

**Gamma-ray Large  
Area Space  
Telescope**



# **GLAST Large Area Telescope**

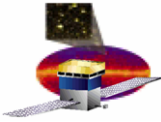
**Instrument Flight Software  
EM2 Review  
26 February 2004**

**Inter-task Communications**

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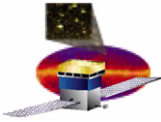
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# ITC: Requirements

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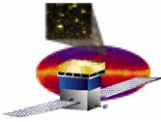
- **Flight Software General Requirements:**
  - **Req. 5.3.4.2.1: FSW shall receive and process all LAT commands from the SC, on the CTDB, in the order that they are received. All other LAT subsystems and components shall be directed by commands and configuration information from the SIU.**
- **Flight Software Requirements (derived):**
  - **FSW shall receive messages (telecommands) from the Spacecraft and route those messages (telecommands) to the correct software task(s)**
  - **FSW shall receive messages (event data) from the LAT instrument and route those messages to the correct software task(s)**
  - **FSW shall receive messages either from within a CPU or from an external CPU and route those messages to the correct software task(s)**
  - **FSW shall manage task synchronization between master and slave tasks on a given CPU and between tasks on different CPUs**



# Inter-task Communications: Functional Components

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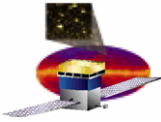
- **Functional Inputs**
  - ITC receives 1553-mediated CCSDS telecommand packets from Spacecraft
  - ITC receives LCB-mediated unsolicited instrument-to-CPU communications in LATp format
  - ITC receives LCB-mediated unsolicited CPU-to-CPU communications in LATp format
  - ITC receives internal CPU communications
- **Functional Processing**
  - ITC provides registration services for incoming message queues for all tasks
  - ITC services incoming CCSDS packets and loads message queues on the SIUs and EPU based on application ID (APID)
  - ITC services incoming LATp packets and loads message queues:
    - On EPUs (for event processing)
    - On SIUs/EPUs (for CPU to CPU communication) using APID and function code
  - ITC manages synchronization between master and slave tasks
    - Scatter/gather problem
- **Functional Output**
  - ITC dispatches messages to ITC-managed queues.



# ITC: Architecture Overview

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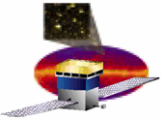
- **FSW's implementation of inter-task communications is based on the well-established model of tasks pending on message queues.**
  - **The ITC function manages message queues, areas of CPU memory that are logically separate from the address space of any process**
  - **All tasks that must communicate have one or two dedicated message queues, depending on the status (master or slave) and role of the task. If a task has two queues, one is an in-band queue (regular priority messages) and the other is out-of-band (high priority messages).**
  - **In FSW's design, queues are implemented as priority-based linked lists, in which each node in the queue contains (1) a message for the associated task and (2) a pointer to the next message in the task's queue**



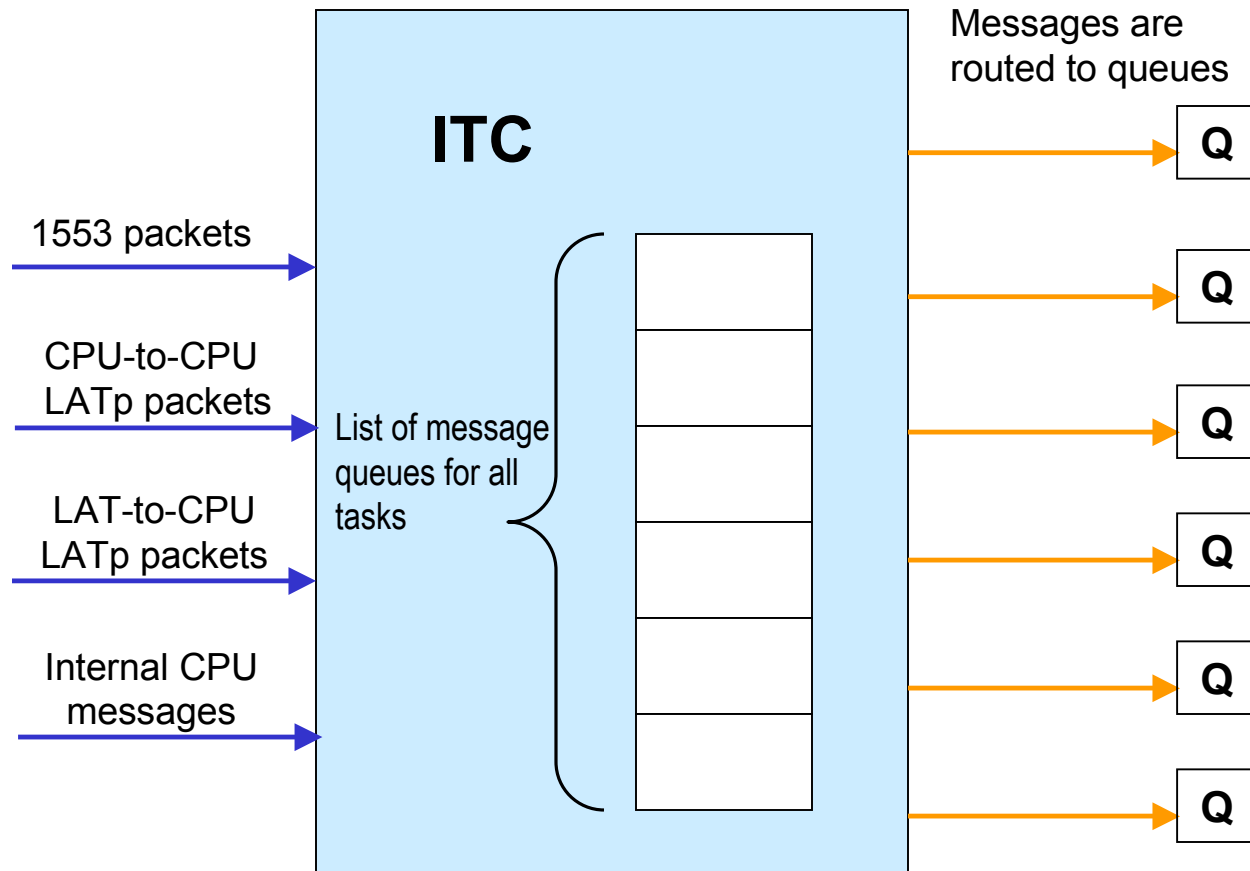
## ITC: Architecture (cont'd)

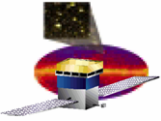
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- **The FSW inter-task communications function controls queuing:**
  - **Within CPUs: On an SIU, a master task sends messages to the message queue of its slave task**
  - **Between CPUs: Master tasks on an SIU send messages to the queues of slave tasks running on EPU.**
  - **From the LAT: Science data from the LAT is processed in the GASU's event builder module; resulting data and processing messages are sent to queues of the slave tasks running on EPU.**
  - **From the Spacecraft: Telecommands are received by SIUs; messages are verified, then routed to message queues throughout the system**

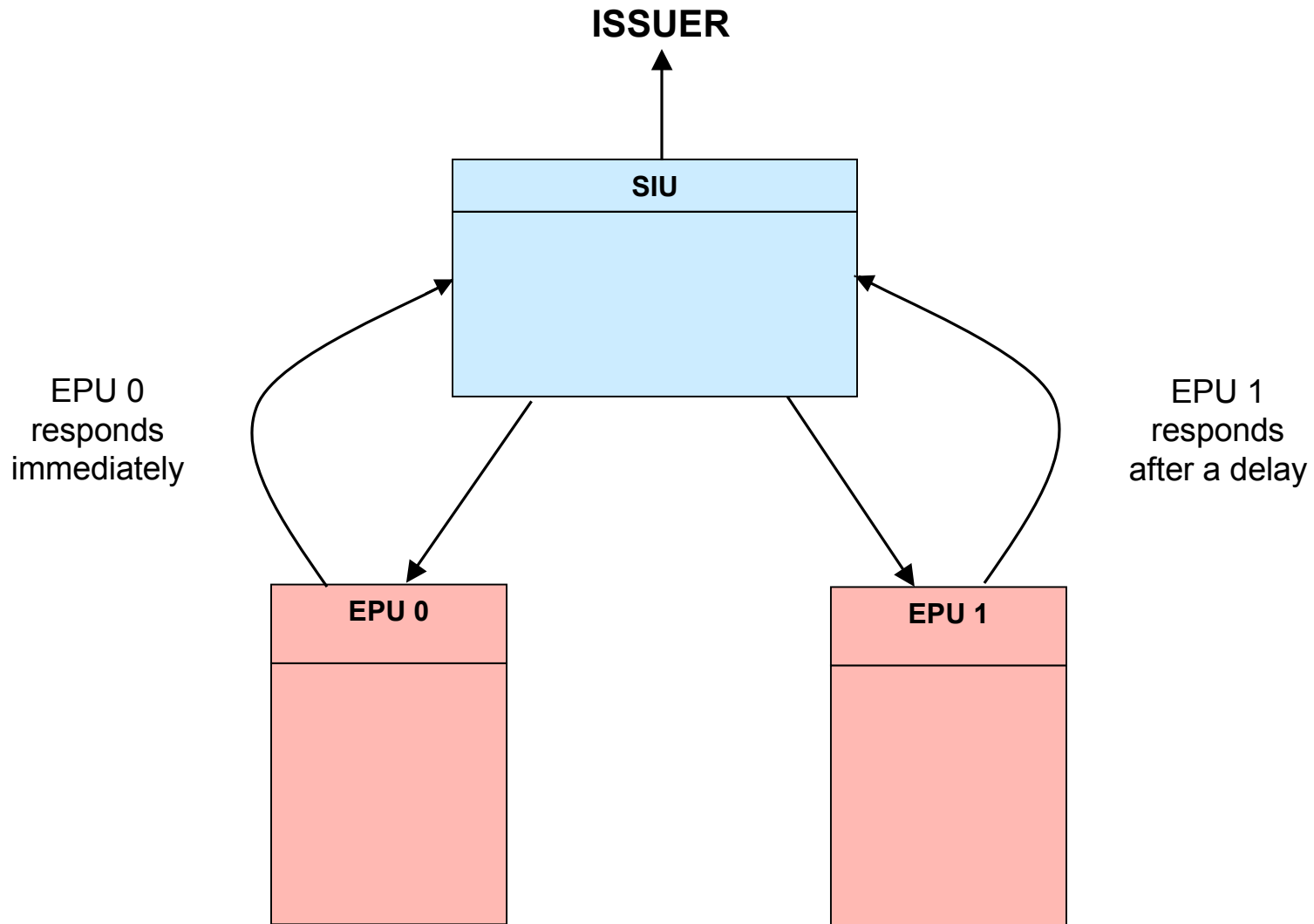


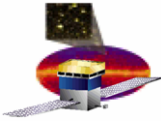
# ITC: Architecture (cont'd)





# ITC: Scatter/Gather Problem





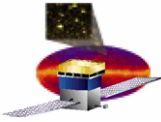
# ITC: Packets to Messages

- Messages are dispatched using a two-tiered dispatch system:
  - Tier 1: APIDs define which queue must receive messages.
  - Tier 2: Function codes define which subroutines/functionality contained within the task are executed.

Figure 40 - Reboot Telecommand Format

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Version = 0			T=1	SH=1	APID = 0x645										
SF		Sequence Count													
Packet Length = 5															
0	Function Code = 1														
LAT Unit				Spare											
Packet Checksum															

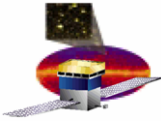
LAT Unit – A code indicating the LAT unit that is the intended target for the Reboot. Expected values are SIU, EPU<sub>0</sub>, EPU<sub>1</sub> or EPU<sub>2</sub>. Reference Table 8.



# ITC: Testing

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- **Since the ITC function operates at all levels (from within-CPU communication to end-to-end communication from the Spacecraft to the LAT and back), testing the ITC function can be performed on different hardware and software configurations:**
  - **Within-CPU communications can be tested on a single SIU running a master and slave task. The master task would send defined test messages to its slave, and the slave would be monitored to confirm receipt and response.**
  - **CPU-to-CPU communications can be tested using an SIU and an EPU, each with a functioning LCB. Again, master tasks on an SIU would send messages to a slave task on an EPU. The slave would be monitored to confirm receipt and response.**
  - **LAT-to-CPU communications can be tested using LAT subsystems, an SIU, and an EPU. Event or command/response packets are sent to a task running on a CPU, and the task is monitored to confirm receipt and response.**
  - **Spacecraft-to-CPU communications can be tested using a Wintel PC running LATTE. Test 1553 CCSDS telecommand packets are sent to a task running on a CPU, and the task is monitored to confirm receipt and response.**



# ITC: Consumers

	Test Stands		ISIS	I&T	FSW Test-bed	FSW Deliverable
	TKR,CAL	ACD				
CPU internal communications/task frameworks			Y	Y	Y	Y

- **Status:**
  - As of EM2, the ITC function handles single CPU, task-to-task communication, and contains the infrastructure hooks to handle CPU-to-CPU inter-task communications. All low-level building blocks related to ITC are complete: CCSDS packet-building and routing, priority queue management, and LCB drivers for transmitting data CPU-to-CPU.
- **ISIS:**
  - Spectrum Astro must have an ITC function at ISIS stage to test whether telecommands are correctly routed from the SIIS to tasks on the CPUs.
- **I&T:**
  - An ITC function is required for all integration and testing activities.
- **FSW Test-bed:**
  - An ITC function is required to provide communications among all software functions developed by FSW.