Spacecraft Interface Unit

Requirements & Electrical Interface

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Spacecraft Interface Unit Requirements (1 of 3)

- Receive Spacecraft Commands From the SC 1553 Bus
- Store Time Released Commands for LAT Autonomous Operations
- Receive SC Discrete Commands
- Receive Program Uploads From the SC 1553 Bus
- Store Program Uploads for Subsequent Re-use
- Provide Program Uploads to the Event Processors
- Decode SIU Commands and Execute Function
- Re-format and Forward LAT Sub-system Commands
- Verify Commanding Function to LAT Sub-systems
- Acquire Housekeeping Telemetry From LAT Sub-systems and Itself
- Monitor and Verify Status of LAT Sub-systems
- Take Appropriate Actions to Protect the Health and Safety of the LAT in Case of Malfunctions
- Format LAT Critical Telemetry and Provide to the SC 1553 Bus for Inclusion in SC Telemetry
- Format LAT Telemetry and Provide to the SC Data Recorder for Storage

Spacecraft Interface Unit Requirements (2 of 3)

- Receive Science Data From the Event Processors and Provide to the SC Data Recorder for Storage
- Configure the LAT for All Modes of Operation
- Receive GRB Messages From the SC 1553 Bus Interface
- Provide GRB Notification to the LAT Sub-systems
- Command the Spacecraft to Point in a Particular Area of Interest to Capture Special Gamma Events
- Control Power Switching of All of the LAT Sub-systems Except for the SIU and PDU
- Provide SC Timing Signals to the GTM for Distribution
- Provide Critical Discrete and Analog Telemetry Points to the Spacecraft
- Receive Spacecraft Orbit Position and Inhibit Events During Susceptible Orbit Positions
- Make Available Spacecraft Orbit Position and Attitude and Other Data Such That Filtered Event Data Stored on the SC Data Recorder Contains the Required Information to Permit Complete Ground Processing

Spacecraft Interface Unit Requirements (3 of 3)

- Baseplate Temperature For the SIU Shall Be Maintained at a -10ºC to +40 º C [TBR] Operating Temperature
- The Total Dose Radiation That the SIU Is Expected to Be Exposed Is 3krad(Si), Designs Shall Use [30]kRad(Si) for Margin.
- Perform in the Expected Orbit Environment Without More Than [TBR] SEU's
- Not Have Any Electrical Parts That SEL at Energy Levels Less Than [TBR]
- Consume Less Than [TBR]W Peak and Less the [TBR] Watts Orbital Average
- Meet the EMI Requirements of GEVS-SE/461 [TBR]

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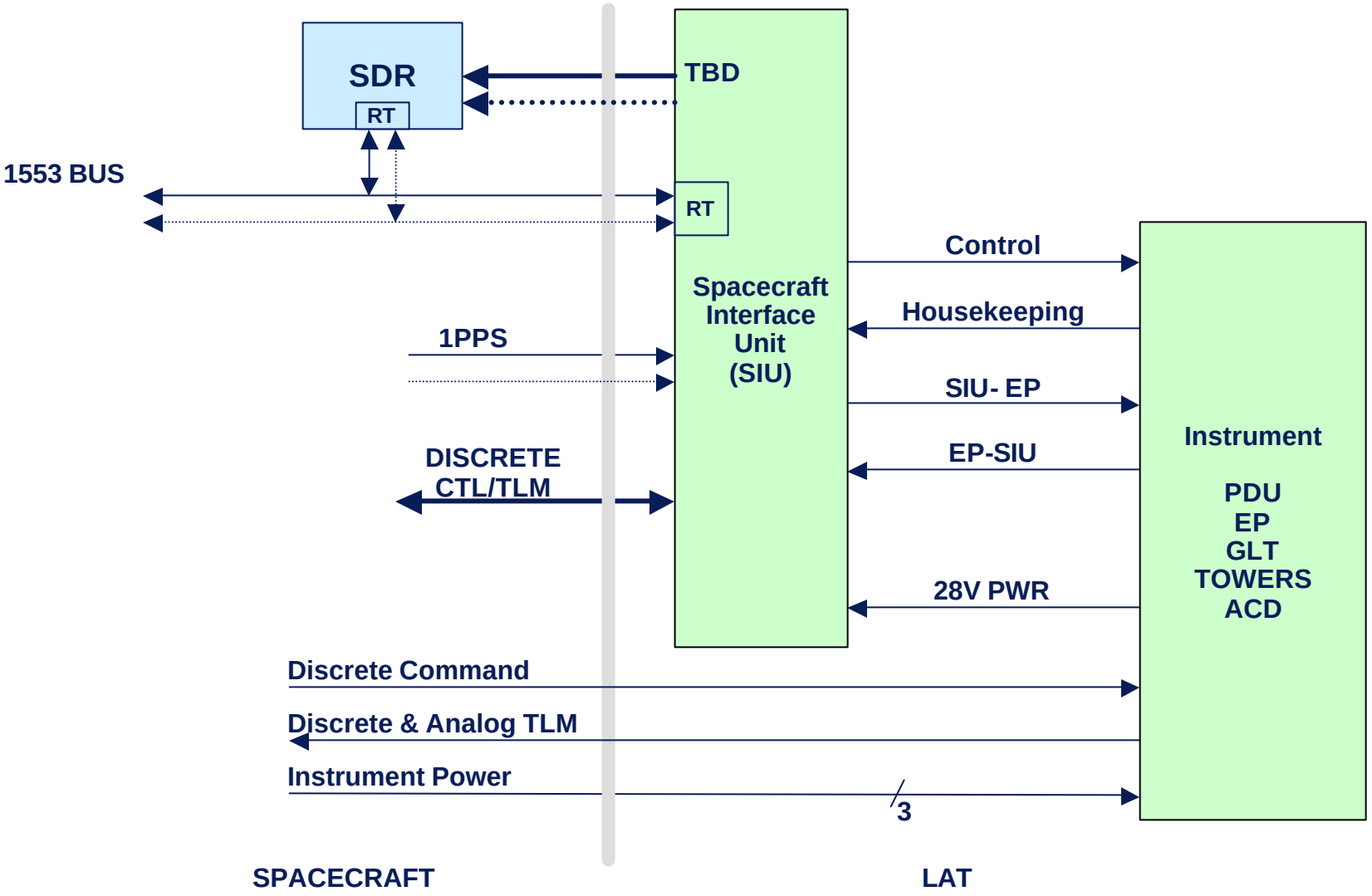
Spacecraft Interface Unit Electrical Interfaces



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Spacecraft Electrical Interface

- Spacecraft Command & Telemetry Communications Occur Over a Common 1553 Bus
  - Commands Received From the Spacecraft Could Be Intended for the Spacecraft Interface Unit (SIU) or for the Instrument
    - SIU Re-formats, Routes and Broadcasts Commands Based on CCSDS Application ID
  - Critical Housekeeping Telemetry Is Forwarded to the Spacecraft Via the 1553 Bus
    - The Majority of Instrument Housekeeping Is Stored in the SSDR
  - Gamma Ray Burst Communication Occurs Over the 1553 Bus
- Instrument Science Data And Housekeeping Is Assembled Into CCSDS Telemetry Packets for Storage on SC Data Recorder (SDR)
  - Average Data Rate To SDR Shall Be 300kbps, Peak Rate Accommodated By SC May Be As High As 64mbps

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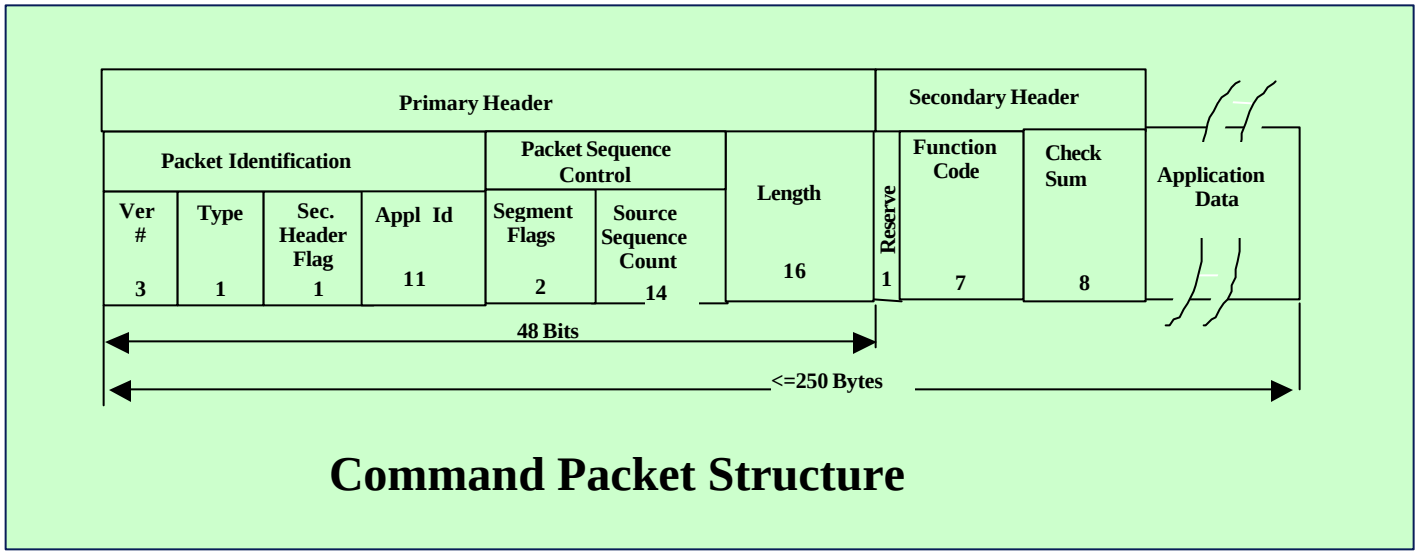
Spacecraft Electrical Interface (Page 2)

- Discrete & Analog Control & Telemetry Is Accommodated by the Spacecraft
  - The Spacecraft Will Accept Up To [TBR] Analog Points for Voltage, Current, and Temperature Telemetry Points
  - The Spacecraft Will Provide [TBR] Digital Control and Status Points
- 1 PPS Interface Provides Time Synchronization Between Subsystems
  - RS-422 Redundant Interface, 10us RMS Accuracy
  - SIU May Re-distribute 1 PPS Signal to LAT Subsystems Using Broadcast Commands
- +28vdc Redundant Power Received From the Spacecraft On Three Switched Busses By The PDU
  - PDU Provides SC Switched Power To The SIU
  - Spacecraft Provides Select Lines To The PDU For SIU And PDU Redundant Sides
  - SIU Monitors Subsystem Voltage and Currents By Communication With The PDU

SC Electrical Interfaces
1553 Bus Interface
Instrument Commanding

- Commands Are Received by the SIU From the Spacecraft Over the 1553 Bus
- CCSDS Command Formats Include an Application ID, Per CCSDS 203.0-B-1
- Specific Application Ids Could Identify High Priority and Broadcast Commands



Command Packet Structure

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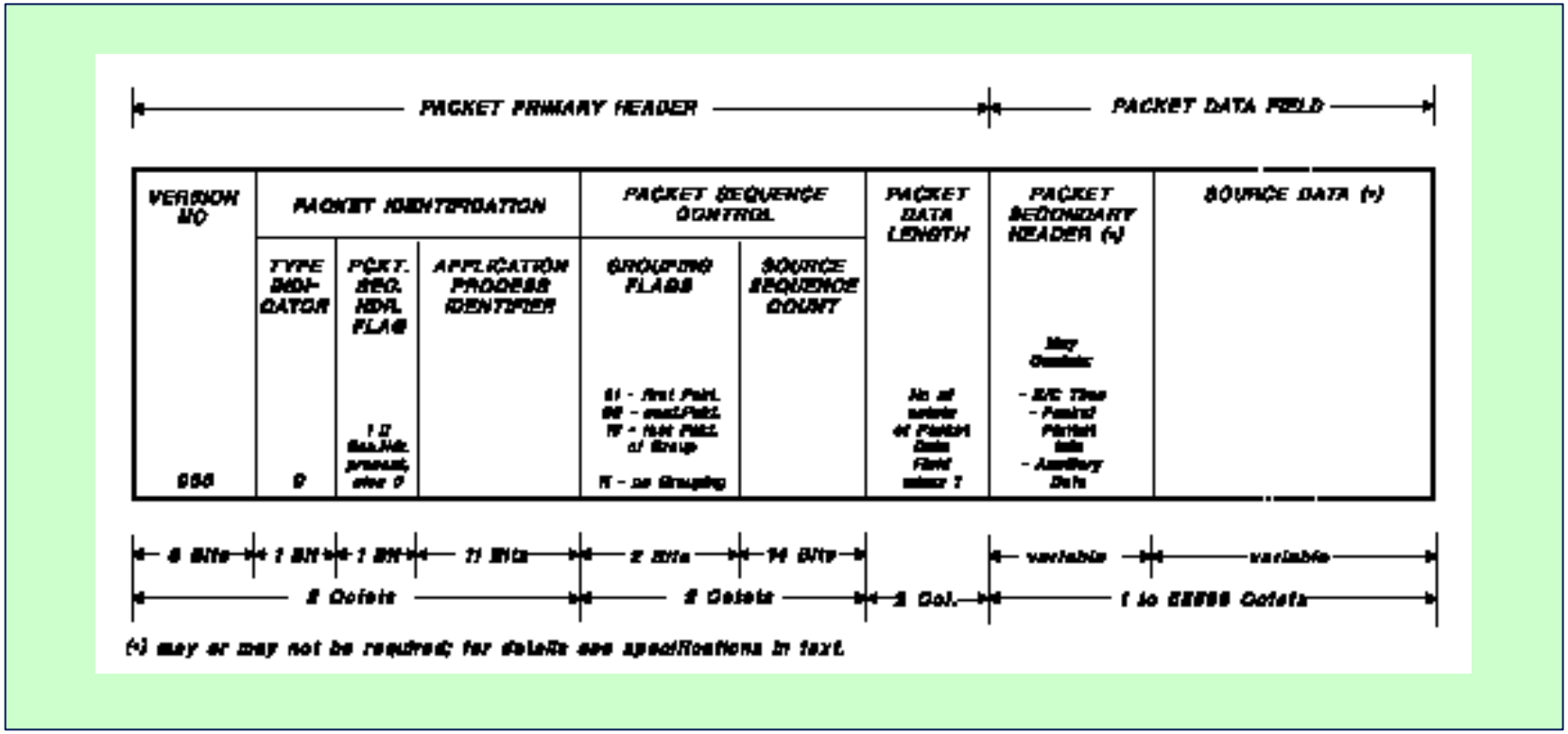
SC Electrical Interfaces
1553 Bus Interface
Instrument Telemetry

- **Per CCSDS 102.0-B-4, Telemetry or Source Packets Shall Have The Format As Specified Below**



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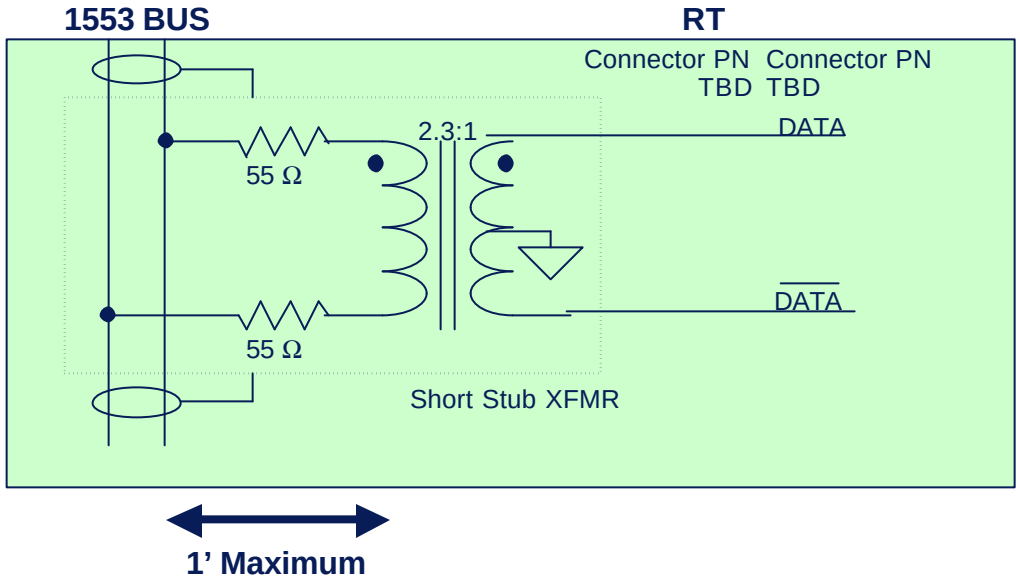
SC Electrical Interfaces
1553 Bus Interface
Electrical Interface

- **RT Interface**
- **Bus Implements Both Primary and Redundant Buses**
- **[Short Stub] Coupling at SIU**
- **[TBD] Bus Slots, [TBD] Ms Per Slot, [TBD] Bits Per Slot, [TBD] Kbps Total Bandwidth, Retry Available on [TBD]**



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SC Electrical Interfaces
SDR Interface
Electrical Interface

- Spacecraft Data Recorder (SDR) Interface Will Be Defined When The SC Has Been Selected
- Average Data Rate To SDR Shall Be 300kbps, Peak Rate Accommodated By SC May Be As High As 64mbps
- Data Format Is Expected To Be CCSDS Telemetry Packets
- Discussions With SC Providers Suggest:
  - LVDS Electrical Interface
  - Existing Low LAT Impact Interface Design

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SC Electrical Interfaces
Analog & Discrete Telemetry Interface

- The SC Shall Accept [TBR] Analog Signals From PDU
  - Critical Temperatures, Voltage & Current Monitors
  - The Sample Rate Shall Be [TBR] Hz
- The SC Shall Provide [TBR] Discrete Control Signals To The PDU
  - PDU A Select
  - PDU B Select
  - SIU A Select
  - SIU B Select
  - Others [TBR]
- The SC Shall Accept [TBR] Discrete Status Signals
  - PDU A On
  - PDU B On
  - SIU A On
  - SIU B On
  - Others [TBR]
- Electrical Interface Is [TBR]

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SC Electrical Interfaces
1 PPS Interface

- SC Shall Provide a Primary and Redundant 1PPS Pulse With An Accuracy Of [±0.5us]
- Time Packet Shall Be Distributed Over The 1553 Bus Within [100ms] Of The 1 PPS Signal In Universal Time Coordinate Format
- In The Event Of GPS Receiver Dropout, The 1 PPS Signal Will Continue With A Maximum Drift Of [±1 Us/TBR]
- [RS-422] Differential Signal Terminated Into 100 Ohm At Receiving End
  - Pulse Width Equal To [TBR]

SC Electrical Interfaces
Primary Power Interface

- The SC Shall Provide Three Switched Primary and Redundant +28V ±6V Bus To The PDU
  - PDU Provides Power To The SIU A Or B Side Based On SC Discrete Control Commands
- The Peak Power Shall Not Exceed [1000W for 10 Minutes] And The Orbital Average Current Shall Not Exceed [650W] For The Entire LAT
  - The SIU Shall Not Exceed [TBR W] Peak And [TBR W] Orbital Average
- Current Inrush Shall Be Limited to [TBD A/ms]
- The SC Shall Provide For Primary and Redundant +28V Survival Heater Power To The PDU
  - Both Sides of the Survival Heater Power Shall Be Powered During Flight

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Instrument Electrical Interfaces

- The SIU Shall Communicate With The PDU, GLT, Event Processors, Towers And ACD Using Serial Links
  - Control Links Send Commands To The GLT, PDU, Towers & ACD
  - Housekeeping Links Read Back Register And Environmental Data From The GLT, PDU, Towers & ACD
  - SIU - EP Links Broadcast Command, Data and Program Upload Packets To All Event Processors
  - EP - SIU Links Are Multiplexed Within the GLT And De-multiplexed Within The SIU
    - EP - SIU Links Contain EP Telemetry, Science Data and Memory Dumps
- LVDS Signaling Shall Be Used Terminated Into 100 Ohm
- Packet Formats Consist Of Header Info, Data Section, Error Control, and End Of Packet
  - Error Control Is [TBR]
  - End Of Packet Is Signified By > [TBR] Zero's
    - Data Section Avoids Having > [TBR] Zero's By [TBR]

Spacecraft Interface Unit

Architecture

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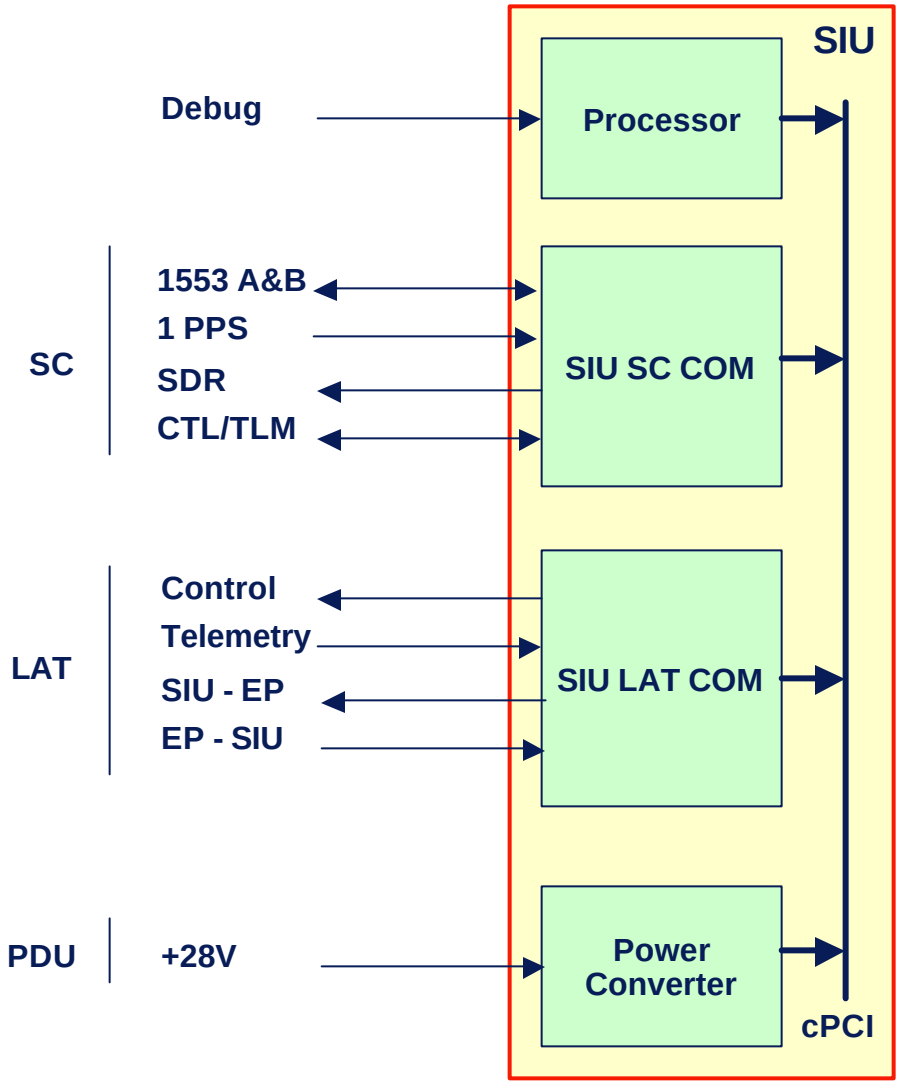
Spacecraft Interface Unit Functional Block Diagram



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Spacecraft Interface Unit Functional Block Diagram

- SIU Consists Of 4 Modules:
  - SIU Processor Maintains Control Over The Instrument
    - PowerPC Processor, PCI Bus Bridge, Memory
    - On Going Trade Study Pending Availability & Cost Issues
  - SIU SC COM Card Provides Interfaces to SC
    - 1553 Bus A&B, SDR, 1 PPS, CTL/TLM
  - SIU LAT COM Card Provides Interfaces to Remainder of LAT Subsystems
    - Control/telemetry/event Processor Communication
  - Power Converter Provides for Secondary Power To SIU Functions
- Redundancy Assures Mission Life
  - SIU Is Dual Redundant In A Cold Spare Configuration
  - Packaged In 2 Separate Enclosures

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SIU Processor Options

- **RAD750 From BAE Systems Is the Baseline Choice for the SIU**
- **RHPPC From Honeywell Is Also Under Consideration**
- **Adapting Recent CPU Card Designs Developed by the NRL for GLAST and NEMO Using the Temic PowerPC 603e May Be an Option If Availability or Cost Issues Dictate**

Function	RAD750	RHPPC	TCPU	Remarks
Processor	750	603e	603e	
MIPS	240	210	~140	
RAM	128MB	64MB	256MB	
EEPROM		4MB	4MB	
SUROM	256kB	512kB	64kB	
cPCI Format	3U	6U	6U VME	
1553 Bus	No	Yes	No	
Voltage	3.3	[TBR]	3.3, 5	
Power	<12W	<8W	<10W	

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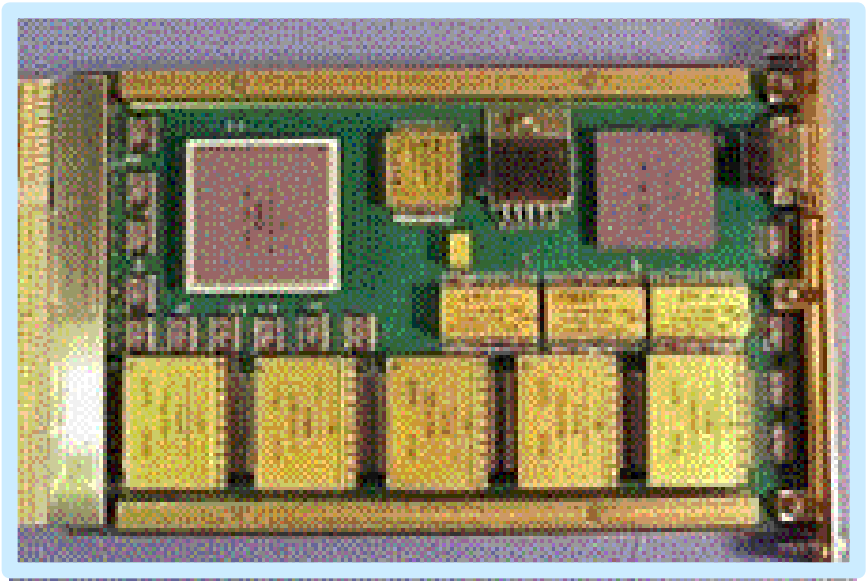
SIU RAD750 Processor

- Off The Shelf Processor Card From BAE Systems
- 240 MIPS at 133mhz, Less Than 12W
- Total Dose > 100 kRad (Si), Latchup Immune, SEU Rate < 1E-5 Upsets/processor-day @ 90% GEO
- 3U Compact PCI Module Format
- VxWorks Operating System
- Requires EEPROM & 1553 Bus Interface To Be Included On SIU SC COM Card

PowerPC™



Courtesy: BAE Systems Inc.

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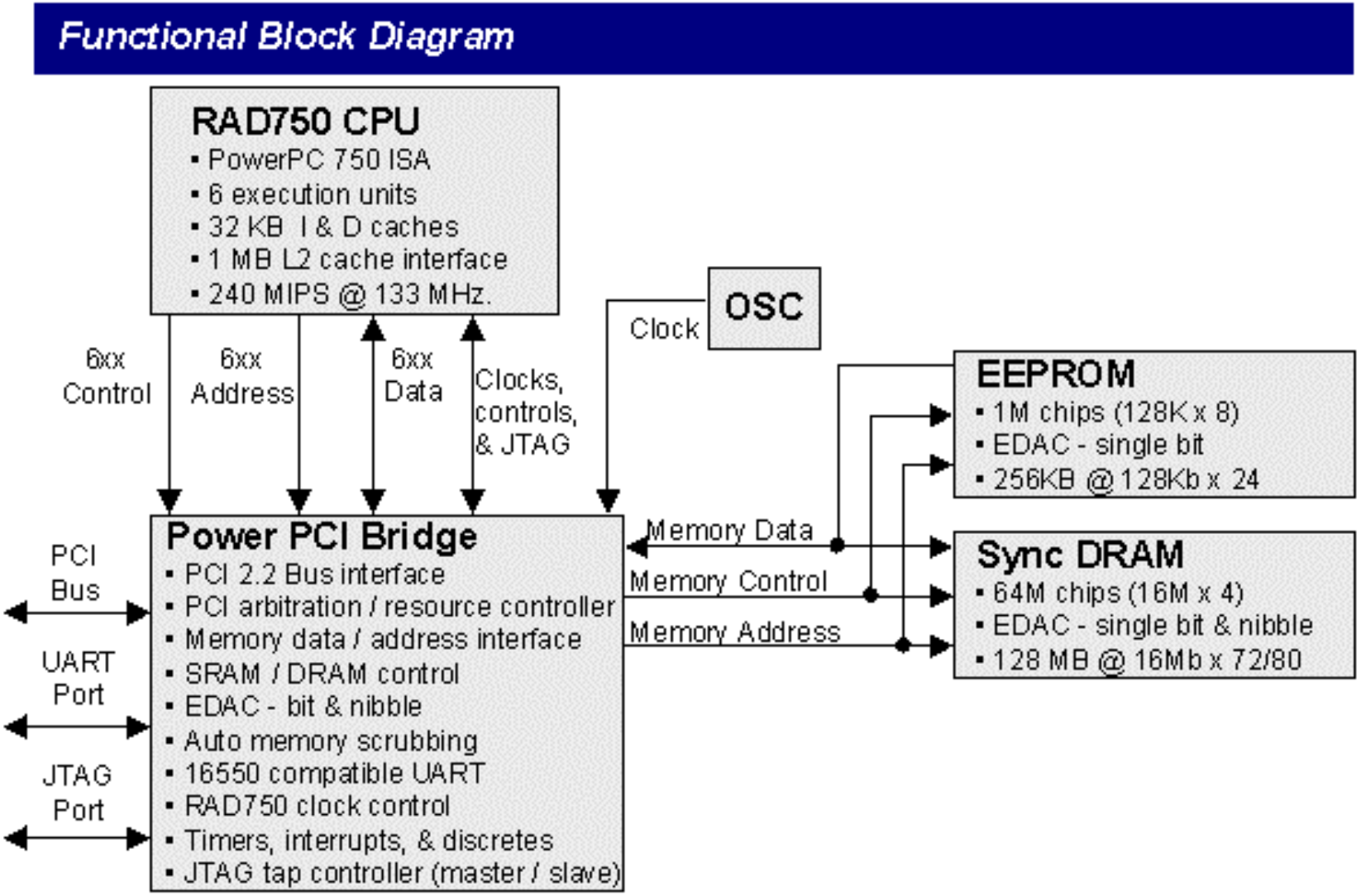
SIU RAD750 Functional Block Diagram



Courtesy: BAE Systems Inc.

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SIU Honeywell RHPPC Option

- RHPPC 150 MHz, 210 DMIPS, 16kbyte I&D Caches
- Memory With EDAC and Scrubbing:
  - 4 Mbyte Hard SRAM or 64MB SDRAM (Optional)
  - 4 Mbyte ROM or EEPROM
  - 512 Kbyte SUROM
  - 1 Mbyte L2 Cache (Parity)
- cPCI Backplane Bus (Optional Dual Configuration), 32-bit, 33 MHz
- Dual Redundant 1553B Upgrade-able to Dual Rate AS1773
- PCI Mezzanine Bus
- 6U X 160 Form Factor, 2.5 Lb., 8W (Nom)
- -40°C to 80°C Rail Temperature
- Ps>0.99, 15 Years, 35°C (With Cold Spare)
- TID >500 kRad, No SEL, SEU Rate < 3e-5/day (Adams 90 Percent WC, GEO)

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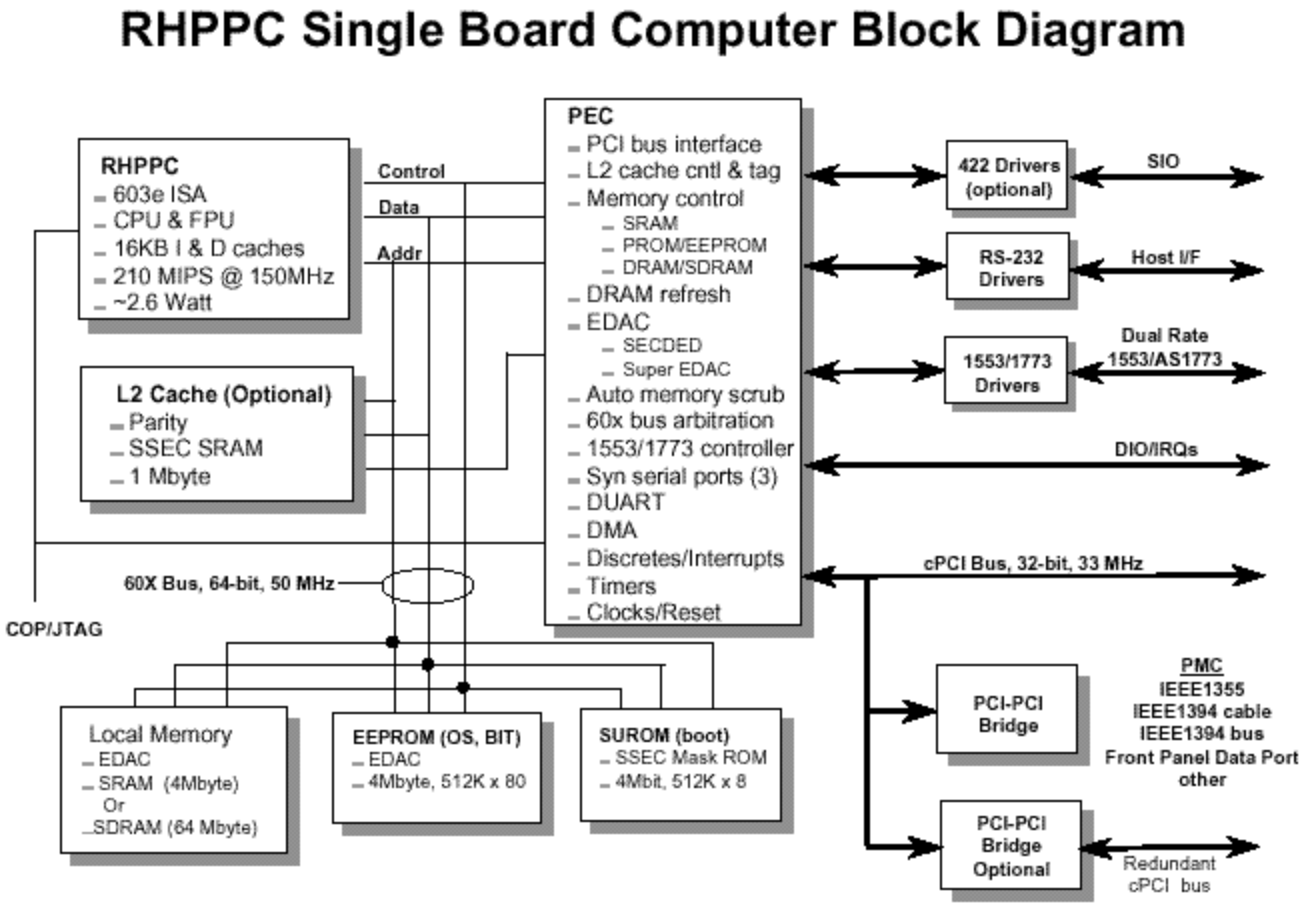
SIU Honeywell RHPPC Functional Block Diagram



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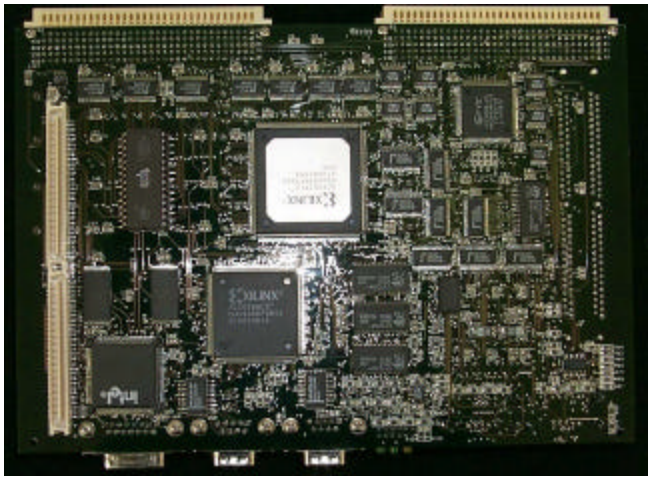
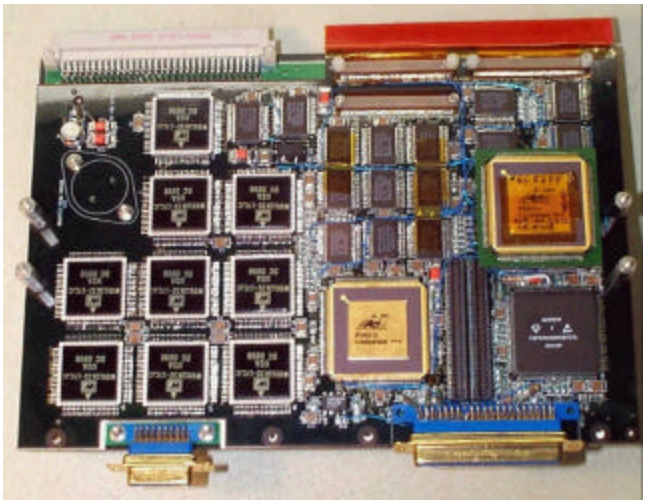
NRL PowerPC CPU Cards

- Two PowerPC PC603e CPU Cards Have Been Developed By The NRL Over the Last 3 Years
- Both Designs Are Based On the Temic PowerPC 603e Processor
- The NEMO Program Developed and Tested a Flight Brassboard Design
  - 30krad(Si) TID, 16MB SRAM, 1553 Bus, 4MB EEPROM, VMEbus, VxWorks
- The GLAST Program Developed the Tower CPU Card, Flight Breadboard for an Advanced Design
  - L2 Cache, 256MB DRAM, 4MB Flash, 64kb SUROM, Ethernet, VMEbus, VxWorks and Linux In-process



GLAST Tower CPU Card



NEMO NPC CPU Card

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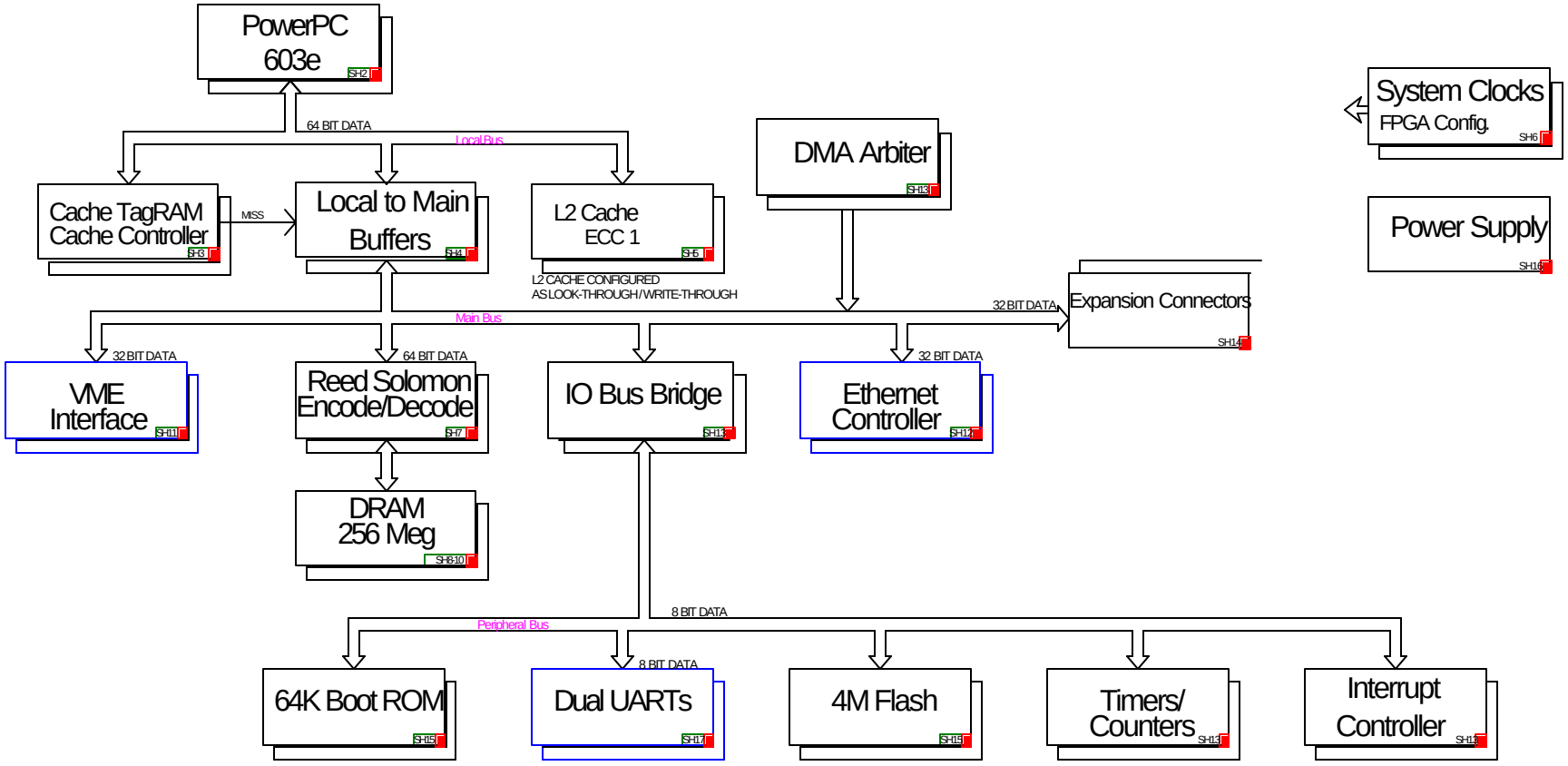
GLAST TCPU Functional Block Diagram



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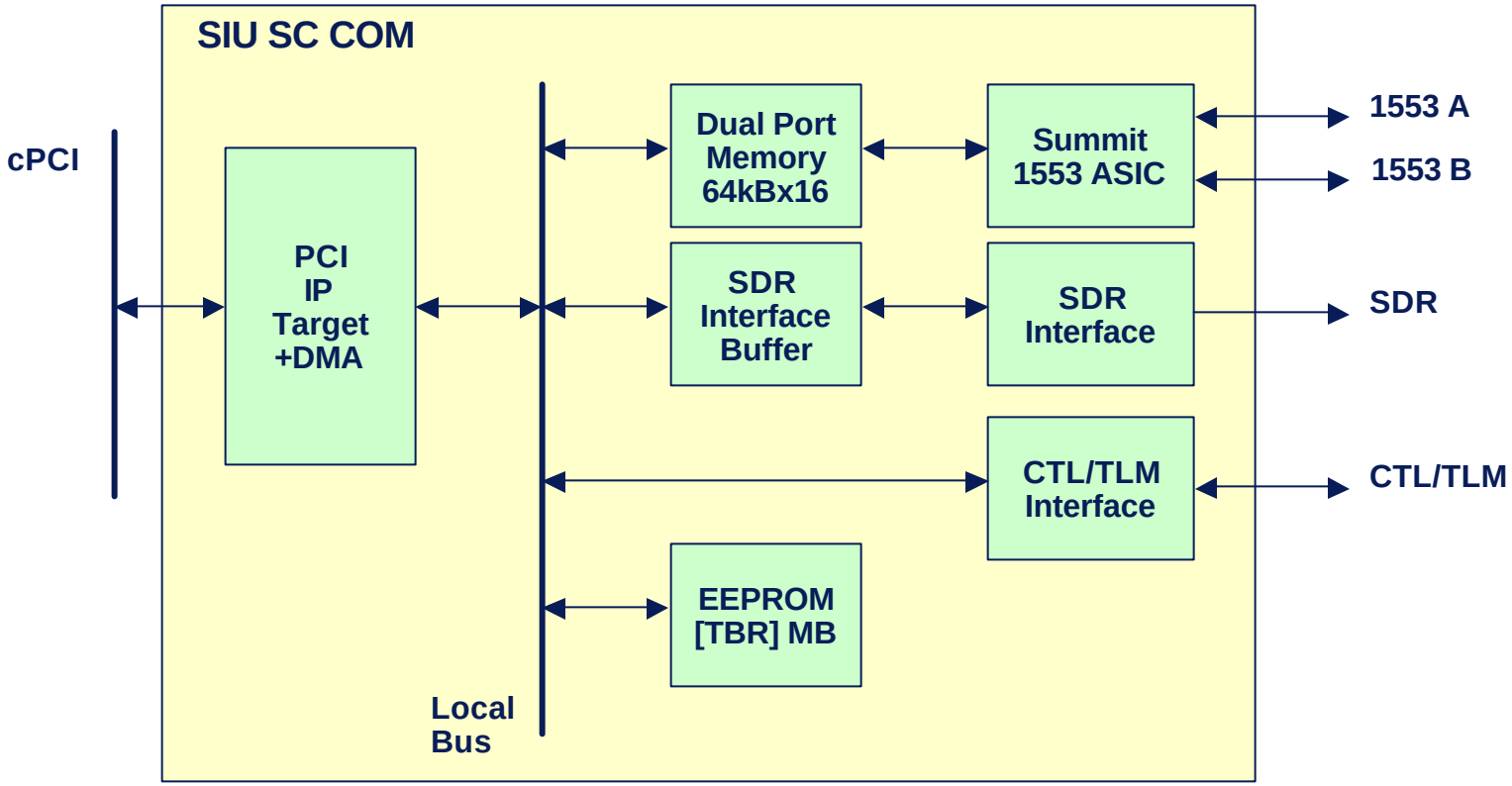
SIU Processor Software

SIU SC COM Card

- SIU SC COM Card Includes a cPCI Interface, SC Data Recorder Interface, SC Control/telemetry Interface
  - May Also Require EEPROM and 1553 Bus Interface If RAD750 Processor Is Selected
- PCI DMA Supported to 1553 Bus Dual Port Memory and SDR Buffer



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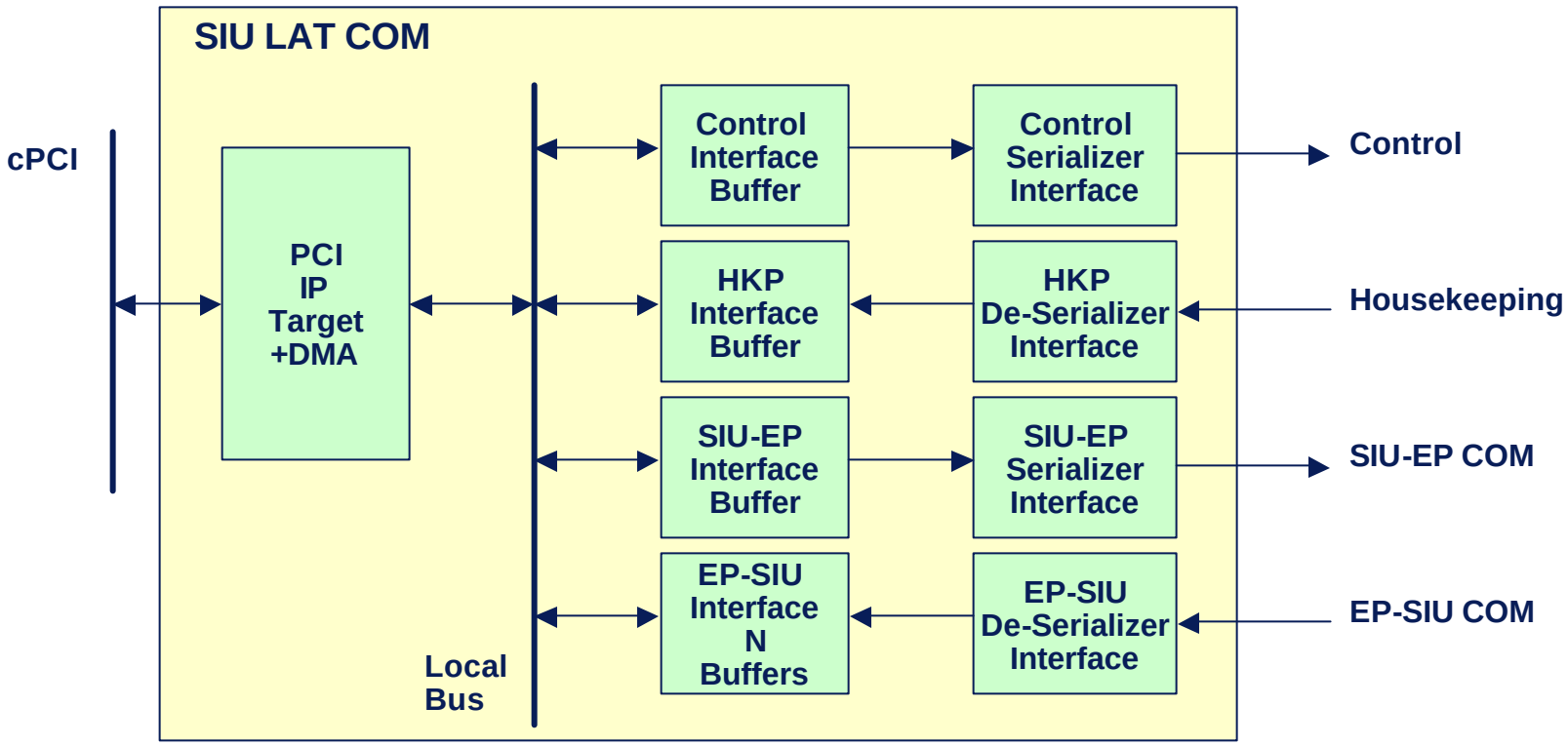
SIU LAT COM Card

- SIU LAT COM Card May Be Identical or Similar to the Event Builder Card Resident in Each Event Processor
- DMA Supported For SIU-EP and EP-SIU Interfaces



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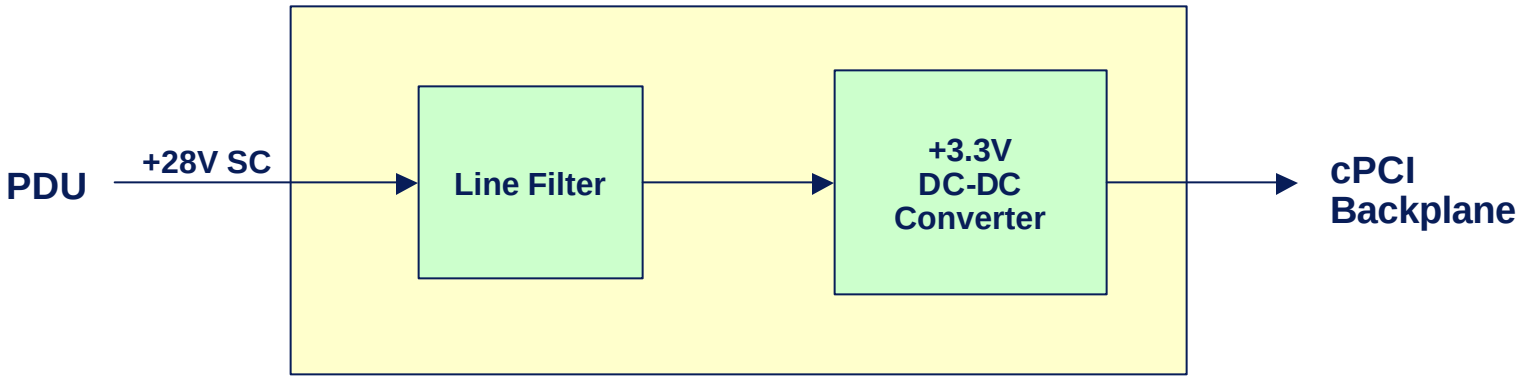
SIU Power Converter

- Discrete Control Signals From The Spacecraft To the PDU Enable Power To The A or B Side Of The SIU
- Output Voltages And Power Levels Are [TBD]



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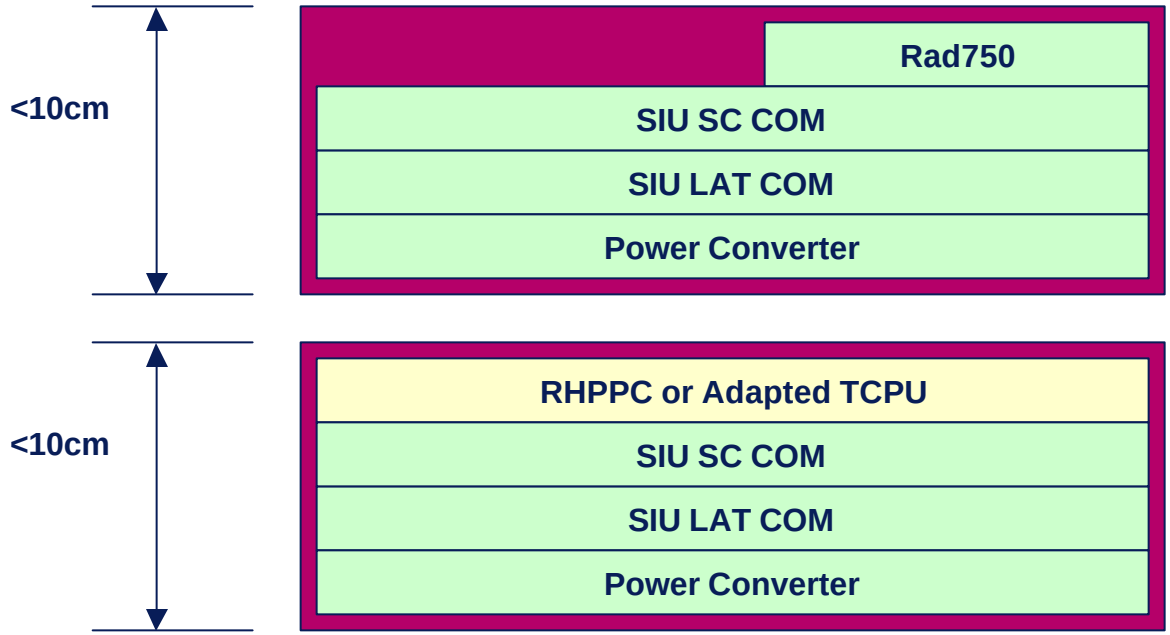
SIU Enclosure Card Layout

- SIU Enclosure Contain One Side of a Redundant Pair
- Two Approaches Shown, One With the 3U RAD750, the Other With the 6U RHPPC or Adapted TCPU Processor Options
- Maximum Height Of 10cm Drives Packaging Concepts



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SIU Power Budget/Estimates

- **Power Estimates Are Based On Previous Programs**

Device	Peak	Orbital	Standby			
RAD750	12	10	6			
SIU SC COM	4	3	2			
SIU LAT COM	4	3	2			
Power Converter (75%)	5	4	2.5			
Total	25	20	12.5			

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