SOC-RTM-1

REQUIREMENTS TRACEABILITY MATRIX

SCIENCE OPERATIONS CENTER
TETHERED SATELLITE SYSTEM

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1. Scope

This document has been prepared in response to SOC CDR RID MSFC-8 and presents a matrix listing the design requirements specified in Table 1 of the baseline issue of SwRI document SOC-DR-1, and the satisfaction of each requirement as a statement of fact or reference to specific CDR data package pages and/or controlling SwRI documents. All figures and tables referenced in the "Requirements Description" column of the matrix refer to the baseline issue of SOC-DR-1.

2. Applicable Documents

The following documents form a part of this document to the extent specified herein:

SOC-DR-1	Design Requirements
SOC-SDS-1	System Design Specifications
SOC-MP-1	Maintenance Plan
SOC-CMP-1	Configuration Management Plan
SOC-SRP-1	Support Responsibility Plan
SOC-VTP-1	Verification Test Procedure
SOC-UM-1	User Manual
SOC-UTP-1	User Training Plan
SOC-JDD-1	Joint Display Definition

REQUIREMENTS TRACEABILITY MATRIX		
ID	*Requirement Description*	*Requirement Satisfactttion*
1	The SOC shall provide equal resources to each PI group for Joint Science purposes, for Joint POCC purposes, and for evaluation of FO success criteria.	Project-provided user workstation hardware is defined in ID43. See ID2 concerning data availability. See ID61 concerning postflight data products.
2	Within the SOC all data is available to each PI group.	Each user has equal access to all data at Data Level C via the listener program as described in SOC-UM-1, Section 2.3, and SOC-SDS-1, Section 8.1.3.
3	All required data needed for both real-time (during mission) operations and post-mission data analysis will be archived. The on-line archive (kept on disk) will consist of three separate mission phases: pre-deployed, deployed, and post-deployed. Inactive sections will be dumped to tape to provide disk storage space for the current mission phase. At no time will the on-line data span a period greater than 36 hours. See Table II for mission phase durations and data rate.	See SOC-SDS-1, Sections 8.1.1 and 8.2.5.
4	The displays shown in SOC-DR-1, Figures 1a–d, called the Joint Science Displays, will be available for evaluating the progress towards achieving the FOs. Display configurations will be finalized at the PDR.	Default files will be provided for each of the four joint science displays. Data necessary to design and code the displays are currently being collected from the cognizant users. The data will be documented in SOC-JDD-1, Joint Display Definition.
5	As only two Joint Sciences Displays are simultaneously displayed, the SOC operator will select the appropriate displays from those shown in Figures 1a–d.	Default files will be provided for each of the four Joint Science Displays. Selection of the appropriate displays is the responsibility of the Joint Science Team designated and trained operator.
6	The SOC system operation must be immune to single point failures of SOC hardware or software which will affect upstream operations.	This will be documented in System Verification Test Procedure SOC-VTP-1 and verified by test.
7	The Joint POCC displays 1, 2, 3, and 4 will be available at all times (See Figures 2a through 2d).	A command script will be provided for each of the four joint POCC displays. Data necessary to design and code the displays are currently being collected from the cognizant users. The data will be documented in SOC-JDD-1, Joint Display Definition. Four joint POCC display monitors are provided. See ID43, Items C.3 and C.4. Each of the four joint POCC displays will be displayed individually and at all times on the four monitors by the TSSPO-designated Joint Display operator.
8	The data integrity within and through the SOC must be assured. During mission operation, all data received at System Level II will be archived. It shall be possible to note the times when the CIP output ceases, has format errors, or is rejected for other reasons. These data can then be requested after mission termination.	See ID3 concerning archive. See SOC-SDS-1, Sections 6.1 and 6.3, concerning data status displays. See ID61 concerning postflight data products.
9	The operational integrity of the SOC must not be compromised by operational errors on a Project-provided workstation.	This will be documented in System Verification Test Procedure SOC-VTP-1 and verified by test.

REQUIREMENTS TRACEABILITY MATRIX (Cont'd)		
ID	*Requirement Description*	*Requirement Satisfactiion*
10	The SOC must ingest PDI data in serial form (NRZ-L and/or Manchester biphase) at RS-422 levels from either the SPCDS at KSC or from a CIP at JSC. Separate interfaces will be provided for PDI from the SFMDM and from the satellite. The SOC-to-JSC interfaces are explicitly defined in the TSS-1 Payload Integration Plan (PIP) 18411, FOSA Annex 3.	The PC Decom contains a NASA-3 framer as described in the BGJA CDR viewgraphs and SOC-SDS-1, Section 6.1. Serial data is accepted in either NRZ-L or Manchester biphase form. Separate interfaces are provided for satellite and SFMDM data streams.
11	A burst data rate of up to 64 kbps must be accommodated for the PDI.	The decommutation subsystem I/D hardware can handle a serial bit rate of TBD bps. The required data rate is within the published specifications of the BGJA PC Decom product.
12	The SOC must ingest CAS data in NASCOM blocks from a JSC-provided CIP. The SOC-to-JSC interfaces are explicitly defined in the TSS-1 Payload Integration Plan (PIP) 18411, FOSA Annex 3.	The PC Decom contains a NASA-CAS framer as described in the BGJA CDR viewgraphs and SOC-SDS-1, Section 6.1.
13	A data rate of up to 19.2 kbps must be accommodated for the CAS.	See ID-11.
14	PDI and CAS data streams will be decommutated into distinct data streams at Data Level C for each of the following: CAS, ROPE, RETE, SETS, SPREE, TEMAG, DCORE, SCORE, DRB, Deployer general parameters, Deployer critical parameters, and satellite parameters. Synchronization and transition words will be discarded from the IDFSs.	See SOC-SDS-1, Section 8.1.3
15	The SOC must handle PDI and CAS dump conditions. (Dump means the JSC playback of recorder data after the end of the mission.)	The SOC will treat this situation exactly the same as during flight operations. A separate set of TLM and IDFS tapes will be created. Postflight dump data is **not** automatically merged with flight data.
16	There will be a display showing the real-time status of the PC Decom ingest and packetizing operations. The following parameters will be displayed: *A*. Number of CAS NASCOM blocks received *B*. Number of SFMDM minor frames received *C*. Number of satellite minor frames received *D*. Number of rejected NASCOM blocks *E*. GMT at which the last NASCOM block was rejected *F*. Number of synchmization losses for serial input *G*. GMT at which either serial or BFD input was lost *H*. No. of packets placed on the Level B LAN by CAS, SFMDM, and satellite	See SOC-SDS-1, Sections 6.1, 6.2, and 6.3.

REQUIREMENTS TRACEABILITY MATRIX (Cont'd)		
ID	*Requirement Description*	*Requirement Satisfacttion*
17	The PC Decom subsystem will keep a status log (on disk) of the parameters listed in ID 16. Parameters A, B, C, and H will be recorded at 5-minute intervals. Parameters D, E, F, and G will be recorded as they occur.	See SOC-SDS-1, Sections 6.1, 6.2, and 6.3.
18	The ingested PDI and CAS data will be verified for format correctness.	See SOC-SDS-1, Section 6.1.
19	The Data Level B data blocks will be time-tagged with GMT to 1/100 second resolution. Satellite time will be correlated to GMT and, thus, satellite data blocks will be time-tagged as just stated.	The method for time-tagging data blocks is TBD pending closeout of CDR RID MSFC-13.
20	The failure of a flight instrument shall not affect the SOC operation, with the exception of those displays directly dependent on data from the instrument.	There is no direct link between the SOC and the flight instruments; thus, a failure of a flight instrument will only affect those displays directly dependent on data from that instrument. Because the internal processing is handled through independent parallel processing, it is not possible for a process that is waiting on data to delay those which have data.
21	Decommutation and archive functions will occur concurrently in two physically distinct computer groups for failsafe operation. The primary and secondary decommutation and archive subsystem groups must be powered by independent circuits so that a single circuit breaker cannot shut down both. These power circuits should come from an uninterruptible power supply. Both subsystem groups will be located in the SOC room.	Redundant decommutation and archive subsystems are provided. Operation of the redundant systems is described in SOC-SDS-1. Provision of independent, uninterruptible power is the responsibility of NASA.
22	For SOC test and development purposes, the decommutation subsystem must be capable of providing data blocks derived from previously recorded data.	The PC Decom computers are configured with a hard disk for storage of test data. This is a "CIP substitute" for SOC development and test purposes only, as stated. The recording and playback of data on this disk is a standard feature of the BGJA software.
23	The operational characteristics of the SOC must not depend on a fixed configuration (i.e., the archive subsystem should not need knowledge of the number of user workstations or their network addresses).	**This requirement needs to be changed.** The operational characteristics of the SOC do not depend upon the number of user workstations present, but the playback during LOS feature does require that the DHS know the address of the workstation requesting playback. This is because the UNIX RCP utility is used to make the data transfer.
24	The SOC LANs will use standardized, off-the-shelf technology. Specifically, the SOC LANs are Ethernet V.2 compatible, using the 10 BASE 2 [3.1.F] wiring method. These LANs will support a 10mbps bandwidth with station taps spaced at 0.5 meter increments. Multiport transceivers are specifically excluded because a failure of one of these units could affect multiple stations. All transceivers, including spares, will be connected before SOC operations begin. Transceivers may be replaced during the SOC mission operation period, if necessary.	Cabletron ST-500 transceivers have been procured for the Data Level B LAN and EOS Model MBAT-1 transceivers have been procured for the Data Level C LAN. Both transceivers types are IEEE Type 10 Base 2 and 802.3 V1.0 / V2.0 compatible.

REQUIREMENTS TRACEABILITY MATRIX (Cont'd)		
ID	*Requirement Description*	*Requirement Satisfacttion*
25	The Joint Science Displays will have 4 possible time scales, selectable by operation command. The time scales will be determined by the IWG.	The time scale of the Joint Science Displays is selectable by operator command. See Section 4 of the User Manual, SOC-UM-1. The default time scale selected by the IWG is 10 minutes.
26	The archival data shall be organized in an experiment-independent manner (e.g., the software must handle each type of data without special customization). The data will be recorded in a canonical format called the Instrument Data File Set (IDFS).	See SOC-SDS-1, Sections 8.1.2 and 8.1.2.1. The IDFS format is defined in SwRI document IDFS File System Definition.
27	The archive subsystem shall be able to produce copies of the data on magnetic tape after the mission operation is complete. These data tapes will be in 1/4 inch QIC-150 format, per ANSI DC-600XTD. Each cartridge tape will hold up to 150mB of data, including label and volume identification data. ANSI labled tape format will be used for volume identification and data recording.	Each archive subsystem is configured with two Sun 66OH 1/4-inch QIC-150 tape units for the dual purposes of archiving data during the mission and producing copies of data after the mission. The IEEE 1003.1-1988 format is provided by the Standard UNIX tar utility program. Any software labeled "Standard UNIX Utility" is available on all SOC workstations.
28	The archive subsystem must accept IDFS playback requests during LOS periods.	See SOC-SDS-1, Section 8.1.
29	The archive subsystem must handle AOS during an archive playback in progress.	See SOC-SDS-1, Section 8.1.
30	The archive subsystem will maintain a disk file log of the amount and quality of the data archived.	See SOC-SDS-1, Section 8.2.5.
31	Software utilities will be provided to package the IDFS archive data using Standard Format Data Units (SFDU).	See SOC-SDS-1, Section 8.5.
32	Software will be provided to allow post-mission meta-data to be added to the archive and packaged within SFDUs.	See SOC-SDS-1, Section 8.5.

REQUIREMENTS TRACEABILITY MATRIX (Cont'd)		
ID	*Requirement Description*	*Requirement Satisfacttion*
33	The software used to access and display the data will be made available on each workstation. The software provided by SwRI, exclusive of the SUN-provided software, is listed below: *A.* GraphIII graphics library, which includes source code and documentation. *B.* SOC Joint Science Display System, including source code and documentation. *C.* SOC Data Access Library for accessing data on the Level C LAN and from the archive system, and for retrieving IDFS fields and data from disk or QIC-150 format tapes. *D.* SOC SFDU library, including documentation. *E.* Makefiles, test, & verification routines will be included where applicable.	Verification that all project-provided workstation software is installed on each user workstation will be documented in the configuration management plan, SOC-CMP-1, and will be performed during the system assembly and check-out phase of the project.
34	The Joint Science and POCC Displays will use a traversing, vertical scroll bar to indicate the current time.	This feature was demonstrated at the CDR. NOTE: "horizontally" needs to be added before "traversing."
35	Each workstation at System Level III must acquire the lookup tables used for logical instrument calibration upon boot-up.	**This requirement needs to be changed.** Each workstation at System Level III will be loaded with the lookup tables used for logical instrument calibration. This software is included in ID33, Item C.
36	The lookup tables must also be downloaded from the archive system when commanded by the operator.	**This requirement needs to be deleted in favor of ID35.**
37	The archive subsystem must handle the asychronous DCORE data so that it can be processed, displayed, and archived in the same manner as the frame-synchronous data. A maximum of 15 minor frames of DCORE data can be lost before synchronization occurs.	This is TBD pending closeout of CDR RID _____.
38	The Joint Display subsystem must generate the correct step voltage for the production of the SETS Langmuir Probe and RPA spectrograms from the asynchronous sweeps.	SOC-SDS-1, Section 8.2.1.3 _____. NOTE: "Joint Display Subsystem" needs to be changed to "archival subsystem."
39	All SOC workstations must reboot in less than 30 secs. In order to stay within this limit, each SOC workstation will disable the *fsck* program during the mission operations.	SOC workstations have been tested to reboot in less than 30 seconds with the fsck program disabled. NOTE: an ECR will be submitted to allow this to be an optional feature selected by the user (see RID SET-SOC-1).
40	Logical instrument definitions must be created for each experiment.	Logical instrument definitions have been created for each data source except CAS. They have been distributed at the June 1990 IWG, prior to the SOC CDR, and on 25 January 1991 for pre-baseline review. These documents (and resulting software) will require updating each time the SRD is changed.

REQUIREMENTS TRACEABILITY MATRIX (Cont'd)		
ID	*Requirement Description*	*Requirement Satisfactiion*
41	Color hardcopies must be easily and quickly made of any display at System Level III. These hardcopies will be produced on Tektronix 4693 RGB raster printers by loading the RGB display output. The 4693 RGB will produce an "A" size color print in 43 seconds, with a capture time of 4 seconds. Three sets of four workstations will share a printer via a 4-channel multiplexer. The IWG will determine which 12 workstations will have direct access to the printers.	Three Tektronix 4693 RGB color printers have been procured for the SOC system. Procurement documentation is available for review. ASI and MSFC are responsible for procurement of the two remaining color printers. Operation of the color printer was demonstrated at the CDR.
42	All TSS CAS parameters available at the CIP will be archived and made available to the workstations at System Level III. These parameters and their sampling rates are defined in PIP Annex 5.	See ID3.

REQUIREMENTS TRACEABILITY MATRIX (Cont'd)		
ID	*Requirement Description*	*Requirement Satisfacttion*
43	The project-furnished SOC system components will have the following configuration (see Figures 3, and 4a-d): *A. Decommutation Subsystem* 1) 80386 PC running at 25 MHz 2) 2-mbyte memory 3) 40-mbyte and 180-mbyte hard disks 4) Special quad-port high-speed serial interface 5) Ethernet V.2 10 Base 2 interface card 6) CGA video adaptor and monitor 7) BGJA PC Decom software This subsystem is duplicated for failsafe operation. *B. Archival Subsystem* 1) SUN 4/370-S-32-P14 SPARCserver 370 2) SUN 450A second ethernet controller 3) HDS 3200 Model 10 15" B/W CRT 4) SUN X660H 150-mbyte 1/4" desktop cartridge tape unit This subsystem is duplicated for failsafe operation. *C. Joint Display Subsystem* 1) SUN 4/60C-8-P3 SPARCstation 1 (w/19" color monitor) 2) SUN X551H 104-mbyte internal disk 3) GraphOn 470HR 16" Color CRT 4) NDS GP220Z 15" B/W CRT There are two of these systems. *D. Project-provided Workstations* 1) SUN 4/60FC-8-P3 SPARCstation 1 (w/16" color monitor) 2) SUN X551H 104-mbyte internal disk 3) SUN X660H 150-mbyte 1/4" desktop cartridge tape unit 4) Sun X450H second ethernet controller There are seven of these systems, plus two spare systems *E. LANs* Ethernet V.2 10 Base 2, with ISOLAN 1114 transceivers	All project-furnished computer equipment, as shown in the CDR review copy of SOC-DR-1A, has been purchased. Also see ID24 and ID41. Procurement documentation is available upon request. All MSFC-funded equipment will be included in the DD250 presented to MSFC upon completion of the final system verification test at JSC. NOTE: MSFC is processing an ECR to increase the quantity of project-provided workstations (Item D) by 1 to provide a workstation for SPREE.
44	A system test and verification procedure will be implemented. This procedure will be approved by the TSSPO.	The verification procedure document will be assigned document number SOC-VTP-1 and is currently scheduled to be issued to MSFC for review and approval on 1 May 1991.

REQUIREMENTS TRACEABILITY MATRIX (Cont'd)		
ID	*Requirement Description*	*Requirement Satisfacttion*
45	The SOC must be a real-time system, e.g., the data flow through the SOC must occur at the highest rate that does not interfere with the archiving task. The SOC system processing shall not add more than 5 seconds of delay time to data packets before they are made available on the Level C LAN.	Due to the nature of certain logical instruments, there are cases in which more than 5 seconds of TLM data is needed to complete a packet. Hence, this requirement is interpreted to refer to the delay in handling a completed packet. Throughput tests have shown that the Data Handling Subsystem is capable of sending packets as fast as they are provided to the internal _____ interface, so post-completion packet delays are well within the 5-second requirement.
46	Training on the SOC functions will be provided to each PI at SwRI. The training plan and schedule will be determined at the preliminary design review.	See SOC User Training Plan, SOC-UTP-1.
47	User EGSEs will be accommodated at Data Level C or System Level III only.	**This requirement needs to be changed.** User EGSEs will be accommodated through the user workstation secondary Ethernet controller. Secondary Ethernet controllers have been procured for all project-provided workstations. See ID43, Item D4.
48	Common decommutation and archival databases will be provided for use at both KSC and JSC.	As stated in the response to ID10, the PC Decom NASA-3 frame accepts serial data in either NRZ-L or Manchester biphase format and, therefore, the decommutation and archival databases can be used with either the SPCDS at KSC or the CIP at JSC.
49	Each experiment group is responsible for all experiment-specific software.	This is not a requirement placed upon SwRI but, rather, a statement that SwRI is not responsible for experiment-specific hardware.
50	Software will be provided for the SETS workstation to build the same SETS TLM page that is input to the SFMDM.	**This requirement needs to be modified.** The agreed upon method of providing SETS telemetry is to buffer the telemetry allocation for eight SFMDM minor frames, and then to broadcast the buffered telemetry page to the SETS workstation. See SOC-SDS-1, Section TBD.
51	The Joint Displays shall be updated in real-time.	This requirement is concerned with the speed at which displays can be generated overall. The data is available to the display software. It has been demonstrated by driving the display software with dummy data that display operations are essentially "realtime." There are no delays caused by scaling, clipping, on short vectors. This is true only when the SwRI graphics library directly drives the SUN PIXREC interface; additional graphics layers, such as windowing software, are specifically excluded from the SOC configuration because this requiement cannot be guaranteed.
52	Software will be provided to receive data from the Level C LAN. The users must provide software to send and receive data on their secondary Ethernet ports.	This software is called the **listener** program and is described in SOC-SDS-1, Section 8.1.3 and in SOC-UM-1, Section 2.3.

REQUIREMENTS TRACEABILITY MATRIX (Cont'd)		
ID	*Requirement Description*	*Requirement Satisfacttion*
53	A SOC System Manager will be provided for each shift for Level IV testing at KSC and for pre-mission simulations and mission operations at JSC.	A SOC system manager is planned for Level IV and for the Red and Blue Teams for the EET, JIS, and mission operations. In addition, PC Decom Subsystem support for these activities is part of the SwRI subcontract with BGJA. See SOC-SRP-1.
54	One PC Decom station, one archive station, two user workstations, and one printer station will be provided at KSC to support Level IV testing. Reusable shipping containers will be provided for this equipment.	One PC Decom station, one archive station, two user workstations, and one color printer station are planned for Level IV support at KSC. See SOC-SRP-1. Reusable shipping containers are available for the SUN and Tektronix equipment, and will be made or purchased for the PC Decom equipment. NOTE: an ECR is being processed by MSFC to increase the number of user workstations to six.
55	SOC activities will be performed in accordance with the schedule shown in Figure 5.	The SOC Schedule shown in Figure 5 (and all references thereto) will be deleted from SOC-DR-1 in favor of a Level II baseline schedule in accordance with RID MSFC-2.
56	Maintenance will be provided through June 1991 for all project-furnished equipment. Maintenance of SUN equipment will be on a next-day, on-site basis with an uplift to 24-hour coverage, 7 days a week, with 2-hour response for the month of May 1991.	SwRI has maintenance agreements as specified with SUN and Tektronix through June 1991. These agreements will have to be extended due to launch slips. Maintenance for PC Decom equipment, monitors, and transceivers will be by on-site spares. See SOC-MP-1.
57	Documentation for existing software which is used for the SOC without modification will be used as-is. Documentation for existing software which is modified for use with the SOC will be changed to clearly show the modification. Documentation for software developed specifically for the SOC will be in accordance with MSFC-PLAN-1554, Paragraph 3.2. Generic documentation will be used to the extent possible for logical instrument software.	
58	The TSSPO will delegate responsibility for review and approval of software documentation to TSS project personnel.	This is a TSSPO responsibility.
59	The TSSPO will delegate responsibility for witness and approval of software/system verification test to TSS project personnel.	This is a TSSPO responsibility.
60	SwRI will provide all cabling necessary for the SOC up to the CIP. JSC is responsible for installation of the cables in the SOC and satellite support rooms.	See SOC-SRP-1.

REQUIREMENTS TRACEABILITY MATRIX (Cont'd)		
ID	*Requirement Description*	*Requirement Satisfacttion*
61	One copy of all archive data will be furnished to each user within 30 days after completion of the mission.	The baseline requirement of furnishing one copy of archive data to each user within 30 days of completion of the mission is in the process of being superceded by new requirments specified in MSFC Document "Tethered Satellite System-1 Science Operations Center Postflight Data Requirements." See CDR data package, pages 71 and 72, and M. Rives TSS-1 SOC Postflight Data Requirements Viewgraph copies. Impact of the new requirements is TBD.
62	NASA is responsible for disposition of all SOC equipment after completion of the mission.	This is a TSSPO responsibility.
63	Raw telemetry may be recorded at System Level II for possible post-mission use. This is a SwRI option only and is not a SOC design requirement. Any such recording shall not interfere with successful processing or archiving of IDFS files.	Tape recorders for this purpose are included in the archival station configuration. See ID43, item B4. NOTE: This requirement is in the process of being changed from "may be recorded" to "will be recorded." See RID MSFC-5.