED, DENIED.

INST_IIE_MASTER and INST_IIE_RECEIVER

These entries are used to plan the role individual instruments in the Inter-Instrument Exchange (IIE). They are first included in the IAP for planning and coordination. The INST_IIE_MASTER entry is used by a given instrument to indicate that this instrument will be master for the specified period of time.

The INST_IIE_RECEIVER entry is used to specify that an instrument will be receiver for the specified period of time.

INST_IIE_MASTER

MSTR_TYPE=	Type of flag
INSTRUME=	Name of the master intrument
MSTR_START=	The start time for the instrument being the master
MSTR_STOP=	The stop time for the instrument being the master
STATUS=	Acceptance status (1)

INST_IIE_RECEIVER

INSTRUME=	Name of a receiving intrument
RCVR_START=	The start time for the instrument being a receiver
RCVR_STOP=	The stop time for the instrument being a receiver
STATUS=	Acceptance status (1)

Notes :

(1) This keyword will only be present in the KAP. If present in the IAP, it will be ignored by the ECS. The possible values are REQUESTED, CONFIRMED, DENIED.

INST_NRT_SESSION

The INST_NRT_SESSION entry is used to specify that an instrumenter is going to be doing near-real-time commanding during a specified period of time.

INST_NRT_SESSION

STARTIME=	Start time of the requested near-real-time commanding activity
ENDTIME=	End time of the requested near-real-time commanding activity
INSTRUME=	Instrument which will have near-real-time privileges
IWS_ID=	Identification of the IWS from which the NRT commanding activity will be performed
CMD_RATE=	Expected average number of commands per minute between start time and end time
STATUS=	Acceptance status for this activity (1)

Notes :

(1) This keyword will only be present in the KAP. The possible values are REQUESTED, CONFIRMED, DENIED. If present in the IAP, it will be ignored by the ECS.

INST_NRT_RESERVED

The INST_NRT_RESERVED entry is used to request a reserved time slot for some special near-real-time commanding activities. This time is reserved for that instrument and no other instrument can request time during that period.

INST_NRT_RESERVED

STARTIME=	Start time of the reserved time NRT commanding activity
ENDTIME=	End time of the reserved time NRT commanding activity
INSTRUME=	Instrument which will have reserved time
CMD_RATE=	Expected average number of OBDH block commands per minute between the start time and end time
STATUS=	Acceptance status for this activity (1)

Notes :

(1) This keyword will only be present in the KAP. If present in the IAP, it will be ignored by the ECS. The possible values are REQUESTED, CONFIRMED, DENIED.

INST_DELAYED_CMD

The INST_DELAYED_CMD entry is used to specify a time window during which a group of delayed commands must be uplinked.

INST_DELAYED_CMD	
EARLIEST=	Earliest uplink time
LATEST=	Latest uplink time
INSTRUME=	Instrument which will performed the delayed commanding
NUM_CMDS=	Number of obdh block commands to be uplinked
STATUS=	Acceptance status (1)

Notes :

(1) This keyword will only be present in the KAP. If present in the IAP, it will be ignored by the ECS. The possible values are REQUESTED, CONFIRMED, DENIED.

INST_TSTOL_EXECUTION

The INST_TSTOL_EXECUTION entry is used to specify a time window during which FOT will be required to execute a given TSTOL procedure.

INST_TSTOL_EXECUTION	
PROC_NAME=	Name of procedure to be executed by the FOT
EARLIEST=	Earliest execution time
LATEST=	Latest execution time
INSTRUME=	Instrument to which the procedure applies
DURATION=	Approximate duration for execution of the procedure (minutes)
STATUS=	Acceptance status (1)

Notes :

(1) This keyword will only be present in the KAP. If present in the IAP, it will be ignored by the ECS. The possible values are REQUESTED, CONFIRMED, DENIED.

LIST OF POSSIBLE OBJECTS

This list applies to the keywords OBJECT and OBJ_ID .

ARC	arcade
AFS	arch filament system
ANE	anemone
AR	active region
BP	bright point
CR	coronal rain
CH	coronal hole
COM	comet
COR	corona
CHR	chromosphere
CS	coronal streamer
CT	coronal transient
CUS	cusp
DB	disparation brusque
DC	disk center
DFL	disappearing filament
DFX	disapppearing flux
DF	downflow
EFL	emerging flux
EPR	eruptive prominence
EFI	erupting filament
EVF	evershed flow
FAC	faculae
FC	filament channel
FLC	flux cancellation
FLG	filigree
FIL	filament
FLR	flare
FP	footpoint
FS	full sun / full disk
FL	flow
GR	granulation
HR	hedge row
JET	jet
LB	loop brightening
LE	loop evacuation
LMB	solar limb
LO	loop
CME	coronal mass ejection
MHR	MDI high resolution field
MS	magnetic shear
MT	mercury transition
MW	moreton wave
NET	network
NL	neutral line
PC	polar crown
PCH	polar coronal hole
PEN	sunspot penumbra
PFL	postflare loops
PHO	photosphere
PLG	plage
POR	pore
PP	polar plume
PR	prominence
PLT	planet
QS	quiet sun
RIB	two-ribbon flare
SPR	spray
SG	supergranulation
SPI	spicule
SR	surge
SS	sunspot
ST	star
SW	solar wind
SYN	synoptic observation
TR	transition region
UF	upflow
UMB	sunspot umbra
VT	Venus transition
WAV	wave
WLF	white light flare

B.6 FORMAT FOR THE ECS ACTIVITY PLAN

The ECS Activity Plan will be available in two formats:

1) the keyword format, providing more flexibility (KAP)
2) the fixed format, providing more readability (EAP)

In addition to the keywords found in the IAP, the following keywords will be used in the KAP. These keywords originate from CMS/FOT and could be modified by operations personnel.

DSN_Contact_xyz

The DSN_Contact_xyz entry provides information on a given DSN contact. The _xyz field represents the ground station name, for example, _CAN or _MAD.

DSN_Contact_xyz

STARTIME=	Start time of contact for this station
ENDTIME=	End time of contact for this station

SVM_Reserved

The SVM_Reserved entry is used to indicate time periods that are reserved by the FOT to perform activities exclusively related to the service module. During these time periods, all instrument-related activities are excluded: near-real-time commanding, uplink of delayed commands and execution of TSTOL procedures for instrument operations.

SVM_Reserved
STARTIME=	Start time
ENDTIME=	End time

Payload_Reserved

The Payload_Reserved entry is used to indicate time periods that are reserved by the FOT but during which some payload operations activities can be performed. These include uplink of instrument delayed commands and execution of TSTOL procedures for instrument operations

Payload_Reserved
STARTIME=	Start time
ENDTIME=	End time

Throughput_RCR

The Throughput_RCR entry is used to specify time periods during which the throughput channel will be opened, the instrument teams will be allowed to command in near-real-time and send RCRs.

Throughput_RCR
STARTIME=	Start time of throughput mode with RCR allowed
ENDTIME=	End time of throughput mode with RCR allowed

Throughput_NoRCR

The Throughput_NoRCR entry is used to specify time periods during which the throughput channel will be opened, the instrument teams will be allowed to command in near-real-time and but RCRs will not be permitted.

Throughput_NoRCR
STARTIME=	Start time of throughput mode with RCR not allowed
ENDTIME=	End time of throughput mode with RCR not allowed

Spacecraft_Maneuver

The Spacecraft_Maneuver entry is provided by the FOT for informational purpose. This will allow the instrument teams to be aware of the occurrence of spacecraft maneuvers that may affect the operations of the instruments.

Spacecraft_Maneuver
STARTIME=	Start time of maneuver
ENDTIME=	End time of maneuver
NOTES=	Description of maneuver

Clock_Adjust

The Clock_Adjust entry is provided by the FOT for informational purpose. It will allow the instrument teams to be aware of upcoming OBT clock adjusts.

Clock_Adjust
STARTIME=	Start time / occurence of clock adjust
TYPE= Description of adjust / reset

TLM_Tape_Dump

The TLM_Tape_Dump entry is provided by the FOT for informational purpose. It will allow the instrument teams to be aware of planned times for tape recorder dumps.

TLM_Tape_Dump
STARTIME= Start time
ENDTIME= End time

TLM_MDI_M

The TLM_MDI_M entry is provided by the FOT for informational purpose. It will allow the instrument teams to be aware of planned times for MDI-M downlink.

TLM_MDI_M
STARTIME= Start time
ENDTIME= End time

TLM_MDI_H

The TLM_MDI_H entry is provided by the FOT for informational purpose. It will allow the instrument teams to be aware of planned times for MDI-H downlink.

TLM_MDI_H
STARTIME= Start time
ENDTIME= End time

TLM_HR_Idle

The TLM_HR_Idle entry is provided by the FOT for informational purpose. It will allow the instrument teams to be aware of planned times for idle high rate telemetry.

TLM_MDI_Idle
STARTIME= Start time
ENDTIME= End time

TLM_Mode

The TLM_Mode entry is provided by the FOT for informational purpose. It will allow the instrument teams to be aware of planned times for switching telemetry mode to low rate, medium rate, high rate or idle. The telemetry mode remains set to the current value until a new TLM_Mode entry changes it.

TLM_Mode
MODE= LR, MR HR or IDLE
STARTIME= The start time for this mode.

TLM_Submode

There are four TLM_Submode keywords that defines the start time for a given telemetry submode. This submode will remain in effect until it is modified by another TLM_Submode entry. The TLM-Sumode entries are input by the ECS operator once the weekly plan has been finalized. Since the FOT will be in attendance at the weekly and daily meetings, modifications to these entries by the FOT are not expected. There are four different telemetry submodes (1 to 4) applying to the medium and high rate telemtry modes.

TLM_Submode_1
STARTIME= The start of mode 1
TLM_Submode_2
STARTIME= The start of mode 2

TLM_Submode_3

STARTIME=	The start of mode 3

TLM_Submode_4

STARTIME=	The start of mode 4.

Other_Obs_xyz

The Other_Obs_xyz entry is used to describe other science programs and events which are of interest to the SOHO team. These activities will be input by the ECS operator interactively from the timeline editor. The possible keywords listed for this entry are similar to the SCIPLAN entry, and they will most likely not apply in many cases. The xyz field is descriptive of a specific event: it can be up to 10 alphanumeric characters, with no blanks embedded, but possible underscores. The Other_Obs_xyz entries may not be included in the IAP.

Other_Obs_xyz

STARTIME=	Start time of the support activity
ENDTIME=	End time of the support activity
TELESCOP=	Spacecraft or observatory implementing the activity
SCI_OBJ=	Scientific objective (1)
SCI_SPEC=	(Optional). More specific scientific objective (1)
OBJECT=	(Optional). Name of the object planned to be observed
OBJ_ID=	(Optional). Unique identifier for the object to be observed. Up to 6 alphanumeric characters, no blank embedded
NOTES=	(Optional). May include references to specific studies or rasters to be run. (1)
PROG_ID=	(Optional). An ID number specifying that this observation is part of a continuing series. Up to 6 numeric characters.
CMP_NO=	(Optional). ID number of the coordinated observing program this observation supports. Up to 6 numeric characters.
DISTURB=	(Optional). Description of any possible disturbances. (1).
DATE_MOD=	(Optional). Last date modified.

Notes : (1) Strings.

B.7 ECS COMBINED ACTIVITY PLAN FILE FORMAT

The Combined Activity Plan (CAP) is the file that ECS receives from the IDL planning tool. The IDL Planning tool will be used to support the weekly and daily science planning meetings. It generates the CAP file which allows to input the results of the science planning meetings into the ECS planning system. The CAP contains the SCIPLAN entries for certain instrumenters.
The CAP does not apply to the interface between ECS and the Instrumenters and its description is included for reference only.

The CAP file header is as follows:

KEYWORD	DESCRIPTION
DATATYPE	"COMBINED ACTIVITY PLAN"
FILENAME	Name of this file: (see Appendix A) ECScccccccccccc.CAP
INSTRUME	"ECS"
ORIG_ID	E-mail address where a validation report on the CAP will be sent.
OBSERVER	Person who generated this file
DATE_CRE	Date file was created YYYY/MM/DD HH:MM:SS (GMT)
STARTIME	Start time of period covered YYYY/MM/DD HH:MM:SS (GMT) where HH:MM:SS is 00:00:00 for a given day DD
ENDTIME	End time of period covered YYYY/MM/DD HH:MM:SS (GMT) where HH:MM:SS is 00:00:00 for day DD+1
COMMENT	Free text. This keyword may be repeated to allow several comment lines
END	

The CAP file body is in the keyword format and is identical to the format of the IAP described in section 3.5.1. However, the CAP only contains SCIPLAN entries.

The ECS planning system receives the CAP and merges its content with existing IAPs that may have been received from the instrumenters. For all the IAPs older than the CAP, all the SCIPLAN entries in the appropriate IAPs are replaced by the SCIPLAN entries in the CAP. Later, if ECS receives updated IAPs, ECS replaces the SCIPLAN entries from the CAP by the SCIPLAN entries from the new the IAPs.

B.8 COMMAND HISTORY REPORT EXAMPLE

NOTE: This is an example of the report which is produced by CMS and is described in Reference 8.

***** COMMAND HISTORY REPORT *****

```
95-265-16:34:19.3   6400   CMS MSG SENT:  0604   11ENABLE
95-265-16:34:41.2   6382   /NRT: remote command request processing has been enabled
95-265-16:37:25.0   6400   CMS MSG SENT:  0604   11RCREN
95-265-16:37:25.0   6415   CPAGE LINE:  0002 16:37:29 NRT 201 018 01 001 001 N  N
95-265-16:37:48.0   6354   /SEND:  command block successfully transmitted
95-265-16:37:48.0   6372   nrt group uplinked with verification on: CDS   14307
95-265-16:37:49.0   6400   CMS MSG SENT:  0601   59CDS   140370501-7Uplink begun with verification
95-265-16:38:10.0   6303   BARM:  TCB #201,1st mnem: CDS   14307, 1st tcm seq:1, 1st tcmseq:1 VERIFIED
95-265-16:38:10.0   6400   CMS MSG SENT:  0601   59CDS   1403705010Uplink verified
.
.
.
```

***** BACKGROUND QUEUE STATUS REPORT *****

Instr File	Time Received	Time to POCC	Status
MDITBL0001.BCK	1995/11/11 17:00:39	1995/11/12 03:10:10	Uplink Verified
MDITBL0002.BCK	1995/11/11 17:01:00	1995/11/12 03:10:12	Uplink Verified
MDITBL0003.BCK	1995/11/11 17:02:00	1995/11/12 03:10:14	Uplink Verified
MDITBL0004.BCK	1995/11/11 17:03:00	1995/11/12 03:10:15	Uplink Failed - BARM

B.9 TELEMETRY GAP REPORT EXAMPLE

***** TELEMETRY GAP REPORT *****

MISSION: SOHO
TIME RANGE: (START) 1995/08/22 00:00:00 (STOP) 1995/08/22 23:59:59

PACKET NAME	APID	MISSING SEQNUMS	START TIME	STOP TIME
SWACC	88CA	11 11	1995/08/22 14:06:10	1995/08/22 14:06:22
SWACC	88CA	26 28	1995/08/22 14:08:31	1995/08/22 14:08:50
MDISC	88C5	150 155	1995/08/22 14:42:10	1995/08/22 14:43:22
MDISC	88C5	226 228	1995/08/22 14:44:31	1995/08/22 14:44:50

B.10 ECS COMMANDING STATUS WINDOW

B.11 ECS TELEMETRY DISTRIBUTION MONITORING WINDOW

B.12 ECS DIRECTORIES

Data	Directory Name	Access by Insts	
Delayed commanding data	/iws_files/delcmd	Write SecureID	One directory for all instruments
Background-queue commanding data	/iws_files/bckque	Write SecureID	One directory for all instruments
Command validation reports	/cms_files/inputval	Read	One directory to store the validation reports generated by CMS for both delayed and background-queue commanding.
Science Activity plan	/iws_files/output_actplan	Read	Contains the ECS science activity plan for retrieval by the instrumenters.
Input to the Activity plan	/iws_files/input_actplan	Write	One directory is used by the instrumenters to deposit their input to the activity plan.
Archived telemetry data	/tlm_files/SVMHK1 /tlm_files/SVMHK2 /tlm_files/SVMHK3 /tlm_files/SVMHK4 /tlm_files/AOCHK1 /tlm_files/AOCHK2 /tlm_files/ATTIT1 /tlm_files/ATTIT2 /tlm_files/CDSHK /tlm_files/CDSSCH /tlm_files/CDSSCL /tlm_files/CDSSCM /tlm_files/CELHK /tlm_files/CELSC1 /tlm_files/CEPHK /tlm_files/CEPSC /tlm_files/ELAHK1 /tlm_files/ELAHK2 /tlm_files/ELAHK3 /tlm_files/ELASCH /tlm_files/ELASCL /tlm_files/EXPHK /tlm_files/GOLHK /tlm_files/GOLSC /tlm_files/MDIHK1 /tlm_files/MDIHK2 /tlm_files/MDIHR /tlm_files/MDISC /tlm_files/OBT /tlm_files/SUMHK /tlm_files/SUMSCH /tlm_files/SUMSCL /tlm_files/SW /tlm_files/SWAHK /tlm_files/SWASC /tlm_files/UVCHK /tlm_files/UVCSSC /tlm_files/VIRHK /tlm_files/VIRSC	Read	One directory for each APID ECS will automatically send files to a list of "default destinations". Instrumenters may also read data when needed.

Data	Directory Name	Access by Insts	
Telemetry Quicklook	/tlm_files/quicklook	Read	Contains telemetry quicklook files.
Telemetry Reports	/tlm_files/reports	Read	Contains the telemetry gap reports.
Summary data	/iws_files/sum_data	Write Read	One directory that contains all summary data (as deposited by instrumenters and as prepared for CDHF). All summary data files may be read by the instrumenters.
Orbit data	/cdhf_files/orbit_data	Read	Contains predictive and definitive orbit data.
Attitude data	/cdhf_files/attitude_data	Read	Contains the definitive attitude data.
Command history	/ancillary_data/chr	Read	One directory can be accessed by the instrumenters for file retrieval
Time correlation log	/ancillary_data/tcf	Read	One directory can be accessed by the instrumenters for file retrieval
SOHO Daily Report	/ancillary_data/sdr	Read	One directory can be accessed by the instrumenters for file retrieval
Project Data Base	/pdb_files	Read	Approximately 30 project data base files

APPENDIX C. ARCHIVED TELEMETRY FILE FORMAT

Production Data Format

<table>
<tr><td>Source Data Units</td><td colspan="2">Telemetry packet 1
Telemetry packet 2
Telemetry packet 3
. . .
. . .
. . .
. . .
. . .
. . .
. . .
. . .
Telemetry packet n</td></tr>
<tr><td>Quality and Accounting List Length</td><td colspan="2">32-bit integer specifying the length in bytes of the Quality and Accounting List</td></tr>
<tr><td rowspan="6">Quality and Accounting List</td><td>Offset of Data Unit</td><td>(32-bits): Position of errored packet in this file</td></tr>
<tr><td>Data Unit sequence number</td><td>(16-bits): Sequence number of packet in error</td></tr>
<tr><td>Error Type Flags</td><td>(8-bits): type of errors found
Bit 0 Not used
Bit 1 R-S header errors
Bit 2 Length code wrong
Bit 3 R-S frame errors
Bit 4 CRC frame errors
Bit 5 Sequence count error
Bit 6 Detected frame errors
Bit 7 Contain fill data</td></tr>
<tr><td>Count of segments CRC/RS errors</td><td>(8-bits): number of segments from frames with errors</td></tr>
<tr><td>Spare</td><td>(32-bits)</td></tr>
<tr><td>Fill start location</td><td>(16-bits); byte location of start of fill. 0000 for no fill</td></tr>
<tr><td>Missing Data Units List Length</td><td colspan="2">32-bit integer specifying the length in bytes of the missing data units list</td></tr>
<tr><td rowspan="3">Offset to Missing Data Units List</td><td>Offset to Missing Data Units List</td><td>(32-bit): position of start of data unit immediately preceding the first data unit of the list</td></tr>
<tr><td>From</td><td>Data unit sequence number</td></tr>
<tr><td>To</td><td>Data unit sequence number</td></tr>
</table>

Interface Control Document
Between
the Solar and Heliospheric Observatory (SOHO)
Experimenters' Operations Facility (EOF)
Core System (ECS)
and the SOHO Instrumenters

Revision 1

October 1995

May 1995

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May 1995

Approved By:

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FORMAT FOR THE INSTRUMENTER INPUT TO THE ACTIVITY PLAN (IAP)

The IAP will be in the keyword format only. (Fixed format is no longer used)
Note that the keywords as listed below can be specified in any order. However, they must be used as described, and they are case sensitive.

SCIPLAN

The SCIPLAN entry specifies the first level of science planning information, i.e. the overall plan as developed during the weekly and daily science planning meetings. The xyz field which follows SCIPLAN_ should be descriptive of a specific science plan. It can be up to 10 alphanumeric characters long, no blanks embedded, but underscores are allowed. This field will be used to specify the occurence of Joint Operations Procedures (JOP). For example, SCIPLAN_JOP_3. All fields described as "strings" contain a maximum of 50 alphanumeric characters, blanks, commas and underscores being allowed.

SCIPLAN_xyz

STARTIME=	Start time of the special activity
ENDTIME=	End time of the special activity
INSTRUME=	Instrument or group implementing the planned activity
SCI_OBJ=	Scientific objective, e.g. "Bright Point Studies". (1)
SCI_SPEC=	(Optional). More specific scientific objective, e.g. "Density Profile". (1)
OBJECT=	Generic name for the object planned to be observed, from a limited list of possible objects, e.g., "Bright point". (1)
OBJ_ID=	(Optional). Unique identifier for the object to be observed. Up to 6 alphanumeric characters, no blank embedded, e.g. BP
NOTES=	(Optional). May include references to specific studies or rasters to be run. (1) (2)
PROG_ID=	(Optional). An ID number specifying that this observation is part of a continuing series. Up to 6 numeric characters.
CMP_NO=	(Optional). ID number of the coordinated observing program this observation supports. Up to 6 numeric characters.
DISTURB=	(Optional). Description of any possible disturbances. (1).
DATE_MOD=	(OPtional). Last date modified.

Notes :
(1) String.
(2) This field can be repeated if necessary.

PROGRAM

The PROGRAM entry is used to describe the specific programs that the instruments would run to satisfy the scientific objectives of the corresponding SCIPLAN activity: for each SCIPLAN entry, there will be a sequence of PROGRAM entries that represent the details of the SCIPLAN. The _xyz which follows PROGRAM is the name of the activity that the instrumenter provides. It can be up to 10 alphanumeric characters long, with no embedded blanks, but underscores are allowed.

PROGRAM_xyz

STARTIME=	Start time of the special activity
	ENDTIME= End time of the special activity
INSTRUME=	Instrument or group implementing the planned activity
OBS_PROG=	The observing program that will be run
SCI_OBJ=	Scientific objective, e.g. "Bright Point Studies". (1)
SCI_SPEC=	(Optional). More specific scientific objective, e.g. "Density Profile". (1)
OBJECT=	Generic name for the object planned to be observed, from list of possible objects. (1)
OBJ_ID=	(Optional). Unique identifier for the object to be observed. Up to 6 characters.
XCEN=	Center of the instrument field-of-view along the solar X-axis. (2) (3)
YCEN=	Center of the instrument field-of-view along the solar Y-axis. (2) (3)
ANGLE=	Rotation angle of vertical axis of instrument field-of-view relative to solar north. (2) (3)

IXWIDTH=	Maximum width of the instrument field-of-view in the instrument X axis, i.e. the direction perpendicular to the vertical axis as used in keyword ANGLE. (2) (3)
IYWIDTH=	Maximum width of the instrument field-of-view in the instrument Y axis, i.e. the direction perpendicular to the vertical axis as used in keyword ANGLE. (2) (3)
PROG_ID=	(Optional). ID number specifying that this observation is part of a continuing series
CMP_NO=	(Optional). ID number of the coordinated observing program that this observation supports
DISTURB=	(Optional). Description of any possible disturbances
JITTER_LIMIT=	(Optional). Maximum amount of jitter allowable for this program and this instrument (in 1/10 arc-seconds)

Notes :

(1) String. The list of objects is provided below.
(2) This field can be repeated if nercessary. The value can be an array of n elements: elements separated by a comma, no blanks embedded.
(3) Units for coordinates are arc-seconds from Sun center and degrees from Solar North for angles.

ACTIVITY

The ACTIVITY entry is used to specify predefined activities that the ECS planning system knows about, that is that have been entered in the knowledge base. These activities typically have constraints associated with them that are checked by the scheduling system. The xyz which follows ACTIVITY is the name of the predefined activity.

ACTIVITY_xyz (1)

STARTTIME=	Start time of the special activity
ENDTIME=	End time of the special activity
INSTRUME=	Instrument or group implementing the planned activity
AMOUNT=	(Optional). Should be specified for certain activities such as jitter (1)

Notes :

(1) Example for jitter: specify the amount of jitter generated by this activity estimated in 1/10 arc-seconds.

INST_IIE_MASTER and INST_IIE_RECEIVER

These entries are used to plan the role individual instruments in the Inter-Instrument Exchange (IIE). They are first included in the IAP for planning and coordination. The INST_IIE_MASTER entry is used by a given instrument to indicate that this instrument will be master for the specified period of time. The INST_IIE_RECEIVER entry is used to specify that an instrument will be receiver for the specified period of time.

INST_IIE_MASTER

MSTR_TYPE=	Type of flag
INSTRUME=	Name of the master intrument
MSTR_START=	The start time for the instrument being the master
MSTR_STOP=	The stop time for the instrument being the master
STATUS=	Acceptance status (1)

INST_IIE_RECEIVER

INSTRUME=	Name of a receiving intrument
RCVR_START=	The start time for the instrument being a receiver
RCVR_STOP=	The stop time for the instrument being a receiver
STATUS=	Acceptance status (1)

Notes :

(1) This keyword will only be present in the EAP. The possible values are REQUESTED, CONFIRMED, DENIED. If present in the IAP, it will be ignored by the ECS.

INST_NRT_SESSION

The INST_NRT_SESSION entry is used to specify that an instrumenter is going to be doing near-real-time commanding during a specified period of time.

INST_NRT_SESSION

STARTTIME=	Start time of the requested near-real-time commanding activity
ENDTIME=	End time of the requested near-real-time commanding activity
INSTRUME=	Instrument which will have near-real-time privileges
IWS_ID=	Identification of the IWS from which the NRT commanding activity will be performed
CMD_RATE=	Expected average number of commands per minute between start time and end time
STATUS=	Acceptance status for this activity (1)

Notes :

(1) This keyword will only be present in the EAP. The possible values are REQUESTED, CONFIRMED, DENIED. If present in the IAP, it will be ignored by the ECS.

INST_NRT_RESERVED

The INST_NRT_RESERVED entry is used to request a reserved time slot for some special near-real-time commanding activities. This time is reserved for that instrument and no other instrument can request time during that period.

INST_NRT_RESERVED

STARTTIME=	Start time of the reserved time NRT commanding activity
ENDTIME=	End time of the reserved time NRT commanding activity
INSTRUME=	Instrument which will have reserved time
CMD_RATE=	Expected average number of OBDH block commands per minute between the start time and end time
STATUS=	Acceptance status for this activity (1)

Notes :

(1) This keyword will only be present in the EAP. The possible values are REQUESTED, CONFIRMED, DENIED. If present in the IAP, it will be ignored by the ECS.

INST_DELAYED_CMD

The INST_DELAYED_CMD entry is used to specify a time window during which a group of delayed commands must be uplinked.

INST_DELAYED_CMD

EARLIEST=	Earliest uplink time
LATEST=	Latest uplink time
INSTRUME=	Instrument which will performed the delayed commanding
NUM_CMDS=	Number of obdh block commands to be uplinked

INST_TSTOL_EXECUTION

The INST_TSTOL_EXECUTION entry is used to specify a time window during which FOT will be required to execute a given TSTOL procedure.

INST_TSTOL_EXECUTION

PROC_NAME	Name of procedure to be executed by the FOT
EARLIEST=	Earliest execution time
LATEST=	Latest execution time
INSTRUME=	Instrument to which the procedure applies
DURATION=	Approximate duration for execution of the procedure (minutes)

FORMAT FOR THE ECS ACTIVITY PLAN (EAP)

The EAP will be available in two formats:

1) **the keyword format, providing more flexibility**
2) **the fixed format, providing more readability**

In addition to the keywords found in the IAP, the following keywords will be used in the EAP.

Keywords originating from CMS/FOT (Still to be confirmed)

DSN_Contact_xyz

The DSN_Contact_xyz entry provides information on a given DSN contact. The _xyz field represents the ground station name, for example, _CAN or _MAD.

```
DSN_Contact_xyz
    STARTIME=       Start time of contact for this station
    ENDTIME=        End time of contact for this station
```

SVM_Reserved

The SVM_Reserved entry is used to indicate time periods that are reserved by the FOT to perform activities exclusively related to the service module. During these time periods, all instrument-related activities are excluded: near-real-time commanding, uplink of delayed commands and execution of TSTOL procedures for instrument operations.

```
SVM_Reserved
    STARTIME=       Start time
    ENDTIME=        End time
```

Payload_Reserved

The Payload_Reserved entry is used to indicate time periods that are reserved by the FOT but during which some payload operations activities can be performed. These include uplink of instrument delayed commands and execution of TSTOL procedures for instrument operations

```
Payload_Reserved
    STARTIME=       Start time
    ENDTIME=        End time
```

Throughput_RCR

The Throughput_RCR entry is used to specify time periods during which the throughput channel will be opened, the instrument teams will be allowed to command in near-real-time and send RCRs.

```
Throughput_RCR
    STARTIME=       Start time of throughput mode with RCR allowed
    ENDTIME=        End time of throughput mode with RCR allowed
```

Throughput_NoRCR

The Throughput_NoRCR entry is used to specify time periods during which the throughput channel will be opened, the instrument teams will be allowed to command in near-real-time and but RCRs will not be permitted.

```
Throughput_NoRCR
    STARTIME=       Start time of throughput mode with RCR not allowed
    ENDTIME=        End time of throughput mode with RCR not allowed
```

Spacecraft_Maneuver
The Spacecraft_Maneuver entry is provided by the FOT for informational purpose. This will allow the instrument teams to be aware of the occurrence of spacecraft maneuvers that may affect the operations of the instruments.

```
Spacecraft_Maneuver
    STARTIME=       Start time of maneuver
    ENDTIME=        End time of maneuver
    NOTES=          Description of maneuver
```

Clock_Adjust
The Clock_Adjust entry is provided by the FOT for informational purpose. It will allow the instrument teams to be aware of upcoming OBT clock adjusts.

```
Clock_Adjust
    STARTIME=       Start time/occurence of clock adjust
    TYPE=           Description of adjust/reset
```

TLM_Tape_Dump
The TLM_Tape_Dump entry is provided by the FOT for informational purpose. It will allow the instrument teams to be aware of planned times for tape recorder dumps.

```
TLM_Tape_Dump
    STARTIME=       Start time
    ENDTIME=        End time
```

TLM_MDI_M
The TLM_MDI_M entry is provided by the FOT for informational purpose. It will allow the instrument teams to be aware of planned times for MDI-M downlink.

```
TLM_MDI_M
    STARTIME=       Start time
    ENDTIME=        End time
```

TLM_MDI_H
The TLM_MDI_H entry is provided by the FOT for informational purpose. It will allow the instrument teams to be aware of planned times for MDI-H downlink.

```
TLM_MDI_H
    STARTIME=       Start time
    ENDTIME=        End time
```

TLM_HR_Idle
The TLM_HR_Idle entry is provided by the FOT for informational purpose. It will allow the instrument teams to be aware of planned times for idle high rate telemetry.

```
TLM_MDI_Idle
    STARTIME=       Start time
    ENDTIME=        End time
```

TLM_Mode
The TLM_Mode entry is provided by the FOT for informational purpose. It will allow the instrument teams to be aware of planned times for switching telemetry mode to low rate, medium rate, high rate or idle. The telemetry mode remains set to the current value until a new TLM_Mode entry changes it.

TLM_Mode

MODE=	LR, MR HR or IDLE
STARTIME=	The start time for this mode.

TLM_Submode

There are four TLM_Submode keywords that defines the start time for a given telemetry submode. This submode will remain in effect until it is modified by another TLM_Submode entry. The TLM-Sumode entries are input by the ECS operator once the weekly plan has been finalized. Since the FOT will be in attendance at the weekly and daily meetings, modifications to these entries by the FOT are not expected. There are four different telemetry submodes (1 to 4) applying to the medium and high rate telemtry modes.

TLM_Submode_1

STARTIME=	The start of mode 1

TLM_Submode_2

STARTIME=	The start of mode 2

TLM_Submode_3

STARTIME=	The start of mode 3

TLM_Submode_4

STARTIME=	The start of mode 4.

Other_Obs_xyz

The Other_Obs_xyz entry is used to describe other science programs and events which are of interest to the SOHO team. These activities will be input by the ECS operator interactively from the timeline editor. The possible keywords listed for this entry are similar to the SCIPLAN entry, and they will most likely not apply in many cases. The xyz field is descriptive of a specific event: it can be up to 10 alphanumeric characters, with no blanks embedded, but possible underscores. The Other_Obs_xyz entries may not be included in the IAP.

Other_Obs_xyz

STARTIME=	Start time of the support activity
ENDTIME=	End time of the support activity
TELESCOP=	Spacecraft or observatory implementing the activity
SCI_OBJ=	Scientific objective (1)
SCI_SPEC=	(Optional). More specific scientific objective (1)
OBJECT=	(Optional). Name of the object planned to be observed
OBJ_ID=	(Optional). Unique identifier for the object to be observed. Up to 6 alphanumeric characters, no blank embedded
NOTES=	(Optional). May include references to specific studies or rasters to be run. (1)
PROG_ID=	(Optional). An ID number specifying that this observation is part of a continuing series. Up to 6 numeric characters.
CMP_NO=	(Optional). ID number of the coordinated observing program this observation supports. Up to 6 numeric characters.
DISTURB=	(Optional). Description of any possible disturbances. (1).
DATE_MOD=	(Optional). Last date modified.

Notes : (1) Strings.

LIST of Possible Objects

ARC	arcade
AFS	arch filament system
ANE	anemone
AR	active region
BP	bright point
CR	coronal rain
CH	coronal hole
COM	comet
COR	corona
CHR	chromosphere
CS	coronal streamer
CT	coronal transient
CUS	cusp
DB	disparation brusque
DC	disk center
DFL	disappearing filament
DFX	disapppearing flux
DF	downflow
EFL	emerging flux
EPR	eruptive prominence
EFI	erupting filament
EVF	evershed flow
FAC	faculae
FC	filament channel
FLC	flux cancellation
FLG	filigree
FIL	filament
FLR	flare
FP	footpoint
FS	full sun
FL	flow
GR	granulation
HR	hedge row
JET	jet
LB	loop brightening
LE	loop evacuation
LMB	solar limb
LO	loop
CME	coronal mass ejection
MS	magnetic shear
MT	mercury transition
MW	moreton wave
NET	network
NL	neutral line
PC	polar crown
PCH	polar coronal hole
PEN	sunspot penumbra
PFL	postflare loops
PHO	photosphere
PLG	plage
POR	pore
PP	polar plume
PR	prominence
PLT	planet
QS	quiet sun
RIB	two-ribbon flare
SPR	spray

SG	supergranulation
SPI	spicule
SR	surge
SS	sunspot
ST	star
SW	solar wind
SYN	synoptic observation
TR	transition region
UF	upflow
UMB	sunspot umbra
VT	Venus transition
WAV	wave
WLF	white light flare

3.5 PLANNING AND SCHEDULING DATA SPECIFICATION

There are two types of data related to the planning functions: the ECS activity (EAP) plan which ECS sends to the instrumenters and the instrumenters' input to the activity plan (IAP). These data are in a file format as described in the following sections.

3.5.1 INSTRUMENTERS INPUT TO THE ACTIVITY PLAN

The instrumenters' Input to the Activity Plan is a file used by each instrument team to specify their activity requests. One input file relates to a single instrument and covers an entire single operational day. When updates and modifications are necessary, the IAP for the entire operational day must be re-submitted to the ECS. In order to allow for greater flexibility in the input, the "keyword=value" format is used for the IAP files.

3.5.1.1 Input to the Activity Plan File Header

The IAP file header is defined in table 3.11.

Table 3.11. File Header for the Instrumenter Input to the Activity Plan

KEYWORD	DESCRIPTION
DATATYPE	"INSTRUMENTER INPUT TO THE ACTIVITY PLAN"
FILENAME	Name of this file: iiicccccccccc.IAP (see Appendix A)
INSTRUME	Instrument for which this IAP is submitted (see section 3.1.4)
ORIG_ID	E-Mail address where a validation report on the IAP will be sent
OBSERVER	Person who generated this file
DATE_CRE	Date file was created YYYY/MM/DD HH:MM:SS (GMT)
STARTIME	Start time of period covered YYYY/MM/DD HH:MM:SS (GMT) ECS will assume that HH:MM:SS is 00:00:00
ENDTIME	End time of period covered YYYY/MM/DD HH:MM:SS (GMT) ECS will assume that HH:MM:SS is 00:00:00 for the day following the start time
COMMENT	Free text. This keyword may be repeated to allow several comment lines
END	

3.5.1.2 Input to the Activity Plan File Body Format

The file body is in the keyword format. It contains a list of statements, each statement consisting of a series of fields of the form KEYWORD = value.

The keywords that may be used in the IAP are defined in the Software User's Guide (Reference 13).

Notes:

- Comment lines may be inserted anywhere in the IAP file. They consist of the keyword COMMENT= followed by free text.

- Typically, the duration of an activity is specified using the STARTIME= and ENDTIME=

keywords, followed by a time field.
All time fields are in the standard format YYYY/MM/DD HH:MM:SS.

- The originator ID (ORIG_ID) must be a valid E-Mail address where a validation report on the IAP will be sent: when the IAP is received, the ECS planning software validates it and generates a report indicating errors if any where found. This report is sent in the form of an E-mail message to the address indicated in the ORIG_ID field. This address will also be used to send availability notifications for the EAP.

3.5.2 ECS ACTIVITY PLAN

The ECS Activity plan (EAP) is a file containing information provided by the SMOCC such as DSN schedule and FOT reserved times as well as merged activity requests as specified by the instrumenters in the IAP files. The activity plan file is made available in two different formats: the fixed-field format which provides more readability but limits the amount of information provided, and the keyword format which offers more flexibitity.

3.5.2.1 ECS Activity Plan File Header

The activity plan file header is defined in table 3.10.

Table 3.10. File Header for the ECS Activity Plan

KEYWORD	DESCRIPTION
DATATYPE	"ECS ACTIVITY PLAN"
FILENAME	Name of this file: (see Appendix A) ECSYYYYMMDDHHv.EAP for files in the fixed-field format ECSYYYYMMDDHHv.KAP for files in the keyword format
OBSERVER	Person who generated this file
DATE_CRE	Date file was created YYYY/MM/DD HH:MM:SS (GMT)
STARTIME	Start time of period covered YYYY/MM/DD HH:MM:SS (GMT) where HH:MM:SS is 00:00:00 for a given day DD
ENDTIME	End time of period covered YYYY/MM/DD HH:MM:SS (GMT) where HH:MM:SS is 00:00:00 for day DD+1
OUT_FORM	Format indicator KEYWORD for the keyword format FIXED_FIELD for the fixed field format
COMMENT	Free text. This keyword may be repeated to allow several comment lines
END	

3.5.2.2 ECS Activity Plan Fixed-field Format

In the fixed-field format, the file body for the ECS activity plan is an ASCII-text formatted report. Each line corresponds to the description of one activity and contains the following in fixed-length fields:

FIELD NAME	BYTE NUMBER	LENGTH (BYTES)	DESCRIPTION

Activity	1	20	Name of the activity or ressource (see keywords as defined in SUG, Ref 13)
Blank-fill	20	2	
Activity Qualifier	22	6	Instrument performing the activity or Ground station ID for DSN contacts or Originating entity for the activity such a FOT or SOC
Blank-fill	28	2	
Start Time	30	19	Start time of the activity in the format YYYY/MM/DD HH:MM:SS
Blank-fill	49	2	
End Time	51	19	End time of the activity in the format YYYY/MM/DD HH:MM:SS
Blank-fill	70	2	
Duration	72		Duration of the activity in the format HH:MM:SS
Blank-fill	80	2	
Description/Comment (optional)	82	80	Textual description of or remarks applying to the activity
New-line separator	162	1	X'0A'

An example of the proposed fixed-field format is included in Appendix B.

3.5.2.3 <u>ECS Activity Plan Keyword Format</u>

In the keyword format, the file body for the ECS activity plan is ASCII text. Refer to The User's Guide (Reference 13) for a list of valid keywords and their format specification.

SOHO Acronyms

750 SGP/OL-A   750th Space Group/Operating Location-A
AAD   Attitude Anomaly Detector
ACE   Advanced Composition Explorer
ACS   Attitude Control System
ACU   Attitude Control Unit
ADC   Analog to Digital Converter
AFSCF   Air Force Satellite Control Facility
AFSCN   Air Force Satellite Control Network
AFT   Abbreviated Functional Test
AGO   Santiago Ground Station
AGSS   Attitude Ground Support System
AI   Associate Investigator
AIS   Automated Information Security
AIT   Assembly, Integration and Test
AIT   Atomic International Time
AIV   Assembly-Integration-Verification
AN   Analog
ANT   Antenna
ANTS   Antenna Subsystem
AOCE   Attitude and Orbit Control Electronics
AOS   Acquisition of Signal
AOCS   Attitude and Orbit Control System
AOCMS   Attitude and Orbit Control Measurement System
AP   Application Processors
APID   Application Identification
APM   Antenna Pointing Mechanism
APME   Attitude Pointing Mechanism Electronics
ARO   Automatic Reconfiguration Order
ARq   Authentication Request
ARs   Authentication Response
ASE   Airborne Support Equipment
ASW   Address and Synchronization Word
ASW   Application Software
AT   Acceptance Testing
ATSC   AlliedSignal Technical Services Corporation
AUX   Auxiliary
AVD   Alternate Voice/Data

BARM   Block Acceptance Reporting Mechanism
BAS   Block Acquisition Sequence
BCP1   Broadcast Pulse 1
BCP3   Broadcast Pulse 3 (LOBT clock)
BDR   Battery Discharge Regulator
BECO   Booster Engine Cutoff
BER   Bit Error Rate
BI0-L   Biphase - Level
BITNET Because It is Time NETwork
BOL   Beginning of Life
BRD   Broadcast (MACS bus transition)
BRML   Block Recorder Mission Log
BRU   Battery Regulation Unit
BSR   Back Surface Reflection

CAE   Control and Actuation Electronic
CAN   Canberra (DSN Station)
CBH   Catalyst Bed Heater
CCAFS   Cape Canaveral Air Force Station
CCAM   Collision and Contamination Avoidance Maneuver
CCB   Configuration Control Board
CCD   Charge Coupled Device
CCL   Close Circuit Loop
CCOM   Control Center Operations Manager

```
CCR     Configuration Change Requests
CCS     Central Checkout System
CCSDS   Consultive Committee for Space Data Systems
CCSM    Control Center Systems Manager
CCTV    Close Circuit Television
C&DH    Command and Data Handling
CDDI    Copper Distributed Data Interface
CDF     Common Data Format (SFDU data format)
CDHF    Central Data Handling Facility
CDMU    Central Data Management Unit
CDR     Critical Design Review
CDS     Coronal Diagnostic Spectrometer
CE      Communications Engineer
CELIAS  Charge, Element and Isotope Analysis System
CEPAC   COSTEP-ERNE Particle Analysis Collaboration
CfA     Harvard-Smithsonian Center for Astrophysics, USA
CM      Configuration Management
CM      Continuus Memory Format
CMD     Command
CMO     Configuration Management Office
CMP     Configuration Management Plan
CMS     Command Management System
CMSE    Command Management Systems Engineer
CNRS    Centre National de la Recherche Scientifique
COBS    Central On Board Software
COSTEP  Comprehensive Supra Thermal and Energetic Particle Analyzer
COSTR   Collaborative Solar-Terrestrial Research
COTS    Commercial Off the Shelf Software
CPM     Command Pulse Module
CRC     Cyclical Redundancy Coding
CRT     Cathode Ray Tube
CSPAAD  Coarse Sun Pointing Attitude Anomaly Detection
CSO     Computer Security Officials
CSTC    Consolidated Satellite Test Center
CTA     Controlled Thrust Assembly
CTA-21  Compatibility Test Area (JPL)
CTOF    Charge Time-Of-Flight
CTV     Compatibility Test Van
CTU     Central Terminal Unit
Co-I    Co-Investigator

D/L     Downlink
DAA     Data Availability Acknowledgment
DAN     Data Availability Notice
dB      Decibels
DB      Digital Bilevel acquisition
dBI     Decibels referenced to Isotropic gain
dBm     Decibels referenced to one milliwatt
dBW     Decibels referenced to one watt
DC      Direct Command
DCF     Data Capture Facility
DCN     Document Change Notice
DDA     Data Delivery Acknowledgement
DDF     Data Distribution Facility
DDFM    Data Distribution Facility Manager
DDN     Data Delivery Notice
DEL     Data Evaluation Laboratory
DEM     Demodulator
DFCD    Data Format Control Documents
DFD     Data Flow Diagram
DGIB    DSN/GSFC Interface Blocks
DGS     Diego Garcia Station
DHP     Direct High Power
DHSS    Data Handling Subsystem
DL      Downlink
```

```
DM      Data Management
DML     Direct Memory Load
DMR     Detailed Mission Requirements
DMR1    Detailed Mission Requirements Issue #1
DMR2    Detailed Mission Requirements Issue #2
DMS     Digital Matrix Switch
DOD     Department of Defense
DPE     Data Processing Engineer
DPI     Data Processing Installation
DPS     Data Processing Segment
DQM     Data Quality Message
DR      Discrepancy Report
DRAC    SOI/MDI Data Reduction and Analysis Center
DS      Data Set
DSCC    Deep Space Communications Complex (NASA/JPL)
DSM     Data Systems Manager
DSN     Deep Space Network
DecNet  Digital Equipment Corporation Network

EAA     Earth Attitude Angle
EAF     Experimenter's Analysis Facility
EARN    European Academic Research Network
ECS     EOF Core System
EDL     Ethernet Data Link
EGSE    Electrical Ground Support Equipment
EHP     Extended High Power
EHPC    Extended High Priority Command
EID     Experiment Interface Document
EIT     Extreme-ultraviolet Imaging Telescope
ELEC    Electronics
ELV     Expendable Launch Vehicle
EM      Engineering Model
EOF     Experimenter's Operations Facility
EOM     End of Mission
EPA     Energetic Particle Analyzer
EPHIN   Electron Proton Helium Instrument
EPSS    Electrical Power Subsystem
EPV     Extended Precision Vector
ER      Eastern Range
ERNE    Energetic and Relativistic Nuclei and Electron Experiment
ESA     European Space Agency
ESDOC   European Science Data and Operations Center
ESMC    Eastern Space and Missile Center
ESOC    European Space Operations Centre (ESA, Darmstadt)
ESPOCC  European Space Project Operations Control Center
ESR     Emergency Sun Reacquisition
ESTEC   European Research and Technology Center
ESTRACK European Space Tracking (Network)
Ethernet Local area network defined by ISO 802.3
EU      Engineering Unit
EUV     Extreme Ultra-Violet
EXP     Experiment

FAC     Facility
FCL     Foldback Current Limiter
FCV     Flow Control Valve
FDD     Flight Dynamics Division
FDDI    Fiber Distributed Data Interface
FDE     Flight Dynamics Engineers
FDE     Failure Detection Electronics
FDF     Flight Dynamics Facility
FDSS    Flight Dynamics Support System
FDST    Flight Dynamics Support Team
FEHEM   Front-End Hardware Emulator
FEP     Front-End Processors
```

```
FIFO    First In First Out
FITS    Flexible Image Transport System
FM      Flight Module
FMI     Finnish Meteorological Institute, Finland
FOLAN   Flight Operations Local Area Network
FOP     Fligth Operations Plan
FOR     Flight Operations Review
FOT     Flight Operations Team
FOV     Field of View
FPSS    Fine Pointing Sun Sensor
FPSSE   Fine Pointing Sun Sensor Electronics
FPSSH   Fine Pointing Sun Sensor Head
FRD     Functional Requirements Document
FRR     Flight Readiness Review
FRTM    Functional Requirements Traceability Matrix
FSA     Fine Sun-pointing Acquisition mode
FSE     File Server Ethernet
FSM     Flight Synchronizer Module
FSMF    Flight Software Maintenance Facility
FSPAAD  Fine Sun Pointing Attitude Anomaly Detection
FTP     File Transfer Protocol
FTR     Flight Tape Recorder

GB      Gigabyte
GBRS    Generic Block Recording System
GCF     Ground Communications Facility
GDCF/Pacor ISTP Program Generic Data Capture Facility / Packet Processor
GDCLS   General Dynamics Commercial Launch Services (San Diego, CA)
GDS     Ground Data System, Goldstone (DSN station)
GDSIRD  Ground Data System Information Requirements Document
GenSAA  Generic Spacecraft Analysis Assistant
GEOTAIL Geomagnetic Tail Laboratory
GESS    Graphics Executive Support System
GEU     Gyroscope Electronics Unit (same as GME)
GGS     Global Geospace Science
GMAN    General Maneuver
GME     Gyro Management Electronics (same as GEU)
GMT     Greenwich Mean Time
GMU     Gyro Mechanical Unit (same as GYP)
GN      Ground Network
GOLF    Global Oscillations at Low Frequency
GPM     Generic Payload Module
GPR     Greenwich Photoheliographic Results
GS      Ground System
GSE     Ground Support Equipment
GSE     Ground Support Electronics
GSE     Geocentric Solar Ecliptic
GSFC    Goddard Space Flight Center
GSIRD   Ground Data System Information Requirements Document
GTAS    Generic Testing and Analysis System
GTDS    Goddard Trajectory Determination System
GW      Gateway
GYP     Gyroscope Package (same as GMU)

H/W     Hardware
HBR     High Bit Rate
HDR     Hardware Design Review
HED     High Energy Detector
HGA     High Gain Antenna
HK      Housekeeping
HOI     Halo Orbit Insertion
HOP     Halo Orbit Phase
HQ      Headquarters
HR      High Rate
HSIO    High Speed Input/Output
```

```
Hz      Hertz

I       Injection
I&T     Integration and Test
I&TRR   Integration and Test Readiness Review
IAC     Instituto de Astrofisica de Canarias, Spain
IAS     Institut d'Astrophysique Spatiale, France
ICA     Integration Control Agreement
ICD     Interface Control Document
ID      Identification
ID      Idle Format
IDL     Interactive Data Language
I/F     Interface
I/O     Input/Output
INIT    Initialization
IOS     Indian Ocean Station
IPD     Information Processing Division
IRD     Information Requirements Document
IRU     Inertial Reference Unit
IRV     Improved Inter-Range Vector
ISA     Initial Sun Acquisition
ISAS    Institute of Space and Astronautical Science
ISI     Instrument/Spacecraft Interface
ISG     ISTP Scheduling Group
ISTP    International Solar-Terrestrial Physics
IUE     International Ultraviolet Explorer
IWS     Instrument Work Stations

JPL     Jet Propulsion Laboratory
JSC     Johnson Space Center

Kbps    Kilobits per second
KCRT    Keyboard CRT
KSC     Kennedy Space Center

L       Launch
LAN     Local Area Network
LASCO   White Light And Spectrometric Coronagraph
LCL     (switchable) Local Current Limiter
LEB     LASCO Electronics Box
LED     Low Energy Detector
LEOP    Launch and Early Orbit Phase
LeRC    Lewis Research Center
LGA     Low Gain Antenna
LION    Low Energy Ion and Electron Instrument
LOBT    Local On Board Time
LOS     Lost of Signal
LPM     Launch and Parking Mode
LR      Low Rate
LRR     Launch Readiness Review
LSB     Least Significant Bit
LSR     Launch Support Room
LV      Latching Valve
LV      Launch Vehicle

MACS    Modular Attitude Control System
MAR     Mission Analysis Room
MASMP   Mission Analysis and Suport Management Plan
MB      Megabyte
MCC     Mid Course Correction
MCP     Micro Channel Plate
MDI     Michelson Doppler Imager
MDI-H   MDI-Helioseismology
MDI-M   MDI-Magnetogram
MDUL    Missing Data Units List
```

ME	Mission Engineer
MECO	Main Engine Cutoff
MELICA	Medium Energy Ion Composition Analyzer
MES	Main Engine Start
MGE	Media Generation Element
MHZ	Megahertz
MI	Mode Indicator
MIL	Merritt Island (GN Station)
MILA	Merritt Island Launch Area
MIL-71	Merritt Island DSN Facility
MLI	Multi-Layer Insulation
MMS-F	Matra Marconi Space-Tolouse, France
MO&DSD	Mission Operations and Data Systems Directorate
MOA	Mission Operations Area
MOC	Mission Operations Center
MOD	Mission Operations Division
MODNET	MO&DSD Operational/Development Network
MOM	Mission Operations Manager
MOR	Mission Operations Review
MOR	Mission Operations Room
MOS	Maneuver Observation System
MOSA	Mission Operations Support Area
MOSP	Mission Operations Support Plan
MOWG	Mission Operations Working Group
MP&A	Mission Planning and Analysis Area
MPAE	Max-Planck-Institut fuer Aeronomie, Germany
MPSR	Monthly Project Status Review
MR	Medium Rate
MRM	Mission Readiness Manager
MRR	Mission Readiness Request
MRT	Mission Readiness Test
MRTT	Mission Readiness Test Team
MSB	Most Significant Bit
MSE	Mission Server Element
MSR	Monthly Status Report
MSS	Message Switching System
MSSL	Mullard Space Science Laboratory, UK
MTASS	Multi-Mission Three-Axis Stabilized Satellite
MTOF	Mass-Time-of-Flight
MTP	Mission Test Plan
MTR	Magnetic Tape Recorder

N	Newton
N/A	Not Applicable
NASA	National Aeronautics and Space Administration
NASCOM	NASA Communications
NAV	Navigation (DSN) Subsystem
NCC	Network Control Center
ND	Network Director
NFS	Network File System
NIF	Nascom Interface Facilities
NMI	NASA Management Instruction
NMOS	Network Mission Operations Support
NOAA	National Oceanic and Atmospheric Administration
NOCC	Network Operations Control Center (DSN)
NOPE	Network Operations Engineer
NRCA	Nonconformance Report and Corrective Action
NRL	Naval Research Laboratory, USA
NRP	NASA Resource Protection
NRT	Near Real-Time
NRZ-L	Non Return to Zero Level
NSDP	Nascom System Development Plan
NSE	Network Support Engineer
NSI	NASA Science Internet
NSO	National Solar Observatory

```
NSSDC   National Space Science Data Center
NTM     Network Test Manager
NTOM    Network Technical and Operations Manager
Nascom  NASA Communications

OA      Operations Agreement
OBC     On Board Computer
OBDH    On Board Data Handling
OBT     On-Board Time
OD      Orbit Determination
OFA     Office of Flight Assurance
ORPA    Operational Readiness and Performance Assurance
ORR     Operational Readiness Review
OSC     Office of Space Communications
OSE     Operations Simulations Engineer
OSO     Orbiting Solar Observatory
OSSA    Office of Space Science and Applications
OTS     Operations Testing and Simulations

P/B     Playback
P/M     Payload Module
PACOR   Packet Processor
PAD     Pressure Anomaly Detection
PB      Playback
PC      Personal Computer
PCC     Power Converter for CDMU
PCM     Pulse Code Modulation
PCS     Predefined Command Sequence
PDB     Project Data Base
PDF     Programmable Data Formatter
PDFE    Programmable Data Formatter Engineer
PDI     Payload Data Interleaver
PDR     Preliminary Design Review
PDU     Power Distribution Unit
PHAS    Payload Module (PLM) Harness Subsystem
PI      Principal Investigator
PLM     Payload Module
PM      Processor Module
PME     Pacor Mission Engineer
PMOD    Physikalisch-Meteorologisches Observatorium Davos
PMP     Project Management Plan
POCC    Payload Operations Control Center
POLAR   Polar Plasma Laboratory
POP     Program Operating Plan
PP      Post Pass
PPM     Parts Per Million
PRD     Program Requirements Document
PROS    Propulsion Subsystem
PRTC    Priority Real Time Commands
PSCN    Program Support Comunications Network
PSK     Phase Shift Keying
PSM     Priority Select Module
PSM     Project Security Manager
PSS     Portable Spacecraft Simulator
PSTS    Payload Module (PLM) Structure Subsystem
PTCS    Payload Module Thermal Control Subsystem
PVL     Parameter Value Language
Pacor   Packet Processor
PacorII Packet Processor Data Capture Facility II

QA      Quality Assurance
QAC     Quality and Accounting Capsule
QAE     Quality Assurance Engineer

Rad     Radian
```

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R-S     Reed-Solomon
R/S     Reed-Solomon
R/T     Real-Time
RAAD    Roll Attitude Anomaly Detection
RAAM    Roll Attitude Acquisition Mode
RAD     Roll Attitude Determination
RAL     Rutherford Appleton Laboratory, UK
RAM     Random Access Memory
RARR    Range and Range Rate
RASM    Remote Access Scheduling Terminal
RCR     Remote Command Request
RD      Reference Document
RDBMS   Relational Data Base Management System
Re      Earth Radii
RF      Radio Frequency
RFDU    Radio Frequency Distribution Unit
RID     DSN Station at Madrid, Spain
RID     Review Item Disposition
RM      Reconfiguration Module
RMW     Roll Maneuver Wheels
ROM     Read Only Memory
RPC     Remote Procedure Calls
RPR     Remote Procedure Request
rpm     Revolutions per minute
RRAD    Roll Rate Anomaly Detection
Rs      Solar Radii
RS      Reed-Solomon
RSS     Root Sum Square
RT      Real-time
RTU     Remote Terminal Unit
RUST    Remote User Scheduling Terminal
RW      Reaction Wheel
RX      Receive

S/C     Spacecraft
S/W     Software
SAD     Solar Array Deployment
SAM     Sun Acquisition Mode
SAM     System Assurance Manage
SAS     Solar Acquisition Sensor
SCAMA   Switching, Conferencing and Monitoring Arrangement
SCI     Real-time Science Data Format
SCID    Spacecraft Identification
SCR     Stripchart Recorder
SDB     Spacecraft Data Base
SDPF    Sensor Data Processing Facility
SDR     System Design Review
SDS     System Design Specification
SECO    Sustainer Engine Cutoff
SELDADS Space Environment Laboratory Data Acquisition and Display System
SELSIS  Space Environment Laboratory Solar Imaging System
SFDU    Standard Formatted Data Unit
SFT     System Functional Test
SGSS    Solar Generator Subsystem
SHAS    Service Module (SVM) Harness Subsystem
SHSS    Structure and Harness Subsystem
SIC     Spacecraft Identification Code
SID     Spacecraft Identification Number
SIM     Simulator
SIM     Solar Irradiance Monitor
SIP     System Implementation Plan
SIT     System Implementation Team
SK      Stationkeeping
SLC     Space Launch Complex
SM      Structural Model
```

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SMIP    SOHO Mission Implementation Plan
SMIRD   SOHO Mission Implementation Requirements Document
SMM     Solar Maximum Mission
SMO     System Management Office
SMOC    SOHO Science and Mission Operations Center
SMOCC   SOHO Mission Operations Control Center
SMP     Systems Management Policy
SOC     Science Operations Coordinator
SOC     Simulations Operations Center
SOCA    Special Operations Control Area
SOHO    Solar and Heliospheric Observatory
SOI     Solar Oscillations Investigation
SOL     Science Operations Leader
SOP     Science Operations Plan
SOSA    Special Operations Support Area
SOT     Science Operations Team
SOTA    Science Operations and Test Area
SOWG    SOHO Science Operations Working Team
SPAN    Space Physics Analysis Network
SPD     Space Physics Division
SPL     Split Phase Level
sps     Symbols per second
SPOF    Science Planning and Operations Facility
SQL     Structured Query Language
SRB     System Review Board
SRB     Solid Rocket Booster
SRD     System Requirements Document
SRL     Spacecraft Reference Line
SRM     Solid Rocket Motor
SRR     System Requirements Review
SRS     System Requirements Specification
SSR     Software Specification Review
SSTS    Service Module (SVM) Structure Subsystem
SSU     Star Sensor Unit
STC     Satellite Test Center
STCS    Service Module Thermal Control Subsystem
STDN    Spaceflight Tracking and Data Network
STOF    Suprathermal-Time-Of-Flight
STOL    System Test and Operations Language
STR     System Test Review
STS     Star Tracker Sensor
STSP    Solar Terrestrial Science Programme
SUM     SOHO User's Manual
SUMER   Solar Ultraviolet Measurements of Emitted Radiation
SVM     Service Module
SWAN    Solar Wind ANisotropies
SWT     Science Working Team

T&DA    Telemetry and Data Acquisition
T&DS    Tracking and Data Systems/JPL
TAB     Timing and Acquisition Bit
TAC     Telemetry and Command Computer
TAI     Temps Atomique International
TBC     To Be Confirmed
TBD     To Be Defined
TC      Telecommand
TCOPS   Trajectory Computation and Orbit Products System
TCP/IP  Transmission Control Protocol/Internet Protocol
TCS     Thermal Control Subsystem
TCXO    Temperature Controlled Crystal Oscillator
TDA     Telecommunications and Data Acquisition
TDR     Test Discrepancy Report
TDSM    Tracking and Data Systems Manager
TFG     Transfer Frame Generator
TGS     Timeline Generation System
```

```
TIRIO   Table of Incompatibilities and Requirements for the Instruments Operation
TLAN    TPOCC LAN
TLM     Telemetry
TOD     Time-out detection
TPOCC   Transportable POCC
TR      Tape Recorder
TRB     TDR Review Board
TRK     Tracking
TRPSA   Transponder Assembly
TRR     Test Readiness Review
TSTOL   TPOCC System Test and Operations Language
TT      Time-Tagged
TT&C    Telemetry, Tracking and Command
TTB     Time-Tagged Buffer
TTI     Transfer Trajectory Insertion
TTP     Transfer Trajectory Phase
TVCF    Transportable Vehicle Checkout Facility
TTY     Teletype
TX      Transmit

U/L     Uplink
UL      Uplink
USO     Ultra Stable Oscillator
UTC     Universal Time Code
UVCS    UltraViolet Coronagraph Spectrometer

VC      Virtual Channel
VCID    Virtual Channel Identification
VCXO    Voltage Controlled Crystal Oscillator
VID     Vehicle Identification Number
VIRGO   Variability of solar IRradiance and Gravity Oscillations

W       Watts
WBS     Work Breakdown Structure
WDE     Wheel Drive Electronic
WIND    Interplanetary Physics Laboratory
WS      Work-Station
WSMC    Western Space and Missile Center

XDR     External Data Representation
XMT     Transmit
XPNDR   Transponder

kbps    Kilobits per second
sps     Symbols per second
```

http://soho.nascom.nasa.gov/