

# GLAST Large Area Telescope

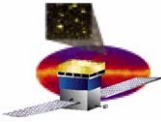
**Instrument Flight Software  
Flight Unit Peer Review  
16 September 2004**

**LAT Communications Board Driver**

**Ed Bacho  
Stanford Linear Accelerator Center**

[ebacho@slac.stanford.edu](mailto:ebacho@slac.stanford.edu)

**650-926-5324**



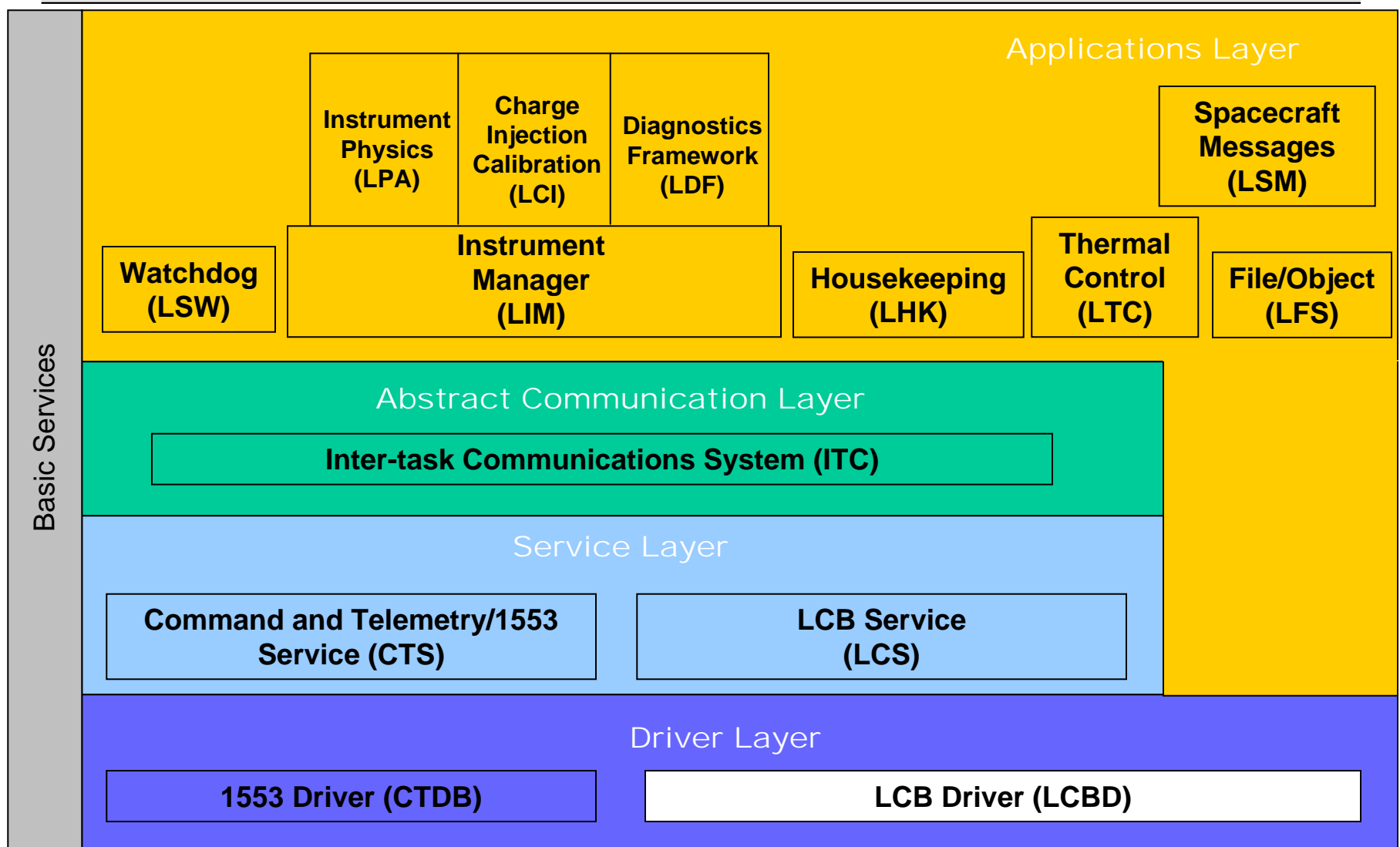
# LCB: Requirements

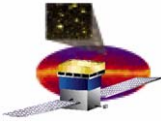
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- **Flight Software General Requirements**
  - **EPU-SIU Interface (5.2.1.1)**
    - The EPU FSW shall communicate with the SIU via a custom CPU-to-CPU serial message protocol described in the TEM, AEM, CRU, EBM, GEM, and PDU Programming ICDs.
  - **Science Data Interface to the Event Builder (5.2.1.3)**
  - **Science Data Rate (5.2.1.3.1)**
    - The FSW shall accommodate LAT science data interface data transfer rates up to 66 Mbps to SC storage via the Event Builder (TBR. Pending CCR to change to 40 Mbps).
  - **Science Data Volume (5.2.1.3.2)**
    - FSW shall send to the SC, via the Event Builder, a maximum of 104 Gbits of high-rate science data in any given 24 hour period.
  - **Science Data Packet Format (5.2.1.3.3)**
    - FSW shall format data into CCSDS telemetry packets tagged with application IDs (APIDs) in the same manner as the CTDB telemetry as specified in GLAST 1553 Bus Protocol Interface Control Document.
  - **Science Data Packet Synchronization Word (5.2.1.3.4)**
    - Each CCSDS source packet shall be preceded with a synchronization word to aid in data recovery.



# FSW Layer Model

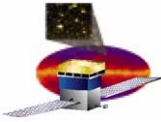




# LCB Driver Overview

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- The LAT Communications Board (LCB) is a cPCI module residing in every cPCI crate within the LAT
  - 2 SIU and 3 EPU crates
  - The LCB provides communication within the LAT using a custom LATp communications protocol.
- The LCB hardware design calls for two FPGAs that communicate via intermediate FIFOs.
  - The PCI FPGA controls the PCI bus and provides the interface to PCI registers.
  - The LATp FPGA controls LATp specific I/O features, e.g. sending commands, receiving response and receiving event data.
  - The LATp FPGA also contains a small number of 32-bit registers.



# LAT Internal Communications Fabrics

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- An LCB can communicate directly with other LCBs (in other crates) on one of two communications fabrics:
  - An Event Data fabric (described in detail earlier by JJ Russell)
  - A Command/Response fabric.
- On the Event Data fabric:
  - Data arrives unsolicited, i.e. whenever it is ready. A handler is notified and processes the unsolicited data in a timely manner.
- On the Command/Response fabric:
  - A node can issue a command to another LATp node and receive the solicited response. For example, this is used to read a register on a remote electronics module.



# Command/Response Items and Lists

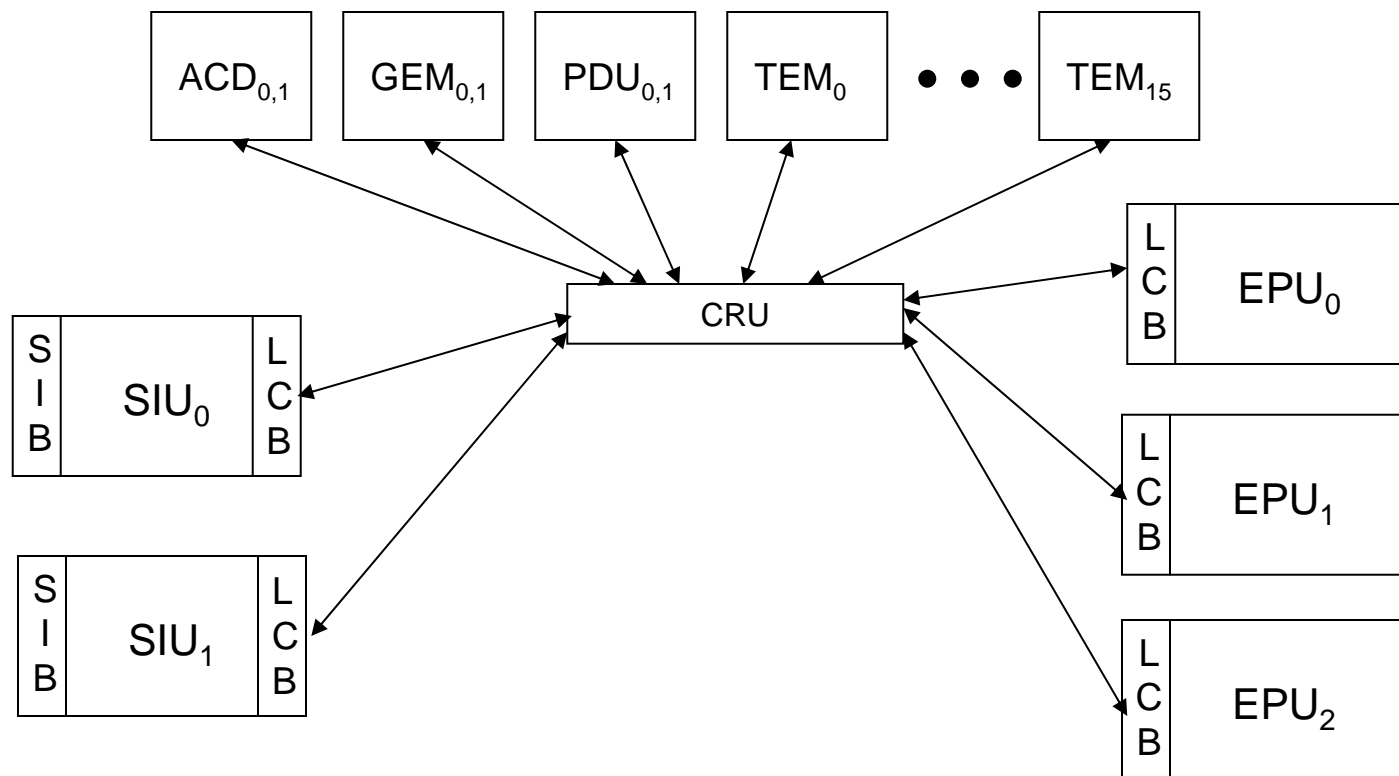
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- **Command and responses can be issued/received individually.**
- **However, to speed up configuration and other commanding operations, multiple Command/Response items can be bundled into DMA transfer operations between a flight CPU (e.g., an SIU) and the LAT Communications Board (LCB):**
  - **Multiple command items in a “command list” are DMA’d to the LCB.**
    - **There the command items are sent one by one to LAT subsystems.**
    - **The command list can be up to 4 KB long, enough space to hold 150 register write commands.**
  - **Multiple responses are assembled into a “results list.”**
    - **All result items have a timestamp and a status word.**
    - **For command items that expect a response, the result item also contains the data read back from the instrument subsystem.**
    - **The results list can also be up to 4 KB long.**
  - **A one-to-one relationship between items on the command and results lists is maintained.**
  - **The results list is DMA’d back to the flight CPU, and LCB raises an interrupt to signal the transfer is complete.**



# Communications on the Command/Response Fabric

- The command/response fabric is the “control” fabric
  - Provides write and read access to registers throughout the instrument
  - Messages routed by the Command/Response Unit (CRU)



## Legend

ACD: Anti-coincidence detector

GEM: Global Trigger Electronics Module

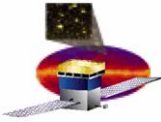
TEM: Tower Electronics Module

SIU: Spacecraft Interface Unit

EPU: Event Processing Unit

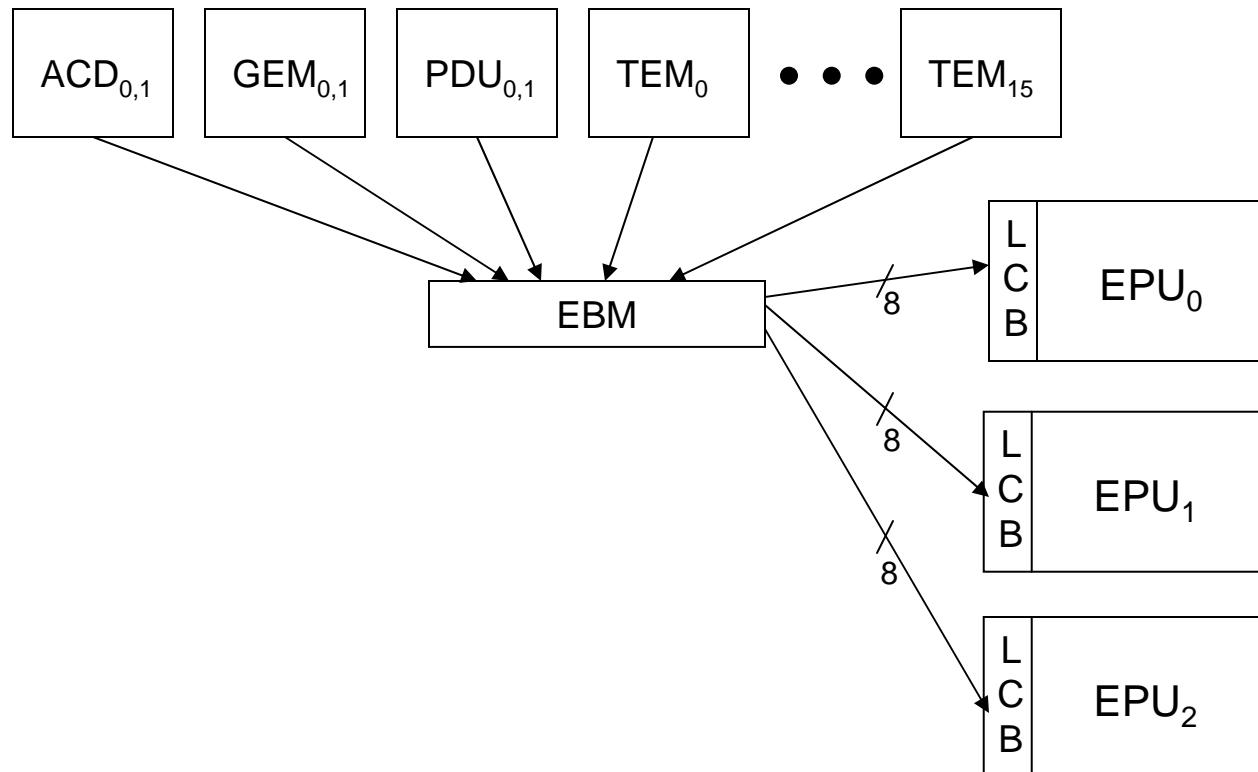
LCB: LAT Comm. Board

SIB: Spacecraft Interface Board



# Communications on Event Data Fabric (Receive Side)

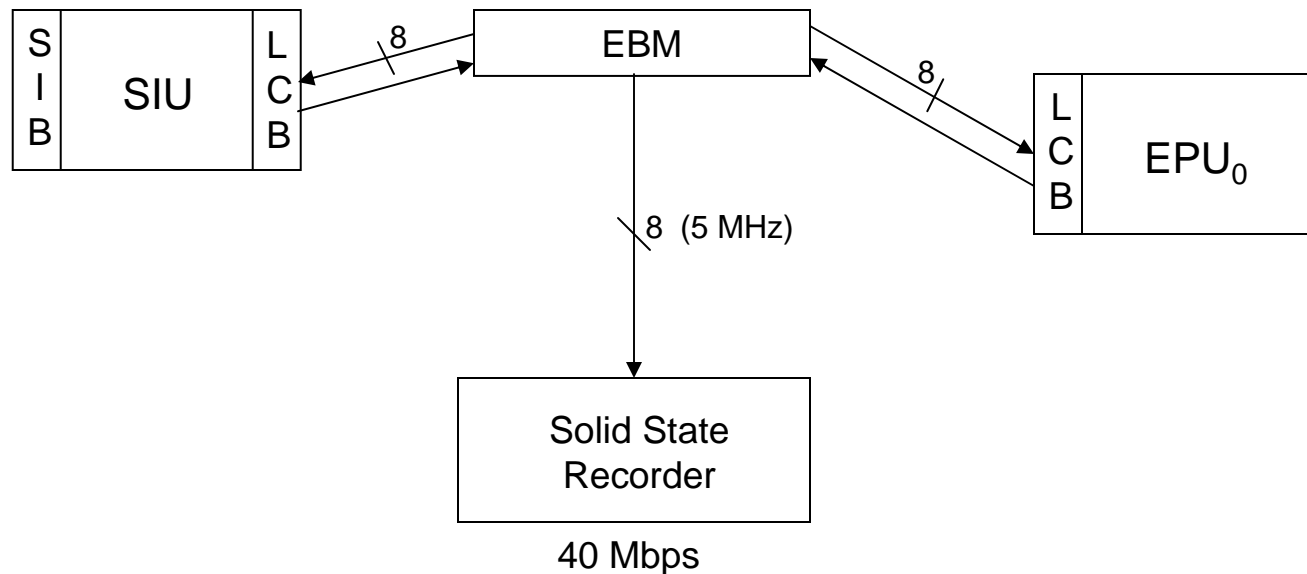
- As its name implies, this is the “data” fabric
  - Data is written to memory inside the EPU
  - Data is routed via the Event Builder Module (EBM)

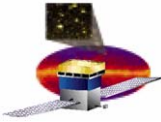




# Communications on the Event Data Fabric (Send Side)

- The major CPU to CPU communications path
- The second SIU, additional EPUs, and associated paths omitted for clarity

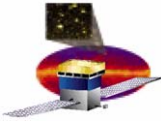




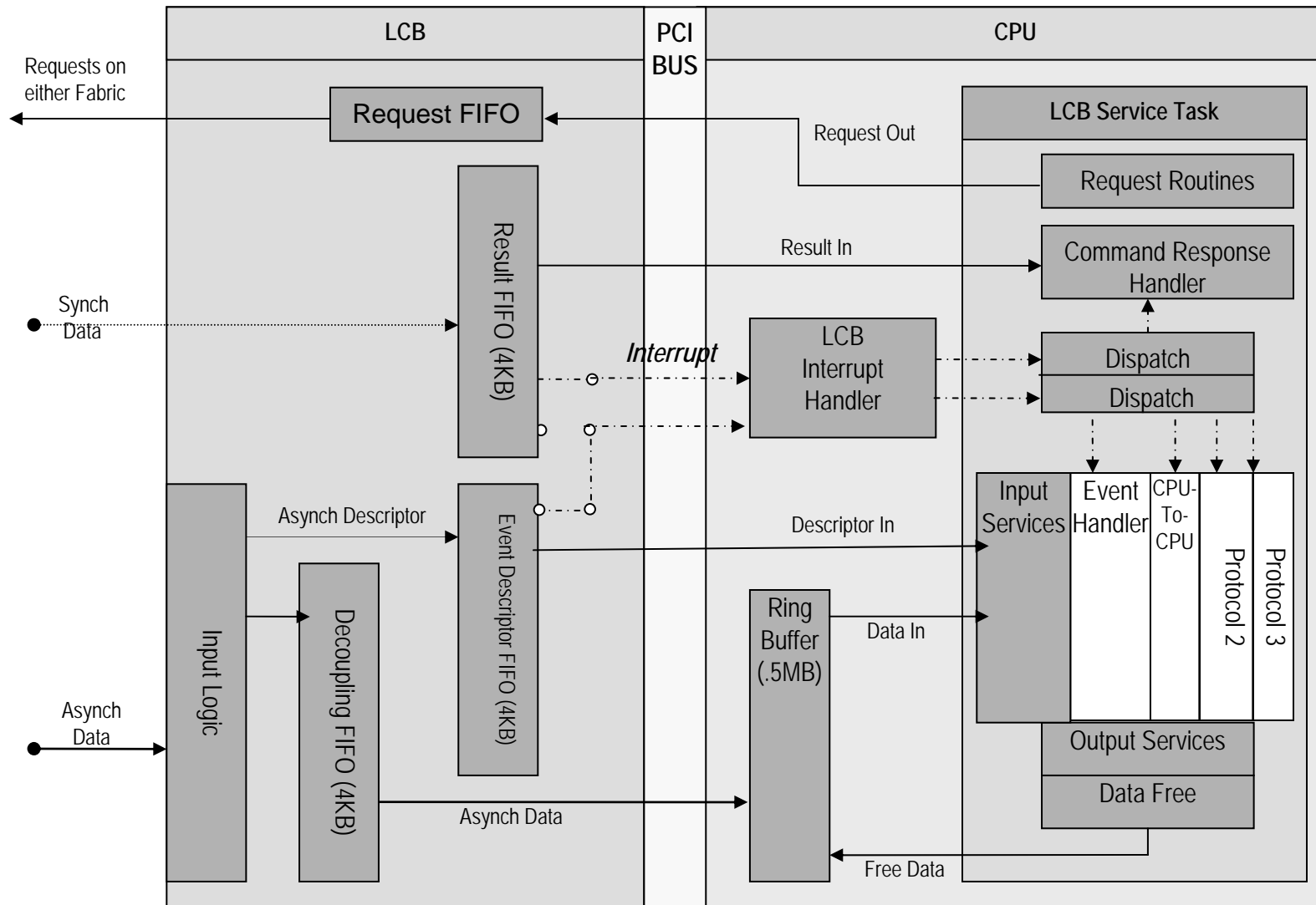
# The Special Case of Event Data: Writing to the Solid State Recorder

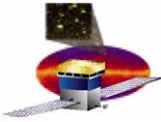
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- Again, Event Data delivery via the LCB Receive path was covered earlier in today's session.
- The LCB can put data on the event fabric for 3 possible uses:
  - LCB to LCB communications
  - Boot message from SIU to EPU
  - SSR data through Event Builder Module
- On the SSR pathway:
  - EPUs send data to EBM serially at 20 Mbps
  - EBM outputs on SSR: 8 bit @ 5 MHz for a total of 40 Mbps



# LCB Driver: System Architecture

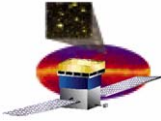




# The LCB Test Package

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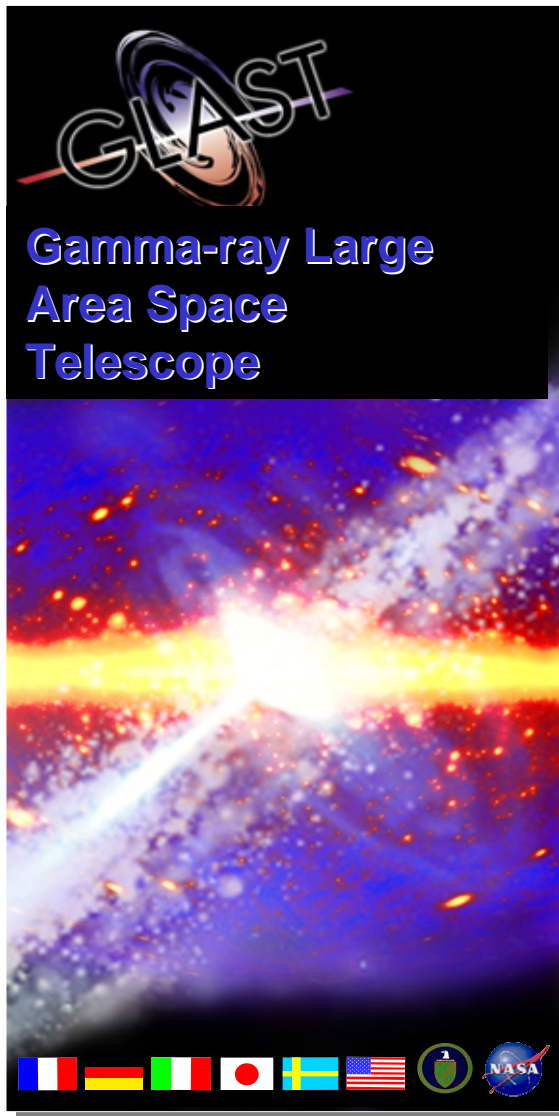
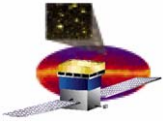
- The LCB driver is critical software that affecting all aspects of CPU-to-CPU communications and CPU-to-LAT communications.
  - All Test Stand and Testbed development depends on having a reliable LCB driver.
  - A special test package, LCBT, has been created for hardware/software testing:
    - Independent testing of driver functions
    - Testing of individual functions
    - “Stress” testing
    - Special case testing:
      - e.g., fill the LCB queues and verify correct behavior
      - Introduce events of random size, set a range of data patterns, etc.



# Forward Work

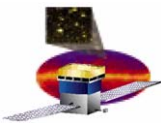
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- Coding is 95% complete
- The LCB driver has been used in several demonstrations so far
  - The latest version of the LCB Driver will be demonstrated in September 2004
- Coding and unit testing complete 12/15/04



# GLAST Large Area Telescope

# Backup



# Data Paths via the LCB

