

DATA PROCESSING REVIEW

April 2000



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Onboard Processing Characteristics

- Science Image Data
 - 1280x256 CCD pixels are readout
 - Optional Region of Interest mapping performed
 - Optional Flat Fielding performed
 - Optional data binning performed
 - Optional rice compression performed
 - Data broken into 256 word blocks
 - 8 words of error correction codes calculated
 - Completed image data packet queued for transmission over X-band

- Instrument State of Health Data
 - Status information sampled in 32 word packet
 - Packets have a common-format block header
 - Header contains packet type, checksum and timestamp
 - SoH is sent over both X-band and S-band
 - A packet scheduler decides when to insert SoH into the downlink streams.

- Data Binning
 - Data is binned into 1x1, 2x2 or 4x4 samples.
 - The 16 most significant bits of a sample are used in the image data packets.

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SMEI Concept Data Flow

- **Science Data Flow**
 - Data Received Over 1Mhz Serial Line From Each Camera
 - FPGA Converts Serial Streams To 16-bit Pixel Values
 - Pixels Are Buffered In a 7 Entry FIFO
 - Processor Interrupt Every 4 Pixels
 - ROI, Flat Fielding and 4 x 1 Binning In Interrupt Routine
 - 4 x 1 Cells Loaded Into A Ring Buffer

 - Second Stage Binning To 4 x 4 Bins
 - Binned Data Is Compressed Using The Lossless Rice Compressor
 - Compressed Data Is Error Correction Encoded With A Rectangular Encoding Scheme

 - Complete Frames Of Data Are Buffered
 - Frames Are Transmitted As Contiguous Units
 - Science-Critical Housekeeping Interleaved Between Frames

- **Housekeeping Data Flow**
 - Samples updated at 1Hz Rate
 - Attitude Solution Received From Spacecraft at 5Hz
 - Stored In A Pool Of Swing Buffers
 - Transmitted Over State Of Health and Science Channels

- **Commanding**
 - Move SMEI Between Major Modes Of Operation
 - Handle Emergency Shutdown Conditions
 - Update Main E²PROM
 - Change Observing Parameters
 - Door Opening

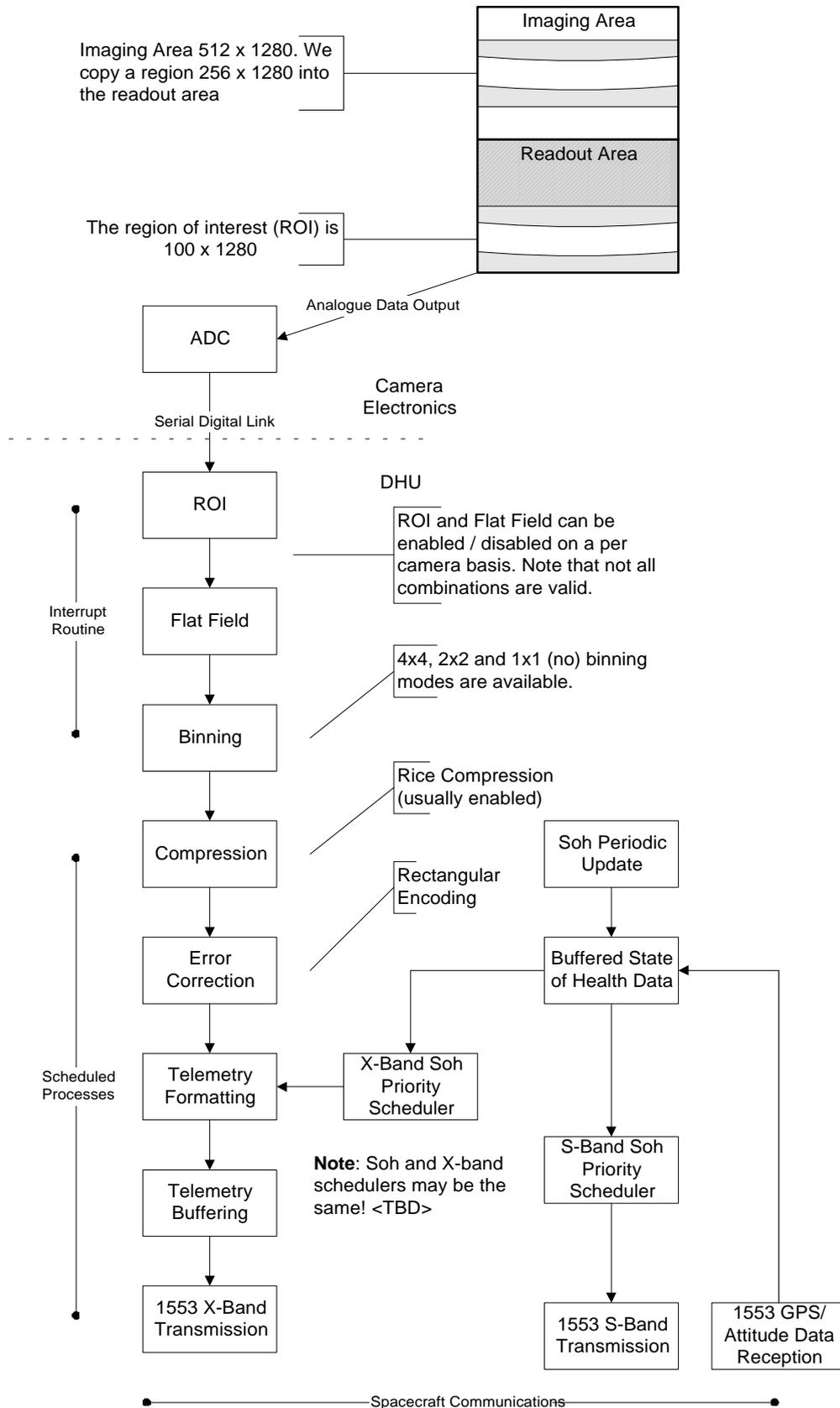
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SMEI Onboard Data Overview



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Observation Modes

Engineering Mode A

- Only 1 Camera
- No Flat Fielding
- No ROI Mapping (1264 x 256 pixel readout)
- No Binning
- 323584 uncompressed words per frame
- 128,000 bps Telemetry
- 992 kwords of DHU memory for a frame buffer

Assuming 2:1 compression, data is produced at 632 kbps, or a duty cycle of 19%. We can buffer 6 complete frames of data in the available DHU memory store.

Engineering Mode B

- Only 1 Camera
- No Flat Fielding
- ROI Mapping (1264 x 100 pixel readout)
- No Binning
- 126400 uncompressed words per frame
- 128,00 bps Telemetry
- 992 kwords of DHU memory for a frame buffer

Assuming 2:1 compression, data is produced at 247 kbps, or a duty cycle of 50%. We can buffer 16 complete frames of data in the available DHU memory store.

Hi Resolution Mode

- Only 1 Camera
- Flat Fielding
- ROI Mapping (1264 x 100 pixel readout)
- 2x2 Binning
- 31600 uncompressed words per frame
- 64,000 bps Telemetry
- 247 kwords of DHU memory for flat fielding tables
- 745 kwords of DHU memory for a frame buffer

Assuming 2:1 compression, data is produced at 62 kbps, or a duty cycle of 100%, with a housekeeping and formatting channel of 0.5 kbps.. We can buffer 48 complete frames of data in the available DHU memory store.

Standard Observing Mode

- 3 Cameras
- Flat Fielding
- ROI Mapping (3 x 1264 x 100 pixel readout)
- 4x4 Binning
- 7900 uncompressed words per frame (23700 in total)
- 64,000 kbps Telemetry
- 741 kwords of DHU memory for flat fielding tables
- 251 kwords of DHU memory for a frame buffer

Assuming 2:1 compression, data is produced at 47 kbps, or a duty cycle of 100%, with a housekeeping and formatting channel of 15 kbps. We can buffer 21 complete frames of data in the available DHU memory store, ie 7 per camera.

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S-Band Telemetry Format Summary

- Defined in SMEI Instrument Telemetry Format Specification (SMEI/BU/SPE/003)
- Fixed size packets (32 words)
- Data multiplexed using a type field
- Packets time-stamped with UTC seconds LSW field
- Packet checksum but no error correction codes

Word	Mask	Mnemonic	Parameter
0	xxxxxxxxxxxxxxxxxxxx 0000000000000001 0000000000000010 0000000000000100 0000000000001000 0000000000010000 0000000000100000 0000000001000000 0000000010000000 0000000100000000 0000001000000000 0000010000000000 0000100000000000 0001000000000000 0010000000000000 0100000000000000 1000000000000000	SOH_TYPE	Multiplex Packet Type Identifier Reserved Block Reserved Block Reserved Block Camera 1 Observation Parameters Camera 2 Observation Parameters Camera 3 Observation Parameters Analogue and Digital Monitors Flat Field Table Checksums Command Status Return Single Event Upset Information Paged Region Memory Dump Fixed Region Memory Dump Software Performance Counters Housekeeping Test Pattern GPS Time and Attitude Parameters Reserved Block
1	xxxxxxxxxxxxxxxxxxxx	SOH_CRC	Cyclic Redundancy Check
2	xxxxxxxxxxxxxxxxxxxx	SOH_TIME	Timestamp of the last update of this data packet
3-31			Variable packet data dependant on the type identifier

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X-Band Telemetry Format Summary

- Defined in SMEI Instrument Telemetry Format Specification (SMEI/BU/SPE/003)

- Variable size packet format
 - Synchronisation Headers (2 words)
 - Image Data Packets (264 or variable words)
 - State Of Health Packets (32 words)

- Synchronisation Header
 - Type of the following data (SoH / Image)
 - Source Camera for image data
 - Image Frame data continuation marker
 - Number of words until the next sync header

- Image Data Packet
 - 8 words of rectangular error correction
 - Upto 256 words of image data

- State Of Health Packets
 - As defined for S-band

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SMEI X-Band Data Reconstruction

- Locate Synchronisation Header
 - This allows decoding of the X-band stream

- Locate camera observation parameters housekeeping
 - Camera configuration
 - Observation mode
 - Frame exposure and readout times
 - Compression settings

- Locate Start of Image Data Synchronisation Header
 - Header flag shows 'image data'
 - Header flag does not show continuation marker

- Extract image data
 - Perform error correction checks
 - Use the SH_SIZE field from the header to read all the image data packets in this chunk
 - If the next synchronisation header is a 'continuation' chunk, read image data packets from the next chunk too.

- Decompress the image data
 - At this point, and dual bit errors can potentially be fixed by doing trial decompressions until the right number of image samples are received.

- Reconstruct the image structure
 - This is based on the current ROI for the camera

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SMEI Onboard Commanding Overview

- SMEI Instrument Commanding Protocol (SMEI/BU/SPE/001)
- SMEI Instrument Commanding Specification (SMEI/BU/SPE/002)

- Fixed length command packets
 - 32 words
 - Unused words filled with 0

- Command Format
 - 16 bit checksum (CRC-16)
 - Sequence number

- Protected Commands
 - Important commands require an enabling command to immediately precede them.

- Sequence Numbers
 - Commands only accepted if sequence = 255 or sequence is 1 more than previous command
 - Used to protect sequences of commands which must be received in-order. (Eg, mode changes, patching)

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SMEI Patch Uploading Overview

- Command SMEI to Patch Mode
 - Halt observing (SMEI in configuration mode)
 - Issue Patch Mode Enable
 - Issue Goto Patch Mode
- Upload Patch Data
 - Issue 1 or more Patch Upload commands
 - These build a copy of the patch in SMEI SRAM
- Commit Patch Data to E²PROM
 - Issue Patch Commit to store the uploaded data
- Software Patching
 - For software patching, the uploaded patch can be disabled or enabled using the appropriate command
 - Software patches are not enabled until a DHU restart
- Leave Patch Mode
 - Issue Goto Configuration Mode command

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SMEI Patch Uploading Overview

