Command Control And Configuration

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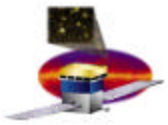


Command Reception

- The LAT receives commands on a MIL-STD-1553 bus
- Flight software is responsible for
  - Removing any jacketing protocol
  - Performing validity checks on the raw packets
    - CRC or parity (TBD)
  - Classifying the command by type (next slide)

Command Types

- **Commands Belong To One Of Two Types**
  - **Real Time Commands**
    - **Validated commands of this type execute immediately**
    - **Flight software keeps statistics of:**
      - **Commands received**
      - **Commands accepted**
      - **Commands executed locally**
      - **Commands forwarded for execution on another processor**
  - **Block Commands Comprising:**
    - **Executable code uploads**
    - **Table/parameter uploads**
    - **Command list uploads**
- **Command Type Is Distinguished By 1553 Subaddress**

Block Commands

- Typically Spread Over Multiple Packets
  - Packets must include a packet protocol
  - Appears naturally in the CCSDS protocol
- Packet Size
  - Packet Size Is A Compromise Between
    - Large packet transmission efficiency
    - Large packet error recovery (retransmission) inefficiency
  - Packets are likely to be in the range 1-2 kByte
- Interleaving Block Commands
  - All block transmissions are not created equal
    - More important to upload a command list than a piece of code
  - FSW will accept multiple block transmissions interleaved
    - Protocol must contain sufficient information to distinguish different blocks

Command Lists

- Command List Is Example Of A Block Command
- Command Lists Determine Time Ordered LAT Activity
  - Each command is time tagged to a precision of one second
  - Command execution is scheduled with an accuracy of 10 msec
  - Flight software will store up to (TBD) such commands
    - Not yet determined, but commensurate with storing up to 48 hours of commands so that a missed uplink does not interrupt LAT operations

Control

- The Spacecraft Interface Unit (SIU) provides LAT control
- SIU Receives And Implements Commands From
  - Real time commands
  - Command lists
- SIU Controls Power Distribution (Except It's Own Power)
  - By command protocol to the power distribution box, to control and monitor power to TEMs, AEM, GLT, EPUs
  - By command protocol to TEMs and AEM to control and monitor power to the front end electronics
- SIU Controls LAT Configuration
  - By command protocol to TEMs, AEM, GLT and front end electronics
  - By CPU to CPU communications with EPUs

Configuration

- A Configuration Completely Describes The State Of The LAT
- Configurations Have Many Uses
  - To meet scientific objectives
    - Change LAT properties during a transient
  - To protect LAT health
    - Shut down ACD HV while transiting the SAA
  - To circumvent component failure
    - Take a noisy tracker strip out of the trigger
  - To control redundancy paths
    - Use global trigger box B instead of global trigger box A

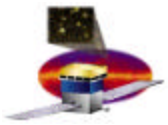
Configuration Management

- **Configurations Are Managed By The SIU**
- **The SIU Must Communicate Configurations Across Three Interfaces**
  - **To and from the ground**
    - **Uplink new configurations (source from 1553)**
    - **Downlink configurations used (sink to SSR)**
  - **To and from non volatile storage (EEPROM)**
    - **Save static configurations arriving from the ground**
    - **Use static configurations to set up the LAT**
  - **To and from the DAQ (using DAQ serial protocol)**
    - **Set up requested configurations in hardware**
    - **Read back the current hardware configuration**

Configuration Arithmetic (1)

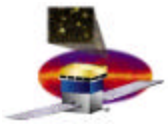
- A Configuration Is A Large Volume Of Information

Subsystem	Element	Bytes/ Element	# Elements	Total (bytes)
ACD	GAFE	4	6 (boards) * 2 (redundancy) * 18 (channels)	864
	GARC	14	6 (boards) * 2 (redundancy)	168
CAL	GCFE	5	16 (towers) * 192 (logs ends)	15360
	GCRC	8	16 (towers) * 16 (GTRC/tower)	2048
TKR	GTFE	26	16 (towers) * 36 (layers) * 24 (GTFE/layer)	359424
	GTRC	2	16 (towers) * 36 (layers)	1152
TEM	Registers	2	16 (towers) * 44 (registers)	1408
AEM	Registers	2	1 * 20 (registers)	40
GLT	Registers	2	8 (triggers) * 6 (registers)	96
Grand Total				380560



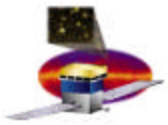
Configuration Arithmetic (2)

- **Simple, Absolute Configuration Descriptions Are Not Viable**
  - **Require large amounts of memory**
  - **Difficult to upload/download**
- **More Compact Notation Needed**
  - **Variation from standard**
    - **Assume standard configuration is to enable all strips into the trigger, then only need to keep a list of those strips which should be removed from the trigger**
    - **Very compact**
    - **Somewhat ad hoc**
  - **Result of command set**
    - **Define configuration as position reached as a result of executing a list of commands**
    - **Comparable to the method that must actually be used to establish the configuration**
    - **Not quite as compact (but not so bad if meta-commands and broadcasts can be used)**



Operational Uses Of Configurations

- **Can Be Divided Into Two Major Categories**
  - **Diagnostic/Calibration Running**
    - Diagnostic configurations difficult to predict
    - Calibration frequently rotates through a list of configurations
    - Neither is a good candidate for static configurations (however compact)
    - Both require programmatic interface to configuration utilities
  - **Physics Running**
    - Physics running requires stable configuration for the duration of an observation/run
    - Good candidate for (compact) static configurations
    - Configurations can be made and tested before launch…
      - **… but don't expect them to remain static over the course of the mission**



Spontaneous Loss Of Configuration

- Configuration During Physics Running Should Remain Constant
  - Load configuration at start of run
  - Read back configuration to confirm it
  - Record configuration for each run
  - Read back the configuration at end run to confirm no change
- But This Is Not A Perfect World
  - A tracker strip might go noisy during a run
  - An event processing unit may take an SEU exception
- SIU Reaction To Loss Of Configuration (In Priority Order)
  - Protect the LAT
    - If a current is far outside tolerance, switch component off
  - Protect the physics data
    - Bring run to a controlled halt
  - Try to continue the mission plan
    - SIU may be able to reboot an EPU that took an exception

Autonomous Update Of Configurations

- **Uplink And Downlink Bandwidth Is A Precious Commodity**
  - **Prefer to use it for physics data, not calibration/diagnosis**
- **Some Calibration/Diagnosis Better Done In Situ. Example:**
  - **Enable all TKR strips into data**
  - **Trigger LAT ~100k times**
  - **Build and save map of dead and noisy strips**
  - **Use maps as part of physics acquisition configuration**
- **Advantages**
  - **Little or no impact on downlink bandwidth (report results of diagnostic, not each event that went into it)**
  - **Little or no impact on uplink bandwidth (no need to uplink the results of a ground analysis)**
  - **Little or no impact on observation time (~100k events can be captured in ~10 seconds)**