# GLAST LAT Flight Software Demonstration

SLAC Campus
Building 84, Central Lab Annex

June 2, 2004
Overview Presentation 5:00 PM (Room B-188)
Demonstrations 5:15 PM

# 1 Demonstration Overview

## 1.1 Agenda for the Demonstrations

The demonstration will take place in the Central Laboratory Annex (Building 84), Room B-101.

| Demo Agenda Item | Presenter(s) |
|---|---|
| **1. Overview of the Demonstration (in Kavli Conference Room, Room B-188)** | Tony Waite |
| **2. Receive / Process SI Ancillary Data Demo** | Tony Waite |
| **3. Receive / Process SI Attitude Data Demo** | Tony Waite |
| **4. Receive / Process SI Time Tone Demo** | Tony Waite |
| **5. Inter-task Communications Demo** | Tony Waite |
| **6. Questions from Attendees** | NA |

Feel free to jot questions and comments down in the margins of this document or in the space provided on page 13.

## 1.2 Goals of the Demonstrations

The end of May 2004 FSW Demonstration (actually held on June 2) is mainly focused on the interface between the Spacecraft and the Spacecraft Interface Unit (SIU). The Spacecraft is represented in these demonstrations by an mv2304 CPU crate. The SIU is represented by a RAD750 flight crate incorporating the boot code demonstrated last month.

The demonstrations show the following:

- A FSW infrastructure exists that allows an SIU to receive and perform simple processing on ancillary, attitude, and time tone data messages. This infrastructure is built from the CCSDS, CTDB, and LSM packages.
- FSW that provides inter-task communication and can successfully route Spacecraft messages to software tasks is operational. This infrastructure is provided by the ITC package.

## 1.3 Expected Outputs of the Demonstrations; Verification of Requirements

This section cites the expected outputs of each of the systems demonstrated today, and provides a space for the demonstration monitors to verify by signature that the demonstrations ran successfully.

| Demo Agenda Item | Relevant FSW Requirements (SRS Version 3) | Expected Output of the Demonstration |
|---|---|---|
| **Receive / Process SI Ancillary Data Demo** | 5.3.14, 5.3.14.1, 5.3.14.2, 5.3.14.3, 5.3.14.4 | For a full description of the outputs of the Receive/Process SI Ancillary Data Demo, see Section 1.3.1.1 starting on page 4.<br>For the demonstration procedure and the demo's software and hardware context, see Section 2.1 on page 10, and Section 2.2.1on page 11. |
| | | **Monitor Signature:** ______________________________ |
| **Receive / Process SI Attitude Data Demo** | 5.3.11.3.2, 5.3.11.3.3 | For a full description of the outputs of the Receive/Process SI Attitude Data Demo, see Section 1.3.1.2 starting on page 5.<br>For the demonstration procedure and the demo's software and hardware context, see Section 2.1 on page 10, and Section 2.2.2 on page 11. |
| | | **Monitor Signature:** ______________________________ |
| **Receive / Process SI Time Tone Demo** | 5.3.4.3 | For a full description of the outputs of the Receive/Process SI Time Tone Demo, see Section 1.3.1.3 starting on page 6.<br>For the demonstration procedure and the demo's software and hardware context, see Section 2.1 on page 10, and Section 2.2.3 on page 11. |
| | | **Monitor Signature:** ______________________________ |

| Demo Agenda Item | Relevant FSW Requirements (SRS Version 3) | Expected Output of the Demonstration |
|---|---|---|
| **Inter-task Communications Demo** | 5.3.3.1, 5.3.3.4, 5.3.3.5 | For a full description of the outputs of the Inter-task Communications Demo, see Section 1.3.2 starting on page 6.<br>For the demonstration procedure and the demo's software and hardware context, see Section 2.1 on page 10, and Section 2.3 on page 11. |
| | | **Monitor Signature:** ______________________ |

## 1.3.1 Output of the Receive / Process SI Ancillary Data, Attitude Data, and SI Time Tone Demos

This demonstration has three parts, corresponding to the three categories of 1553 messages sent by the Spacecraft:

- Ancillary Data Messages indicating (1) SSR usage information, (2) presence of LAT in or out of South Atlantic Anomaly, (3) GPS device status, (4) S-band and X-band transmitter status.
- Attitude Data Messages.
- Time Tone Messages -- GPS messages sent at 1 Hz between 500 msec and 800 msec before the GPS time hack.

In each case, to confirm that the messages were sent and received, the Spacecraft crate and flight crate dump the message contents to their respective control terminal windows. Samples of these message dumps are shown in the following sections.

### 1.3.1.1 Part One: Receive/Process SI Ancillary Data Demo

When the demonstrator enters the **LSM_sendAncillary** command at the Spacecraft crate control terminal window, the Spacecraft crate sends ancillary data messages over the 1553 line connecting the Spacecraft crate and flight crate. The ancillary data messages are received by the flight crate, and the contents are displayed at the flight crate control terminal window as illustrated below.

```
********************************************************************************
CCSDS header
--------------------------------------------------------------------------------
Offset  Literal    Bits  Value      Description      Interpretation
------- ---------- ----- ---------- ---------------- --------------------------
  0-  1 0x1f01      0- 2 0x00       CCSDS version    CCSDS version 1 packet
                    3- 3 0x01       Type             Telecommand
                    4- 4 0x01       Sec. header      Yes
                    5-15 0x0701     APID             1793 (decimal)
```

```
  2-  3 0xc000      0- 1 0x03       Seq. flags       Standalone packet
                    2-15 0x0000     Seq. count       0 (decimal)
  4-  5 0x0027                      CCSDS length     -> 36 byte payload
  6-  7 0x0002      0- 0 0x00       MBZ              Must be zero
                    1-15 0x0002     Function code    2 (decimal)
===============================================================================
LSM: Ancillary packet payload
-------------------------------------------------------------------------------
Offset  Literal    Bits  Value      Description      Interpretation
------- ---------- ----- ---------- ---------------- -------------------------
  8- 11 0x00000001  0-31 0x00000001 Time (secs)      Since LAT epoch
 12- 15 0x00000002  0-31 0x00000002 Time (usec)      Since LAT epoch
 16- 19 0x3e99999a  0-31        0.3 X position       ECI (meters)
 20- 23 0x3ecccccd  0-31        0.4 Y position       ECI (meters)
 24- 27 0x3f000000  0-31        0.5 Z position       ECI (meters)
 28- 31 0x3f19999a  0-31        0.6 X velocity       ECI (meters/sec)
 32- 35 0x3f333333  0-31        0.7 Y velocity       ECI (meters/sec)
 36- 39 0x3f4ccccd  0-31        0.8 Z velocity       ECI (meters/sec)
 40- 40 0x03        0- 4 0x00       MBZ              Must be zero
                    5- 7 0x05       GNC mode         Mission zenith point
 41- 41 0x04        0- 7 0x04       SSR fill         4 %
 42- 43 0x0005      0- 8 0x00       MBZ              Must be zero
                    9- 9 0x00       ARR enable       False
                   10-10 0x00       In SAA (GBM)     False
                   11-11 0x00       X-band on        False
                   12-12 0x00       S-band on        False
                   13-13 0x01       GPS outage       True
                   14-14 0x00       In sun           False
                   15-15 0x01       In SAA (LAT)     True
===============================================================================
CCSDS telecommand checksum
-------------------------------------------------------------------------------
Offset  Literal    Bits  Value      Description      Interpretation
------- ---------- ----- ---------- ---------------- -------------------------
 44- 45 0x0a8b                      Checksum         Should be 0x0a8b
*******************************************************************************
```

### 1.3.1.2 Part Two: Receive/Process SI Attitude Data Demo

When the demonstrator enters the **LSM_sendAttitude** command at the Spacecraft crate control terminal window, the Spacecraft crate sends attitude data messages over the 1553 line connecting the Spacecraft crate and flight crate. The attitude data messages are received by the flight crate, and the contents are displayed at the flight crate control terminal window as illustrated below.

```
*******************************************************************************
CCSDS header
-------------------------------------------------------------------------------
Offset  Literal    Bits  Value      Description      Interpretation
------- ---------- ----- ---------- ---------------- -------------------------
  0-  1 0x1f01      0- 2 0x00       CCSDS version    CCSDS version 1 packet
                    3- 3 0x01       Type             Telecommand
                    4- 4 0x01       Sec. header      Yes
                    5-15 0x0701     APID             1793 (decimal)
  2-  3 0xc000      0- 1 0x03       Seq. flags       Standalone packet
```

```
                   2-15 0x0000     Seq. count       0 (decimal)
  4-  5 0x0037                     CCSDS length     -> 52 byte payload
  6-  7 0x0001     0- 0 0x00       MBZ              Must be zero
                   1-15 0x0001     Function code    1 (decimal)
===============================================================================
LSM: Attitude packet payload
-------------------------------------------------------------------------------
Offset  Literal    Bits  Value      Description      Interpretation
------- ---------- ----- ---------- ---------------- --------------------------
  8- 11 0x00000001  0-31 0x00000001 Time (secs)      Since LAT epoch
 12- 15 0x00000002  0-31 0x00000002 Time (usec)      Since LAT epoch
 16- 23 0x3fd33333  0-63        0.3 X-axis quat
        0x10173333
 24- 31 0x3fd99999  0-63        0.4 Y-axis quat
        0x99999999
 32- 39 0x3fe00000  0-63        0.5 Z-axis quat
        0x00000000
 40- 47 0x3fe33333  0-63        0.6 Scalar quat
        0x33333333
 48- 51 0x3f333333  0-31        0.7 X-axis ang.vel.  rad/sec
 52- 55 0x3f4ccccd  0-31        0.8 Y-axis ang.vel.  rad/sec
 56- 59 0x3f666666  0-31        0.9 Z-axis ang.vel.  rad/sec
===============================================================================
CCSDS telecommand checksum
-------------------------------------------------------------------------------
Offset  Literal    Bits  Value      Description      Interpretation
------- ---------- ----- ---------- ---------------- --------------------------
 60- 61 0x0fee                      Checksum         Should be 0x0fee
*******************************************************************************
```

### 1.3.1.3 Part Three: Receive/Process SI Time Tone Data Demo

When the demonstrator enters the **LSM_sendTimetone** command at the Spacecraft crate control terminal window, the Spacecraft crate sends time tone data messages over the 1553 line connecting the Spacecraft crate and flight crate. The time tone data messages are received by the flight crate, and the contents are displayed at the flight crate control terminal window as illustrated below.

```
*******************************************************************************
CCSDS header
-------------------------------------------------------------------------------
Offset  Literal    Bits  Value      Description      Interpretation
------- ---------- ----- ---------- ---------------- --------------------------
  0-  1 0x1f01     0- 2 0x00       CCSDS version    CCSDS version 1 packet
                   3- 3 0x01       Type             Telecommand
                   4- 4 0x01       Sec. header      Yes
                   5-15 0x0701     APID             1793 (decimal)
  2-  3 0xc000     0- 1 0x03       Seq. flags       Standalone packet
                   2-15 0x0000     Seq. count       0 (decimal)
  4-  5 0x0009                     CCSDS length     -> 6 byte payload
  6-  7 0x0003     0- 0 0x00       MBZ              Must be zero
                   1-15 0x0003     Function code    3 (decimal)
===============================================================================
LSM: Timetone packet payload
-------------------------------------------------------------------------------
```

```
Offset  Literal    Bits  Value      Description      Interpretation
------- ---------- ----- ---------- ---------------- -------------------------
  8- 11 0x00000002  0-31 0x00000002 Time (secs)      Since LAT epoch
 12- 13 0x0001      0-14 0x0000     MBZ              Must be zero
                   15-15 0x0001     GPS source       Is  GPS
===============================================================================
CCSDS telecommand checksum
-------------------------------------------------------------------------------
Offset  Literal    Bits  Value      Description      Interpretation
------- ---------- ----- ---------- ---------------- -------------------------
 14- 15 0x00ef                      Checksum         Should be 0x00ef
*******************************************************************************
```

## 1.3.2 Output of the Inter-task Communications Demos

This demonstration also has three parts, corresponding to three combinations of APID, function code, and message content:

- Part One: A test payload is sent to an invalid destination APID.
- Part Two: A test payload is sent to a valid APID, but using an invalid function code.
- Part Three: A test payload is sent to a valid APID and function code, but the receiving task cannot process the “bogus” payload.

In each case, to confirm that the messages were sent and received, the Spacecraft crate and flight crate dump the message contents to their respective control terminal windows. Samples of these message dumps are shown in the following sections.

### 1.3.2.1 Part One: Invalid APID

When the demonstrator enters the **SCS_sendCommand(APID, FuncCode, PacketLength)** command (specifying an invalid **APID** parameter) at the Spacecraft crate control terminal window, the Spacecraft crate sends a command packet containing a random data payload. The ITC task dumps an error message (“No APID table entry”) and the packet contents to the crate control terminal, as shown below.

```
-> ITC_dispatchApid ITC-E-GENERROR No APID table entry

********************************************************************************
CCSDS header
--------------------------------------------------------------------------------
Offset  Literal    Bits  Value      Description      Interpretation
------- ---------- ----- ---------- ---------------- --------------------------
  0-  1 0x1e66      0- 2 0x00       CCSDS version    CCSDS version 1 packet
                    3- 3 0x01       Type             Telecommand
                    4- 4 0x01       Sec. header      Yes
                    5-15 0x0666     APID             1638 (decimal)
  2-  3 0xc000      0- 1 0x03       Seq. flags       Standalone packet
                    2-15 0x0000     Seq. count       0 (decimal)
  4-  5 0x001b                      CCSDS length     -> 24 byte payload
  6-  7 0x0001      0- 0 0x00       MBZ              Must be zero
                    1-15 0x0001     Function code    1 (decimal)
================================================================================
CCSDS anonymous payload
--------------------------------------------------------------------------------
Offset  Literal    Bits  Value      Description      Interpretation
------- ---------- ----- ---------- ---------------- --------------------------
  8- 11 0x00000001
 12- 15 0x00020003
 16- 19 0x00040005
 20- 23 0x00060007
 24- 27 0x00080009
 28- 31 0x000a000b
================================================================================
CCSDS telecommand checksum
--------------------------------------------------------------------------------
Offset  Literal    Bits  Value      Description      Interpretation
------- ---------- ----- ---------- ---------------- --------------------------
 32- 33 0x01a2                      Checksum         Should be 0x01a2
********************************************************************************
```

### 1.3.2.2 Part Two: Invalid Function Code

When the demonstrator enters the **SCS_sendCommand(APID, FuncCode, PacketLength)** command (specifying an invalid **FuncCode** parameter) at the Spacecraft crate control terminal window, the Spacecraft crate sends a command packet containing a random data payload. The ITC task dumps an error message (“Cannot identify a dispatch routine”) and the packet contents to the crate control terminal, as shown below.

```
-> ITC_dispatchCommand ITC-E-GENERROR Cannot identify a dispatch routine

******************************************************************************
CCSDS header
------------------------------------------------------------------------------
Offset  Literal    Bits  Value      Description      Interpretation
------- ---------- ----- ---------- ---------------- -------------------------
  0-  1 0x1f01      0- 2 0x00       CCSDS version    CCSDS version 1 packet
                    3- 3 0x01       Type             Telecommand
                    4- 4 0x01       Sec. header      Yes
                    5-15 0x0701     APID             1793 (decimal)
  2-  3 0xc000      0- 1 0x03       Seq. flags       Standalone packet
                    2-15 0x0000     Seq. count       0 (decimal)
  4-  5 0x0033                      CCSDS length     -> 48 byte payload
  6-  7 0x0004      0- 0 0x00       MBZ              Must be zero
                    1-15 0x0004     Function code    4 (decimal)
==============================================================================
CCSDS anonymous payload
------------------------------------------------------------------------------
Offset  Literal    Bits  Value      Description      Interpretation
------- ---------- ----- ---------- ---------------- -------------------------
  8- 11 0x000c000d
 12- 15 0x000e000f
 16- 19 0x00100011
 20- 23 0x00120013
 24- 27 0x00140015
 28- 31 0x00160017
 32- 35 0x00180019
 36- 39 0x001a001b
 40- 43 0x001c001d
 44- 47 0x001e001f
 48- 51 0x00200021
 52- 55 0x00220023
==============================================================================
CCSDS telecommand checksum
------------------------------------------------------------------------------
Offset  Literal    Bits  Value      Description      Interpretation
------- ---------- ----- ---------- ---------------- -------------------------
 56- 57 0x034b                      Checksum         Should be 0x034b
******************************************************************************
```

### 1.3.2.3 Part Three: Invalid Payload

When the demonstrator enters the **SCS_sendCommand(APID, FuncCode, PacketLength)** command (to send a random payload of **PacketLength** to a task that expects a particular message format) at the Spacecraft crate control terminal window, the Spacecraft crate sends a command packet. Note that, in this unusual, very non-flight configuration, since the APID and function code were valid, ITC task does *not* send an error message in this case; it simply dumps the packet contents as shown below.

```
********************************************************************************
CCSDS header
--------------------------------------------------------------------------------
Offset  Literal    Bits  Value      Description      Interpretation
------- ---------- ----- ---------- ---------------- -------------------------
  0-  1 0x1f01      0- 2 0x00       CCSDS version    CCSDS version 1 packet
                    3- 3 0x01       Type             Telecommand
                    4- 4 0x01       Sec. header      Yes
                    5-15 0x0701     APID             1793 (decimal)
  2-  3 0xc000      0- 1 0x03       Seq. flags       Standalone packet
                    2-15 0x0000     Seq. count       0 (decimal)
  4-  5 0x0033                      CCSDS length     -> 48 byte payload
  6-  7 0x0002      0- 0 0x00       MBZ              Must be zero
                    1-15 0x0002     Function code    2 (decimal)
================================================================================
LSM: Ancillary packet payload
--------------------------------------------------------------------------------
Offset  Literal    Bits  Value      Description      Interpretation
------- ---------- ----- ---------- ---------------- -------------------------
  8- 11 0x003c003d  0-31 0x003c003d Time (secs)      Since LAT epoch
 12- 15 0x003e003f  0-31 0x003e003f Time (usec)      Since LAT epoch
 16- 19 0x00400041  0-31   5.88e-39 X position       ECI (meters)
 20- 23 0x00420043  0-31   6.06e-39 Y position       ECI (meters)
 24- 27 0x00440045  0-31   6.24e-39 Z position       ECI (meters)
 28- 31 0x00460047  0-31   6.43e-39 X velocity       ECI (meters/sec)
 32- 35 0x00480049  0-31   6.61e-39 Y velocity       ECI (meters/sec)
 36- 39 0x004a004b  0-31    6.8e-39 Z velocity       ECI (meters/sec)
 40- 40 0x00        0- 4 0x09       MBZ              Must be zero
                    5- 7 0x05       GNC mode         Mission zenith point
 41- 41 0x4c        0- 7 0x4c       SSR fill         76 %
 42- 43 0x004d      0- 8 0x00       MBZ              Must be zero
                    9- 9 0x01       ARR enable       True
                   10-10 0x00       In SAA (GBM)     False
                   11-11 0x00       X-band on        False
                   12-12 0x01       S-band on        True
                   13-13 0x01       GPS outage       True
                   14-14 0x00       In sun           False
                   15-15 0x01       In SAA (LAT)     True
================================================================================
CCSDS telecommand checksum
--------------------------------------------------------------------------------
Offset  Literal    Bits  Value      Description      Interpretation
------- ---------- ----- ---------- ---------------- -------------------------
 56- 57 0x07c9                      Checksum         Should be 0x07c9
********************************************************************************
```

# 2 Demonstration Procedure

## 2.1 Overall Context of the Demonstrations

### 2.1.1 Spacecraft Crate

The Spacecraft crate is configured as follows:

- Hardware: the Spacecraft is represented by a CPU crate configured with an mv2304 processor and a PMC 1553 communications board.
- Preloaded Software: PBS\pbs, MSG\msg_mt, MSG\msg_print, CCSDS\ccsds_pkt, CCSDS\ccsds_dump, CCSDS\ccsds_swap, CTDB\co1553_bc, CTDB\sumt_bc_pmc1553, SVC\itc_dump, ITC\ itc, SCS\scs_sumtdevice, SCS\scs, SCS\ scs_dump, LSM\lsm_send. Software in the SCS package is special test code that will not be used by the flight unit.

### 2.1.2 Flight Crate and Flight Software

The flight crate is configured as follows:

- Hardware: RAD750 processor, a 1553-capable compact PCI (cPCI) Spacecraft Interface Board (SIB), a cPCI LAT Communications Board, a serial line, and a Ramix Ethernet board.
- Preloaded Flight Software: the PBC (primary boot code) package is preburned into the RAD750 SUROM. Two bundles of software (the RTOS (VxWorks) image and SBC (secondary boot code) package) are preloaded in the SIB's EEPROM banks.
- The following FSW software package constituents are loaded onto the flight crate using the Tornado windSh and and Ethernet connection after the boot process is complete: RAD750\rad750_reboot, PBS\ pbs, MSG\msg_mt, MSG\msg_print, CCSDS\ccsds_pkt, CCSDS\ccsds_dump, CCSDS\ccsds_swap, CTDB\co1553_rt, CTDB\sumt_rt_sib, ITC\itc_dump, ITC\ itc, LSM\lsm_recv, LAT\ LAT_sumt. Software in the LAT package is special test code that will not be used by the flight unit.

The first step in the demonstration session is to boot the flight crate through the primary boot stage, issue a command to the flight crate to continue to secondary boot, and wait while the flight crate finishes secondary boot. Then, the demonstrator loads demonstration-specific application software using the Tornado windSh over an Ethernet connection, as described above.

## 2.2 Receive/Process SI Ancillary Data, Attitude Data, Time Tone Demonstrations

This demonstration has three parts, corresponding to the three categories of 1553 messages sent by the Spacecraft:

- Ancillary Data Messages indicating (1) SSR usage information, (2) presence of LAT in or out of South Atlantic Anomaly, (3) GPS device status, (4) S-band and X-band transmitter status.

- Attitude Data Messages
- Time Tone Messages -- GPS messages sent at 1 Hz between 500 msec and 800 msec before the GPS time hack.

### 2.2.1 Receive/Process Ancillary Data Demo Procedure

With the hardware and software configured and initialized as discussed above, the demonstration proceeds as follows:

- The Spacecraft crate is initialized for the demonstration with the **SCS_start** command.
- The flight crate is initialized for the demonstration with the **LAT_start** command.
- Since ancillary messages are sent continuously over the 1553 interface, and would be difficult to observe if they scrolled rapidly in the terminal window, the **LSM_setAncillary X** command (where **X** is a number of messages to display) is executed on the flight crate to limit the number of messages displayed. This task captures and displays the specified number of messages, one at a time.
- On the Spacecraft crate, the **LSM_sendAncillary** command is run to begin transmission of Ancillary data messages over the 1553 connection.

### 2.2.2 Receive/Process Attitude Data Demo Procedure

The demonstration proceeds as follows:

- The Spacecraft and flight crates are already initialized for the demonstration using the **SCS_start** and **LAT_start** commands, as discussed above.
- The **LSM_setAttitude X** command (where **X** is a number of messages to display) is executed on the flight crate to limit the number of messages displayed.
- On the Spacecraft crate, the **LSM_sendAttitude** command is run to begin transmission of Attitude data messages over the 1553 connection.

### 2.2.3 Part Three: Receive/Process Time Tone Demo Procedure

The demonstration proceeds as follows:

- The Spacecraft and flight crates are already initialized for the demonstration using the **SCS_start** and **LAT_start** commands, as discussed above.
- The **LSM_setTimetone X** command (where **X** is a number of messages to display) is executed on the flight crate to limit the number of messages displayed.
- On the Spacecraft crate, the **LSM_sendTimetone** command is run to begin transmission of Time Tone data messages over the 1553 connection.

## 2.3 Inter-task Communications Demonstration

This demonstration also has three parts, corresponding to three combinations of APID, function code, and message content:

- Part One: A test payload is sent to an invalid destination APID.
- Part Two: A test payload is sent to a valid APID, but using an invalid function code.
- Part Three: A test payload is sent to a valid APID and function code, but the receiving task cannot process the “bogus” payload.

### 2.3.1 Part One: Invalid APID Demo Procedure

The demonstration proceeds as follows:

- The **SCS_start** and **LAT_start** commands are executed to initialize the Spacecraft and flight crates for the demo, if this has not already been done.
- At the Spacecraft crate, the demonstrator runs the **SCS_sendCommand(APID, FuncCode, PacketLength)** command, specifying an **APID** parameter that is known to be invalid.

### 2.3.2 Part Two: Invalid Function Code Demo Procedure

The demonstration proceeds as follows:

- At the Spacecraft crate, the demonstrator runs the **SCS_sendCommand(APID, FuncCode, PacketLength)** command, specifying a **FuncCode** parameter that is known to be invalid.

### 2.3.3 Part Three: Invalid Payload Demo Procedure

The demonstration proceeds as follows:

- At the Spacecraft crate, the demonstrator runs the **SCS_sendCommand(APID, FuncCode, PacketLength)** command, specifying valid APID and function codes. However, this command sends a dummy payload which the destination software task cannot process.

# 3 Demo Wrapup and Summary

The FSW Team thanks you for attending the demonstration and welcomes any questions about the software and hardware systems showcased. Comments or questions can be written in the following space.

# 4 Glossary

**1553 – MIL-STD-1553B.** Serial data bus specification; in particular, the serial data bus and data protocol implemented for the GLAST mission.

**APID.** CCSDS packet application identifier. A numerical code indicating the general type of data in a CCSDS packet.

**Crate**. Fond, generic term for development versions of Spacecraft Interface Units (SIUs) or Event-Processor Units (EPUs): custom-built, standalone on-board FSW processors and communications hardware units that control the LAT and communicate with the spacecraft (SIU), and process/filter instrument events (EPU). Crates are used for development purposes and will be replaced in the flight unit with single board computers with the same functionality.

**GASU (Global-Trigger/ACD-EM/Signal-Distribution Unit).** Portion of the FSW hardware suite that serves as the major hardware interface between data acquisition electronics on the LAT and other hardware and electronics that make up the FSW hardware package. The GASU contains the GEM, EBM, AEM, and CRU.

**HKP.** Real-time housekeeping telemetry data; telemetry data which relates to the health and safety of the LAT instrument.

**LCB – The LAT Communications Board.** A cPCI board that allows the internal components of the LAT to communicate with one another.

**PID – Programmable Discrete.** The RAD750 CPU board contains 32 channels of digital I/O. The primary boot code uses two channels configured as outputs.

**PDU (Power Distribution Unit).** Portion of the FSW hardware suite that manages power distribution from the spacecraft and monitors the health of other FSW hardware.

**RTOS – Real Time Operating System.** In particular the VxWorks 5.4 operating system used by the LAT.

**SC – The GLAST Spacecraft.** As built by Spectrum Astro. Refer to the GLAST LAT Instrument – Spacecraft Interface Control Document for the formal specifications of the SC as seen by the LAT.

**SDRAM.** The RAD750 CPU board 128 MB of synchronous DRAM; the SDRAM serves as the RAD750 main memory.

**SIB – Spacecraft Interface Board.** The board in the SIU crates that contains the LAT 1553 remote terminal hardware.

**SIU – Spacecraft Interface Unit.** A type of single board computer (SBC) in the FSW hardware suite that acts as an interface between the spacecraft and the LAT.

**SUROM – Startup ROM.** 256 KB of EEPROM memory on the RAD750 CPU boards that holds the primary boot code; the SUROM is only programmable on the bench through the PPCI JTAG interface.

**T&DF (Trigger and Dataflow System).** Large LAT subsystem that provides gamma-ray identification, readout of the detector measurements, assembly of gamma-ray source location and energy measurements, and the streaming of data to the spacecraft. The T&DF subsystem contains the TKR, CAL, and ACD front-end electronics, Tower Electronics Modules (TEMs), ACD

Electronics Modules (AEMs), Event Builder Module (EBM), Global Trigger (GLT), Global Trigger Electronics Module (GEM), and CPUs used for instrument configuration and data processing.

**VxWorks.** Computer operating system used on board the RAD750 processor.