

STEREO *IMPACT*

GSE Software Development Plan

GSE_SDP_C.doc
Version C – 2002-Oct-25

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Document Revision Record

Rev.	Date	Description of Change	Approved By
A	2001-Sep-6	Preliminary Draft	-
B	2001-Oct-31		
C	2002-Oct-25	<ul style="list-style-type: none"> • Add SAR, SRVM, VDD, peer reviews, problem reporting for Critical GSE Software • Remove ISG from Critical GSE Software list • Minor changes to GSE description in section 2. 	

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1. Overview

1.1. Introduction

IMPACT consists of a number of instruments connected to the STEREO spacecraft via the IMPACT IDPU. A number of such GSE shall be developed at UCB, Caltech, and GSFC. This document describes the software development plan for UCB GSE software used in the development and test of the IMPACT suite. In addition, this document covers the software used in the post-launch data production tasks.

UCB has had experience with similar GSE and data processing software tasks on HESSI, Lunar Prospector, FAST, Cluster, Mars Global Surveyor, Wind, Polar, etc.

1.2. Document Conventions

In this document, **TBD** (To Be Determined) means that no data currently exists. A value followed by **TBR** (To Be Resolved) means that this value is preliminary. In either case, the value is typically followed by a code such as UCB indicating who is responsible for providing the data, and a unique reference number.

1.3. Applicable Documents

The following documents include drawings and STEREO Project policies, and are part of the Interface Requirements. In the event of a conflict between this SDP and the following documents, this SDP takes precedence. Most documents can be found on the Berkeley STEREO/IMPACT FTP site:

<http://sprg.ssl.berkeley.edu/impact/dwc/>

1. Specifications/IDPUSimSpec – specification for the IDPU Simulator GSE hardware
2. Specifications/STEREO IMPACT GSE Requirements
3. Plans/STEREO-IMPACT-PAIP – Performance Assurance Implementation Plan

1.4. Acronyms

CDR	Critical Design Review
CSCI	Computer Software Configuration Item
DCB	Data Controller Board
GSE	Ground Support Equipment
GSFC	Goddard Space Flight Center
ICD	Interface Control Document
IDPU	Instrument Data Processing Unit
IMPACT	In-situ Measurements of Particles and CME Transients
ISG	IDPU Simulator GSE
MAG	Magnetometer instrument
MOC	Mission Operations Center
PDR	Preliminary Design Review
PLASTIC	PLasma and SupraThermal Ion Composition instrument

PER	Pre-Environmental Review
POC	Payload Operations Center
SDP	Software Development Plan
SEP	Solar Energetic Particle instrument suite
SSC	Stereo Science Center
SSL	Space Sciences Laboratory
STE	SupraThermal Electron instrument
SWAVES	STEREO Waves instrument
SWEA	Solar Wind Electron Analyzer
TBD	To Be Determined
TBR	To Be Resolved
UCB	University of California at Berkeley
UNH	University of New Hampshire

2. Instrument Ground System Description

2.1. IDPU Simulator GSE

The IDPU Simulator GSE is used to test instruments prior to integration with the IDPU. The GSE consists of a hardware box (the ISG) that performs the low-level interface functions, and a PC on which runs the user interface software. This software consists of two modules that may or may not run on the same PC: The ISG Core Software, which performs the low-level interface with the ISG hardware, and can formulate instrument commands and display instrument data at a very low level (Hex), and a Science Module Module, optimized for each instrument to display data and send commands. The link between the PC and the ISG is through the PC parallel port.

UCB is responsible for the ISG hardware, the ISG Core Software, and Science Modules for SWEA, STE, and MAG. Caltech will develop Science Modules for SEP, which will be basically the same as the Science Display software used with the Command & Telemetry GSE at the IMPACT suite level (since the IDPU is mostly a bent pipe for SEP commands and telemetry). UNH is responsible for Science Module for PLASTIC.

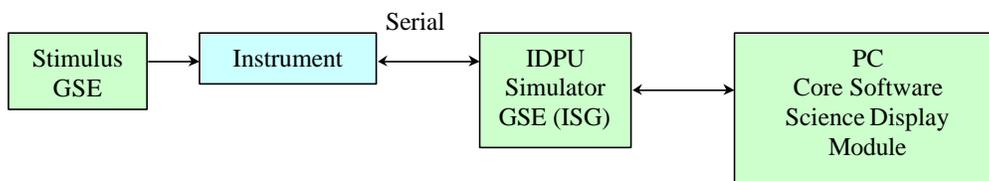


Figure 2.1-1 IDPU Simulator GSE Setup

2.2. Instrument Simulator GSE

The ISG hardware can also be used as an instrument simulator input to the IDPU. In this application, the ISG will be connected to a PC running Instrument Simulator software to provide a continuous stream of data similar to what is made by the instrument, and displaying any commands received from the IDPU. This software will be developed by

UCB. It will only be used in bench-level tests of the IDPU prior to integration with the instruments.

2.3. Command & Telemetry GSE

This GSE is used at the IMPACT Suite level, and interfaces to either the APL-supplied Spacecraft Emulator (prior to IMPACT integration with the spacecraft), or the MOC (after integration with the spacecraft). It performs the command scripting and housekeeping display / limit checking functions. It will be used starting at IDPU bench testing, through Suite and Spacecraft I&T, and will form the heart of the POC during post-launch Operations. Note that since the connection to the MOC or Emulator is via Ethernet, the Command & Telemetry GSE may be remote.

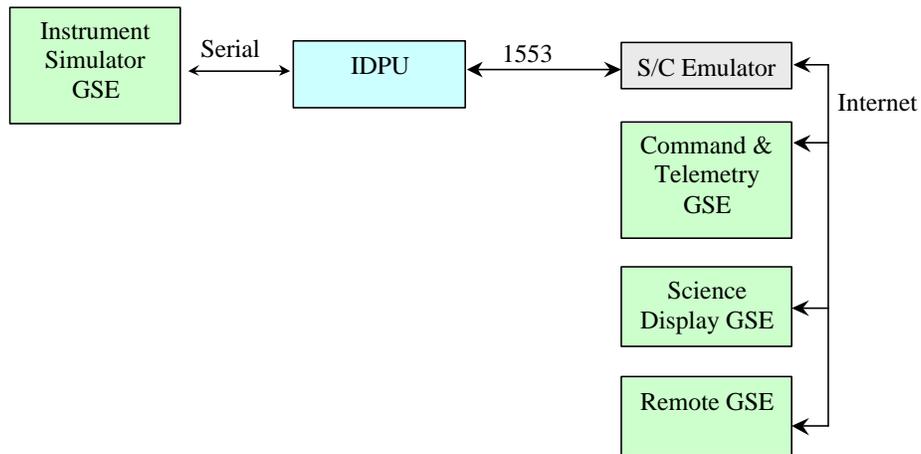


Figure 2.3-1 IDPU GSE Setup

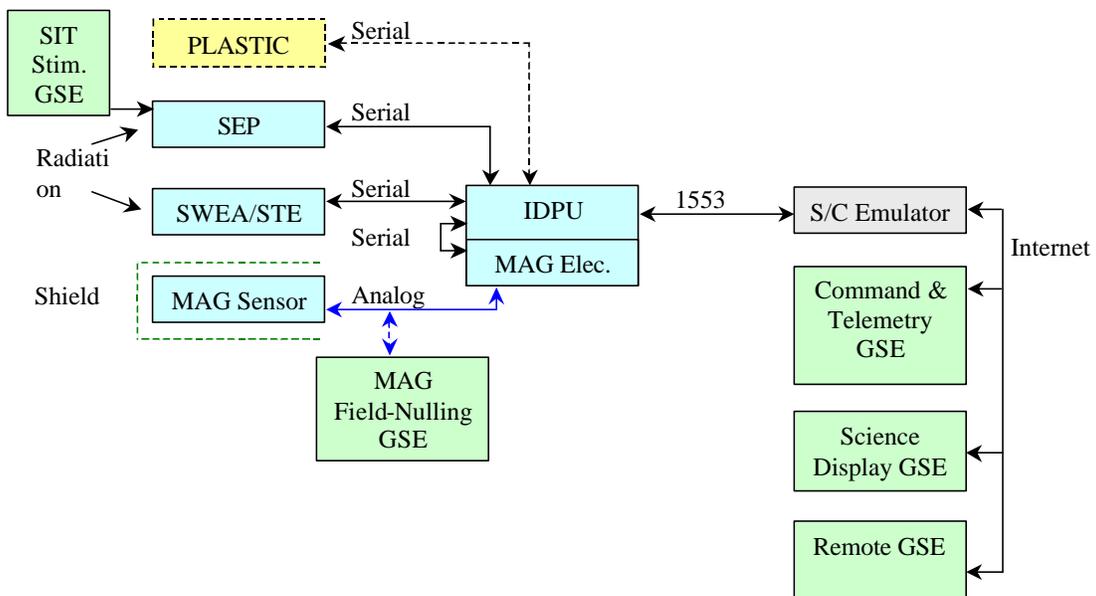


Figure 2.3-2 IMPACT Suite GSE Setup

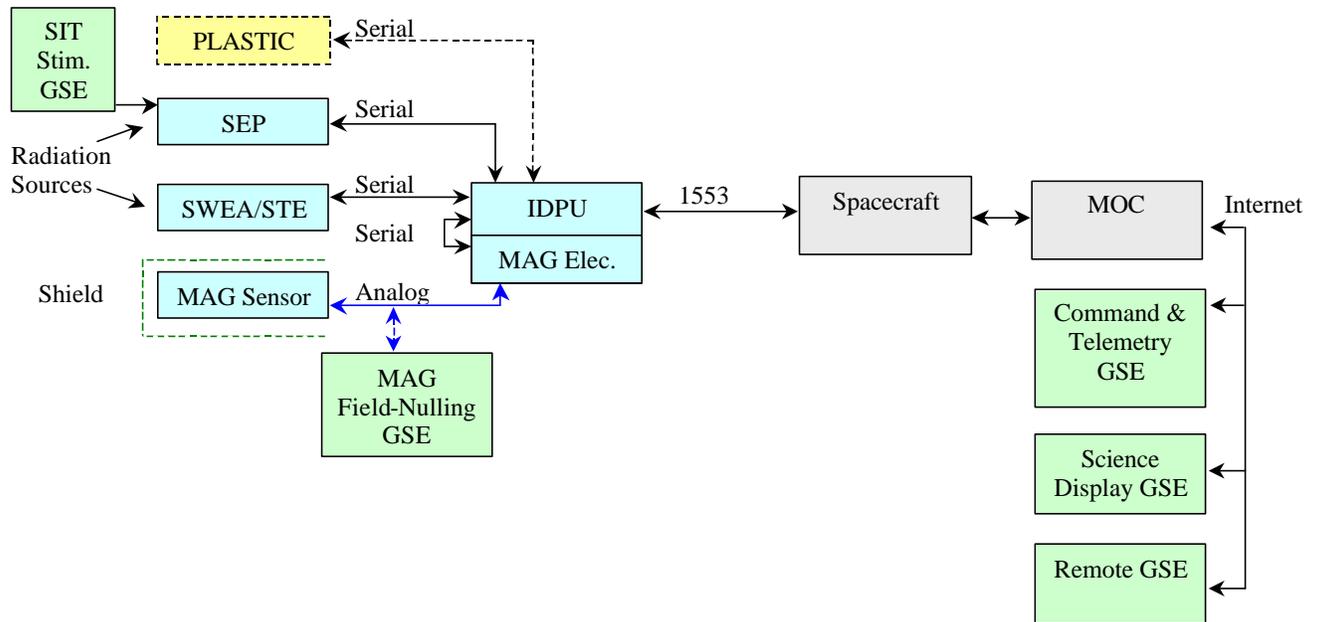


Figure 2.3-3 Spacecraft I&T GSE Setup

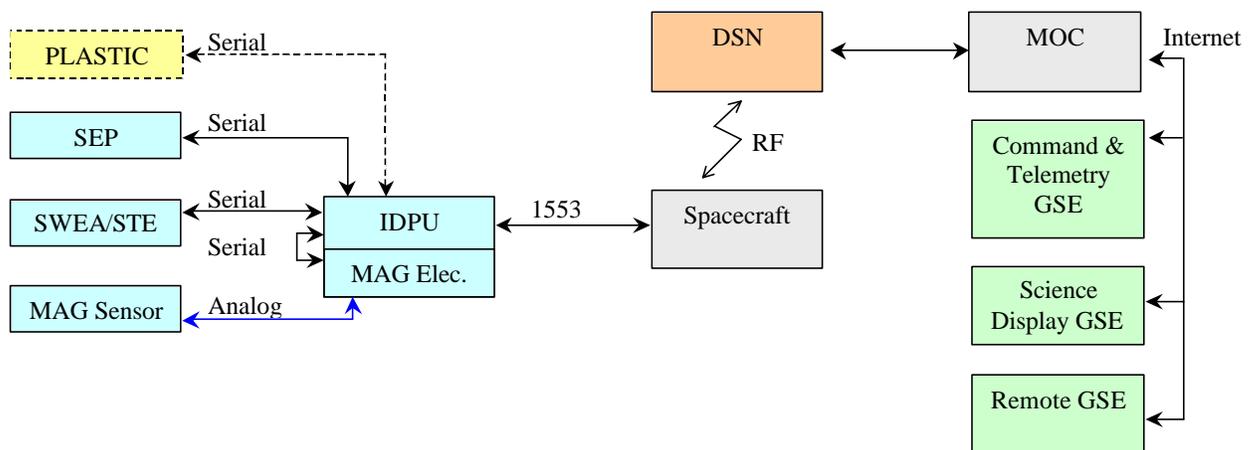


Figure 2.3-4 On-Orbit POC Setup

2.4. *Science Display GSE*

The Science Display GSE is an augmentation to the Command & Display GSE designed to display instrument science data. It will connect to **either** the Emulator or MOC just like the Command & Telemetry GSE, but only for telemetry, not command, **or it can be connected to the Command & Telemetry GSE which will forward all telemetry received.** A different Science Display GSE shall be developed for each instrument to optimally display the telemetry from that instrument in real time. It normally runs on a separate PC to decouple the operator from the scientist and provide more space for the user interface on the screen. It also decouples the development effort, and makes changes to the Science Display GSE less cumbersome since it is not part of the Critical GSE, and so has less configuration control.

The Science Display GSE for SWEA, STE, and MAG will be written by UCB. Caltech will write the Science Display program for the SEP instruments. (UNH is responsible for the Science Display software for PLASTIC)

Note that for most instruments the Science Module that connects to the IDPU Simulator will be significantly different from the Science Display that works with the Command & Telemetry GSE because the data format and bandwidth is much different. The exception is SEP, for which the data looks the same (SEP provides packetized telemetry to the IDPU, which it just passes on).

2.5. ***Beacon Data Decommutator***

This is a simple program to decomutate the beacon telemetry stream and convert the data to engineering units. It will be developed by UCB to run in the SSC.

2.6. ***Level 1 Decomutators***

These will be developed at the instrument home institutions. They convert Level zero data to Level 1 data, which is synoptic time series data in engineering units for the science community. The SWEA and STE versions will be developed at UCB. The MAG version will be developed at GSFC by the MAG team. The SEP version will be developed by Caltech.

3. **Development Plan**

3.1. ***Ground Software Identification***

1. ISG Core
2. ISG Science Modules:
 - 2.1. MAG Science Module
 - 2.2. SWEA Science Module
 - 2.3. STE Science Module
3. Instrument Simulator GSE
4. Command & Telemetry GSE
5. Science Displays:
 - 5.1. MAG Science Display
 - 5.2. SWEA Science Display
 - 5.3. STE Science Display
6. Beacon Data Decommutator
7. Level 1 Generators
 - 7.1. SWEA
 - 7.2. STE

Item 1 will be based on a stripped-down version of the HESSI Spacecraft Simulator GSE, with significant changes in the data interface, and a new command & telemetry database

Item 4 will also be based on the HESSI Spacecraft Simulator GSE, with significant changes in the data interface, and a new command & telemetry database

Items 6 and 7 will be loosely based on existing software from previous programs such as ACE, MGS, and Lunar Prospector.

The remaining items are mostly new code, though made simple by the use of existing user interface code libraries such as Labview CVI.

3.2. **Development Environment and Equipment Needed**

The GSE fall into two categories: the real-time PC-based GSE (items 1-5 above), and Workstation-based data analysis tools (items 6 and 7 above). The PC-based GSE shall be developed using Labview CVI, which is a C language development environment with a graphical user interface library. The Workstation-based tools will be developed using C and IDL. GSE that can control the instruments shall be tested on prototype hardware prior to its first use on flight hardware.

3.3. **Mission Critical Ground Software**

Mission Critical software is that which can significantly negatively impact the IMPACT project if it fails. In that category is the Command and Telemetry GSE, since it will command the instruments and monitoring state of health on the ground and in orbit.

3.3.1. Testing

GSE software shall be tested at the module and system level. Mission Critical software will receive extra attention in testing to those features that make it mission critical. Commanding features shall be fully rung-out against ETU hardware prior to use on Flight Hardware. Safety monitors shall be verified by simulating out-of-range conditions in the ETU hardware.

A Software Verification Matrix shall be developed for critical software that indicates the verification status of each of the software requirements. Emphasis will be on critical functions (commanding, hazardous command verification, state of health display and limit checking). Following Acceptance Testing against this Matrix, a Software Acceptance Review (SAR) shall be held. The completed matrix shall be available for review by Project on request by Project.

3.3.2. Software configuration management / backup plan

Mission Critical GSE software shall come under configuration control prior to starting acceptance tests and is ready for use on Flight hardware. Any subsequent changes shall be subject to acceptance testing, and shall be approved by the Project Manager prior to being incorporated into the GSE.

Once under configuration management, formal problem reporting will be used for all non-trivial problems in the critical GSE. The same system used for flight hardware will be used as described in the PAIP (reference 3).

Starting with the first version under configuration management, all critical GSE software software versions will be documented by a Version Description Document noting any changes from previous versions, referring to any problems fixed and features added, and noting any known deficiencies. Any special build or installation instructions not captured in the Users Manual shall be noted.

An archive of all released versions of GSE software shall be maintained and backed up on a regular basis.

3.4. **Reviews**

GSE software shall be included in the IMPACT formal design reviews (PDR, CDR, PER, PSR). A peer review and Software Acceptance Review of critical GSE software shall also be carried out. Action items from all reviews will be stasured at the formal design reviews.

3.5. **Documentation**

GSE software development is documented by this plan. In addition, a brief set of requirements shall be written and agreed to by the intended users prior to the start of coding, and a Users guide shall be written following coding. Because the C&T GSE shall be used throughout the mission as part of the POC, a design document for the C&T GSE shall be developed providing sufficient detail to allow a programmer to maintain and modify the code. Other than this plan, these are internal, non-deliverable documents for the use of the IMPACT team.

4. **Management Plan**

4.1. **Heritage and Reuse**

The HESSI GSE, which is the root of all the UCB real-time PC-based GSE, consists of approximately 10,000 lines of code. About half of this will be usable as the core of the IMPACT real-time GSE, the other half being instrument specific.

The Workstation-based IDL and C software shall be loosely based on the Wind 3D Plasma instrument data production software.

4.2. **Staffing Plan**

4.2.1. Level of effort

The same programmer who developed the HESSI GSE shall develop the PC-based GSE (Mike Hashii). Developing the suite of GSE software is expected to take 2.5 man-years, plus some continuing support through I&T.

The UCB data production software effort consists of the combined efforts of the SWEA/STE scientist Davin Larson, and the Operational lead, Peter Schroeder. A total of one man-year prior to launch is scheduled for this effort, with some continuing effort post-launch.

4.2.2. Manpower

Mike Hashii is full time through mid FY04, when he transitions onto the IMPACT I&T team.

Peter Schroeder and Davin Larson shall start putting significant effort into the data production software at L-1 year, and shall invest approximately half time each on that task.

4.3. **Ground Software Development Schedule**

- This Software Develop Plan shall be released prior to PDR.
- The first version of the IDPU Simulator GSE shall be available by 1/2001
- The first instrument simulator GSE shall be available by 5/2002
- **A peer review of critical GSE shall be held prior to CDR (8/2002)**
- The Command & Telemetry GSE shall be available by 12/2002
- The first revision of the Science Modules shall be available by 3/03
- These GSE shall evolve as the instruments develop, towards a firm state about the time that instrument qualification tests start. **Acceptance testing and SAR shall be complete and the software shall come under configuration control at that time.**
- The Users manuals and the Design description for the C&T GSE shall be available by the time of instrument delivery to the spacecraft.
- The Data production decommutators shall be available by launch (Note that these are not required until heliocentric orbit is achieved).