

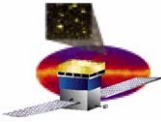
# GLAST Large Area Telescope

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

## Deadtime Management

**J.J. Russell  
Stanford Linear Accelerator Center**

[russell@slac.stanford.edu](mailto:russell@slac.stanford.edu)  
650-926-2583



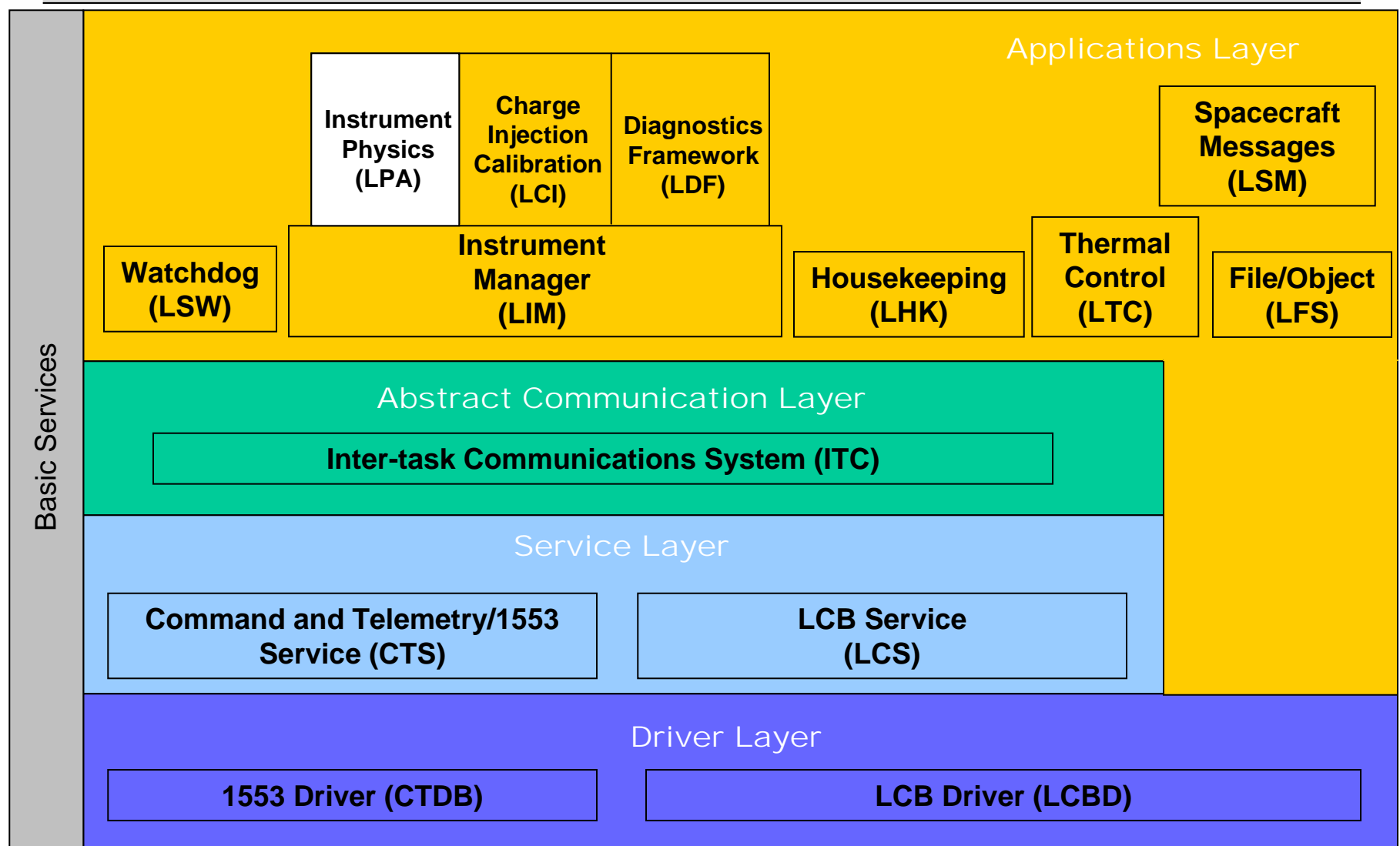
# Deadtime Monitoring : Requirements

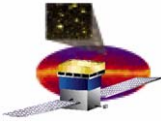
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- **Flight Software General Requirements**
  - **Deadtime during Normal Operations (5.3.6.1)**
    - The SIU FSW shall contribute less than 0.5% to the deadtime at trigger rates less than 1 kHz and less than 5% at trigger rates greater than 1 kHz and less than 10 kHz. (During normal operations, the trigger rate is dominated by background events, with the gamma ray component being less than 10 Hz).
  - **Deadtime During Gamma Ray Bursts (5.3.6.2)**
    - The SIU FSW shall contribute less than 25% additional deadtime over that for normal operations for bursts of less than 1 K gamma events within 1 second.
  - **Deadtime Monitoring (5.3.6.3)**
    - The FSW shall monitor deadtime and report it in the low-rate science telemetry.



# FSW Layer Architecture

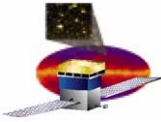




# Deadtime Management

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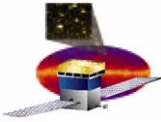
- **Flight Software does not do 'Deadtime Management'**
- **There are two major contributions to deadtime**
  - **(1) Intrinsic deadtime of the detector (20-30  $\mu$ secs/event)**
  - **(2) Filter software running too slowly**
- **Management of source (1) is achieved by adjusting the trigger**
- **Management of source (2) is achieved by adjusting filter parameters or installing new filtering software. Addresses 5.3.6.1**
- **Both are ground-based policy decisions**
  - **This is not something you want software doing**
- **Information in the housekeeping and the events serve as the basis for physicists to intelligently adjust the trigger. Addresses 5.3.6.3**
- **Dealing with deadtime during GRBs is done with buffering (5.3.6.2)**



# Deadtime Monitoring: Functional Components

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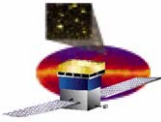
- **Functional Inputs from the GEM Performance Counters**
  - **GEM Maintains 4 registers**
    - **Livetime**
      - 20MHz clock gated by NOT BUSY
    - **Prescaled**
      - Number of events discarded due to prescaling (25 bits)
    - **Discarded**
      - Number of events discarded due to BUSY (25 bits)
    - **Sent**
      - Number of events sent (16 bits)
  - **These values are both:**
    - **Read over the LAT's command/response network**
    - **Sampled at trigger time into the GEM's event contribution**



# Deadtime Monitoring: Functional Components

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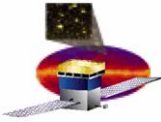
- Interesting facts about performance counters:
  - $N_{\text{Window\_Turns}} = N_{\text{Prescaled}} + N_{\text{Discarded}} + N_{\text{Sent}}$ 
    - Used to calculate deadtime due to window turns
    - Approximately  $N_{\text{Window\_Turns/sec}} * 500 \text{ nsecs}$
  - Livetime can be measured by both of the following ratios:
    - Livetime / Total Time
    - $1.0 - N_{\text{Discarded}} / N_{\text{Window\_Turns}}$
  - To the extent that livetime is purely statistical
    - These two values should be the same



# Deadtime Monitoring: Functional Components

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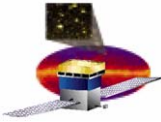
- **To address deadtime during GRBs**
  - **Hardware (CPU) buffering, ~500 events, .5MBytes**
    - **Covers fluctuations ~ 50-100 msec**
  - **Input side software buffering, >10K gamma's, 1-10MBytes**
    - **Covers fluctuations ~1sec**
    - **Filter takes ~50-100 μsecs for a gamma**
    - **Perhaps not necessary**
  - **Output side software buffering ~ 1K events (uses .3MBytes)**
    - **@ 1KHz output -> 1000 \* 2400 bits/sec -> 2.5Mbytes**
    - **About 1/2 the limit of the CPU -> SSR bandwidth per CPU**
    - **Perhaps not necessary**



# Deadtime Monitoring: Functional Processing & Output

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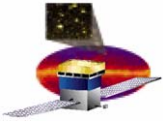
- **Functional Processing in FSW**
  - **Livetime is monitored in two ways**
    - **As part of the housekeeping data**
      - The performance counters will be periodically read
      - Meant to provide a strip chart view of livetime for operations
    - **By the values in GEM's contribution to the data**
      - Meant to provide detailed information for physics analysis
- **Functional Outputs to Spacecraft**
  - **The housekeeping data will be packaged and sent along with the rest of the housekeeping data**
  - **The values in the event will be**
    - **Included with the event data (obvious)**
    - **Used to form part of an event-based housekeeping packet**



# Deadtime: Functional Processing

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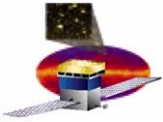
- **Worth saying a bit more about the counters in the event data.**
  - **Most detailed information about the time-structure of the deadtime**
  - **These are kept as running counters**
  - **The livetime between any two events is always**
    - **Delta (livetime) / Delta (event times)**
  - **Important because events are being discarded in many places**
    - **By the trigger**
    - **By the filter**
    - **By ground techniques**
  - **To guard against roll-over:**
    - **FSW must augment the time-based counters with extra bits.**
    - **This theme comes up many times**
      - **Looking for a common/consistent solution**



# Deadtime: Functional Processing (cont'd)

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- **Counting the livetime instead of deadtime was by design**
  - **If the deadtime goes to 100%**
    - No events will be taken
    - Any finite deadtime counter could roll-over an unknown number of times during this period
  - **Counting livetime avoids this problem**
    - Will inject a periodic trigger to ensure a steady stream of events



# Deadtime: Telecommands and Telemetry

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- **Telecommands**
  - File upload commands to load new trigger configuration
  - File upload commands to load new filtering parameters
  - File upload for new filtering software
  
- **Telemetry**
  - Housekeeping telemetry packets
  - Event data