



Electrical Aerospace Ground Equipment (EAGE)

Paul Jaffe
Electronics Engineer
NRL
202-767-6616
jaffe@ssdd.nrl.navy.mil



Top Level Requirements



- **Provide FAME Spacecraft Controller (FSC) Electrical Aerospace Ground Equipment (EAGE) and Support FSC Box Level Testing, Integration, and Validation**
- **Provide Spacecraft EAGE, Electrical Launch Support Equipment (ELSE) and Support System Level Spacecraft Integration, Test, and Validation Through Launch Base Operations**
- **Provide a Spacecraft Simulator (SATSIM) and Support Flight Software Development and Mission Operations**
- **Ensure Safety of Brassboard and Flight Hardware During All Phases**
- **Test to a Flight-like State**



Derived Requirements (1 of 2)



- **Provide FSC Interface Simulation to Support FSC Box Level Testing, Integration, and Validation**
- **Provide Spacecraft Interfaces Simulation to Support System Level Integration, Test, and Validation**
- **Allow Commanding and Status of the Spacecraft During Launch Ops**
- **Ensure All EAGE Can Be Powered by Readily Available AC Power, Either Single Phase or Three Phase As Appropriate**
- **Ensure Spacecraft EAGE and ELSE Are Wheelable and Portable by Forklift**
- **Provide Power Conditioning to All EAGE and ELSE**
- **Adhere to Established MIL/NCST Safety and Fabrication Standards**



Derived Requirements (2 of 2)



- **Provide Uninterruptible Power and Automatic Power Failure Shutdown to Computer Equipment**
- **Spacecraft ELSE Must Have a Mass of Less Than TBD kg**
- **EAGE and ELSE Will Employ Single Point Power Grounding**
- **EAGE and ELSE Will Fit Within TBD Dimensions**



Major Trade Studies



- None



Issues



- **Fidelity of Closed Loop Attitude Modeling/Testing With Spacecraft**
- **Validation of FAME Instrument After Mate With Spacecraft Bus**
- **Determine the Extent and Nature of Coordination Between Bus (NRL) and Instrument (LM) EAGE During System I&T**



Backup



System Requirements



System-Subsystem	Component	Category	Item	Sub-Item	Requirement	Description
EAGE - ISC EAGE	ISC I/F		Uplink		Simulate 2 kbps CCSDS	
	ISC I/F		Downlink		Simulate 409.6 kbps	
	ISC I/F		Processor		Support debug	
	ISC I/F		IMU (2)		Simulate RS-422	
	ISC I/F		Star Tracker (2)		Simulate 1553	
	ISC I/F		Sun Sensor		Simulate TBD	
	ISC I/F		Magnetometer		Simulate TBD	
	ISC I/F		Instrument Control/Status		Simulate 1553	
	ISC I/F		Instrument Data		Simulate QHSS 25 Mbit/s	
	ISC I/F		Voltage		Provide 28 +/- 4V	
	ISC I/F		Power		Provide 40W @ 28V	
	S/C I/F		Bus protection		Protect flight hardware	
	Power system		UPS &Conditioner		Clean,uninterruptible power for computers	
	EAGE - S/C EAGE	S/C I/F		Uplink		Simulate 2 kbps CCSDS
S/C I/F			Downlink		Simulate 409.6 kbps	
S/C I/F			Processor		Support debug	
S/C I/F			Star Tracker (2)		Simulate starfield	
S/C I/F			Sun Sensor		Simulate sun	
S/C I/F			Magnetometer		Simulate earth's field	
S/C I/F			Instrument		Simulate starfield	
S/C I/F			Voltage		Provide 28 +/- 4V	
S/C I/F			Power (Batt/Solar)		Provide 600W @ 28V, simulate batt & solar array	
S/C I/F			Bus protection		Protect flight hardware	
Power system			UPS &Conditioner		Clean,uninterruptible power for computers	
Power system			Input		Single or Three phase	
All			Mass		<TBD kg	
All			Portability		Easily transportable	
EAGE - ELSE	S/C I/F		Commanding		Provide launch base commanding	
	S/C I/F		Battery charging		Provide pad battery charging	
	S/C I/F		Bus protection		Protect flight hardware	
	Power system		UPS &Conditioner		Clean,uninterruptible power for computers	
	Power system		Input		Single or Three phase	
	All		Mass		<TBD kg	
	All		Portability		Easily transportable	
SATSIM - TBD						



Overall Testing and Integration Approach



- **Use a VME-Based Chassis and Sun Workstations Running Test Software That Utilizes Scripting and Allows for Commanding and Telemetry Display**
- **Employ Automated Testing Using Scripting**
- **Protect Brassboard and Flight Hardware by**
 - **Observing Safe Grounding and Static-Sensitive Handling Procedures**
 - **Utilizing Bus Protection Units (BPUS) When Powering Spacecraft Systems and Subsystems**



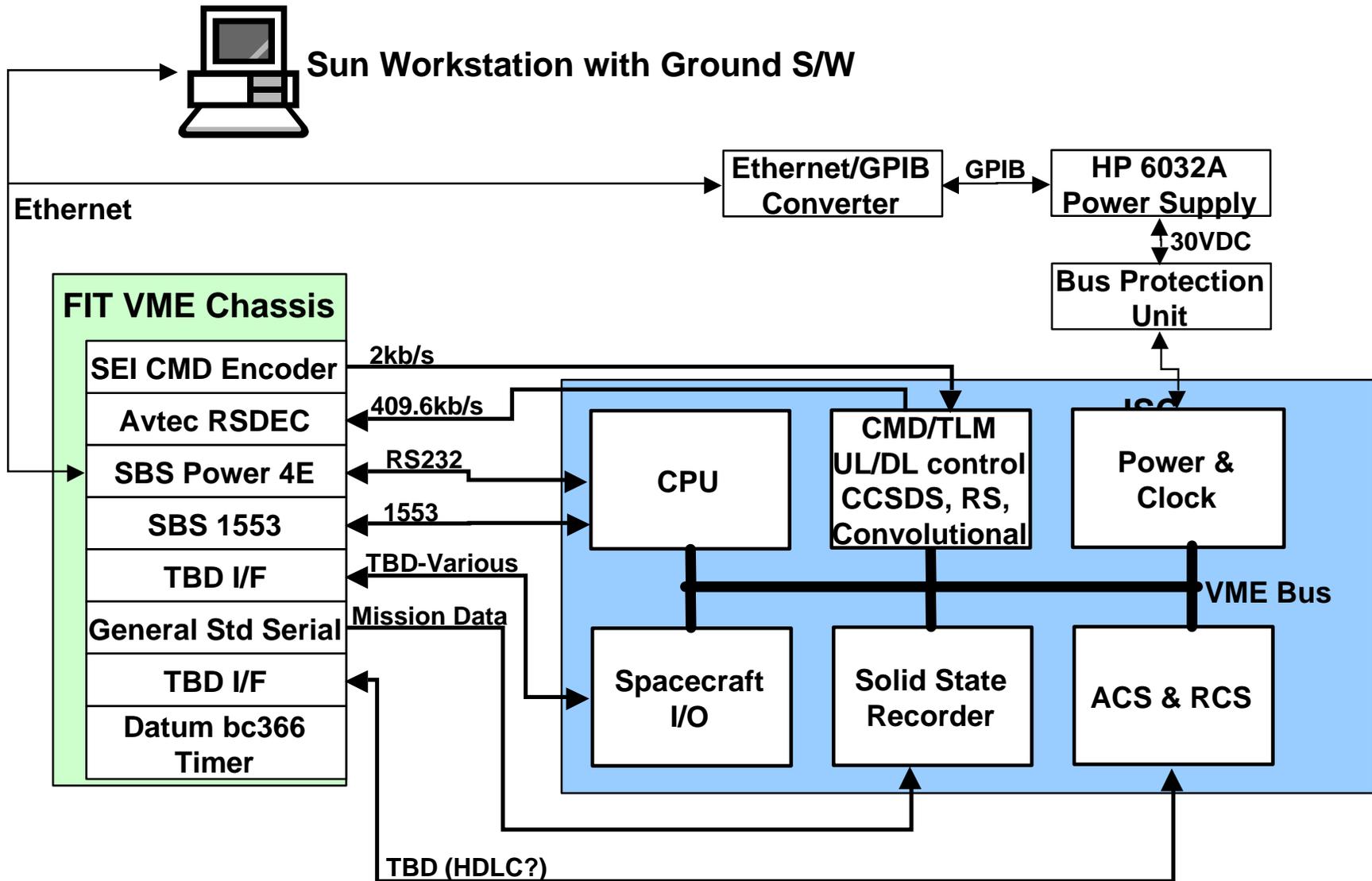
ISC Testing and Integration



- **Interfaces to Be Addressed**
 - **RS-232 (Processor Test Port)**
 - **CMD/TLM Links (Clock & Data)**
 - **Power (30 +/-6 VDC)**
 - **Data Recorder Control Port**
 - **Data Recorder Data Port**
 - **IMU, Sun Sensor Inputs (ACS/RCS)**
 - **Spacecraft Subsystem CMD/TLM**



Network Diagram





FAME Integration and Test 1 (FIT1)



- SBS 1553 Card ABI-V6-2
- SEI Command Encoder Unit
- Avtec Data Decoder RSDEC (Framesync)
- Datum Timer Card Bc366
- To Be Added:
 - General Standards Serial Card
 - TBD Mission Data I/F
 - TBD S/C I/O I/F





Spacecraft EAGE

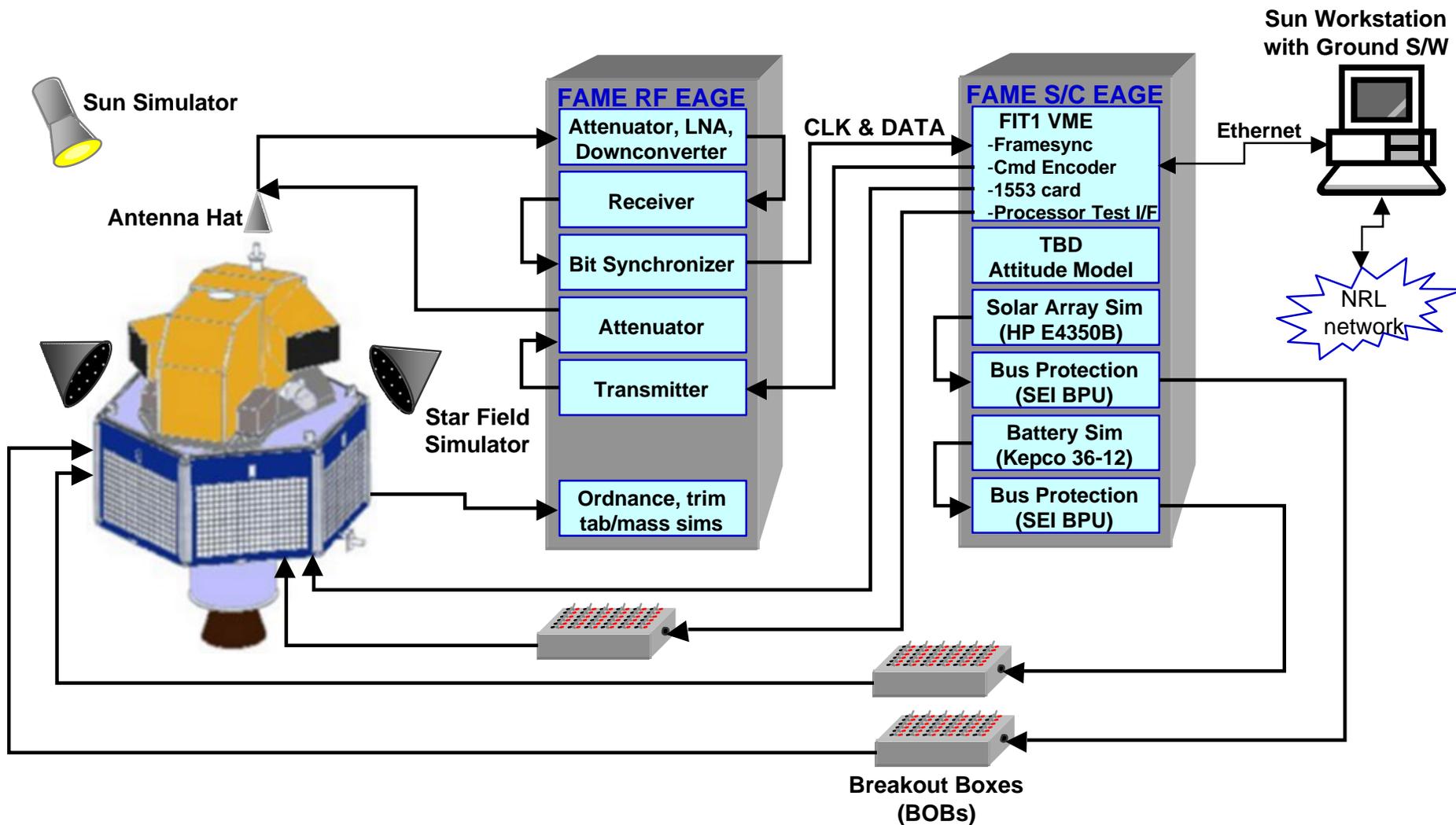


- Expand/Change ISC EAGE to Address Spacecraft Interfaces
- Interfaces to Be Addressed
 - ISC Test Port SBS Power 4E
 - S-Band Transponder RF EAGE (Not Shown)
 - Star Trackers Depends on Manufacturer
 - Sun Sensor Sun Lamp
 - Battery Kepco BOP 36-12M
 - Solar Arrays HP E4350B
 - Bus Protection for Power Supplies Silver Engineering BPU





Spacecraft EAGE Diagram



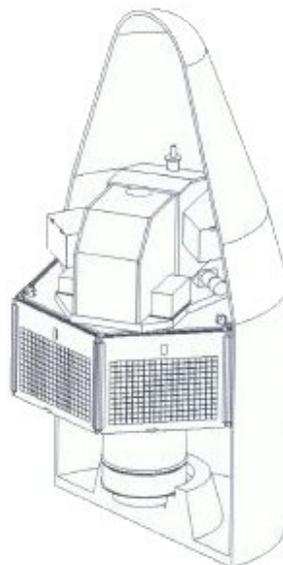
* Most Testing Scenarios Do Not Use Antennas



ELSE



- **Use Similar Approach to Spacecraft EAGE, Remove Unnecessary Functions, Add Else-Specific Functions**
- **Provide Spacecraft Support Through Umbilical Cord**
 - **Support Battery Charging HP 6032A-J01**
 - **Support Spacecraft Commanding**
 - **Ordnance Control Functions:**
 - **Thruster/Motor Arming**





SATSIM



- Use VME-based Chassis and Existing Breadboard/brassboard Hardware As It Becomes Available

