

CubeSat Data Management and Truncation System



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Computing Challenges Addressed

- Strict power budget
- Data bottleneck caused by low baud rates
- Organization of system data
- Autonomous data management

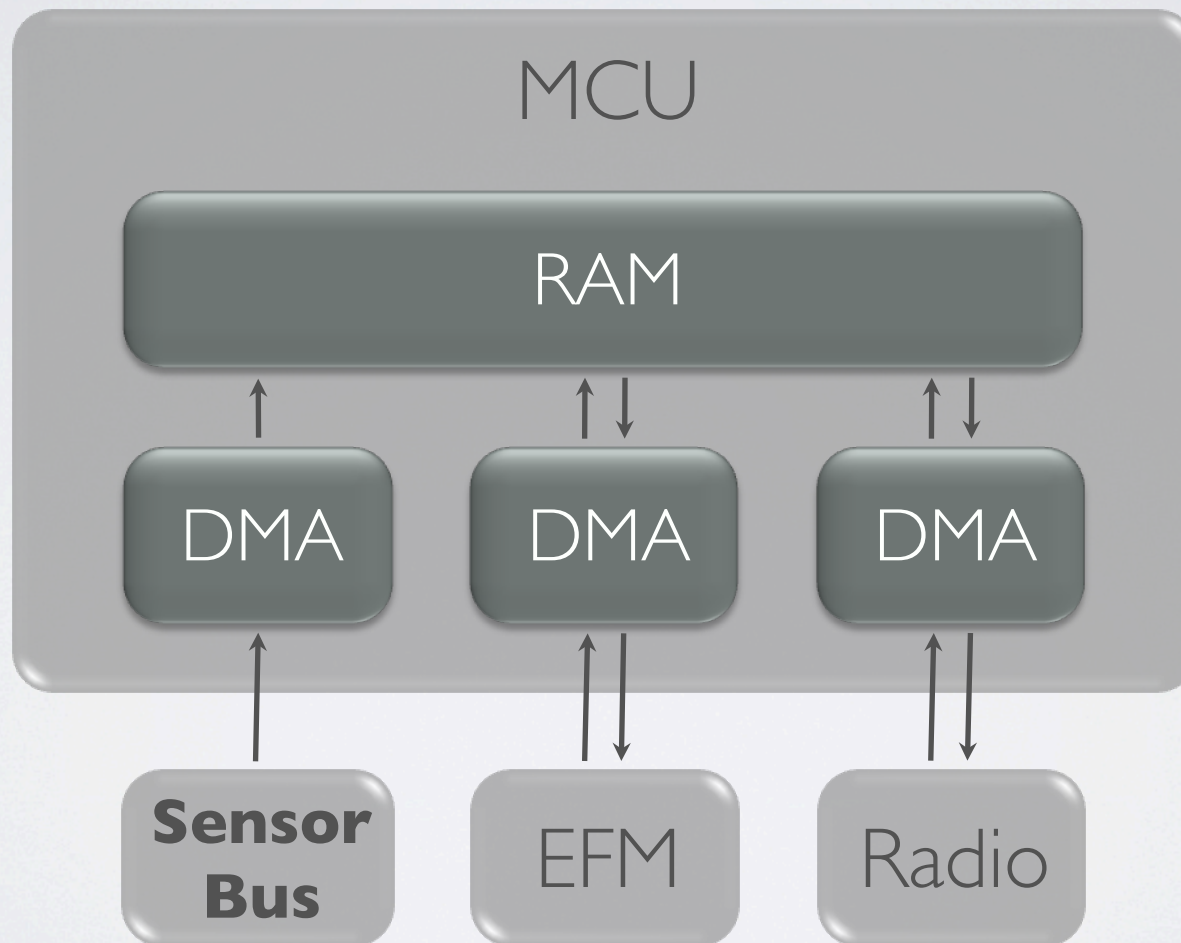
Hardware Specifications

- Microcontroller (MCU)
 - Atmel ATXmega256A1
- External Flash Memory (EFM)
 - Micron MT29FI6G08FAA
- Radio Interface
 - Texas Instruments CCI101

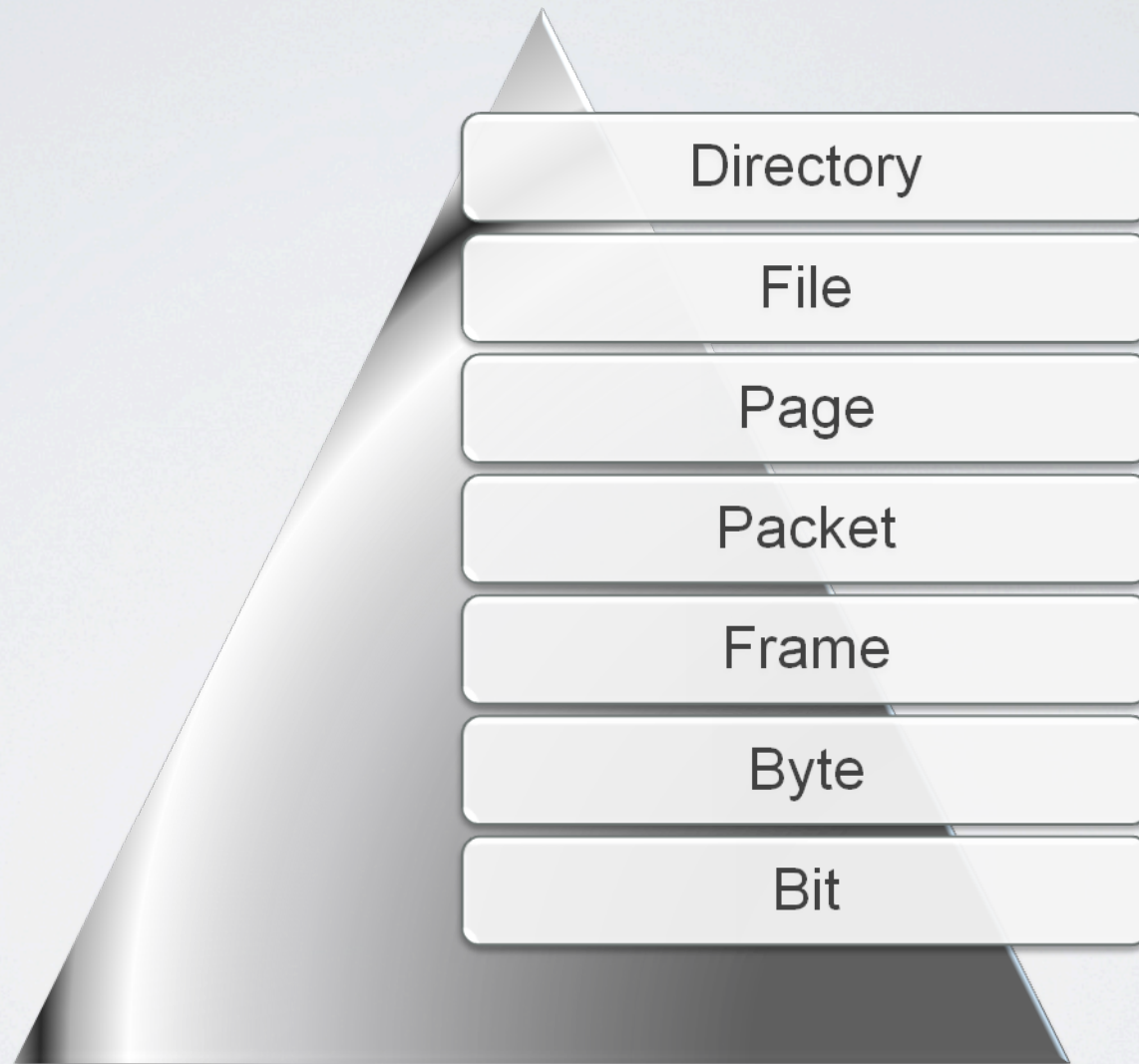


Image used from
Atmel

Hardware Block Diagram

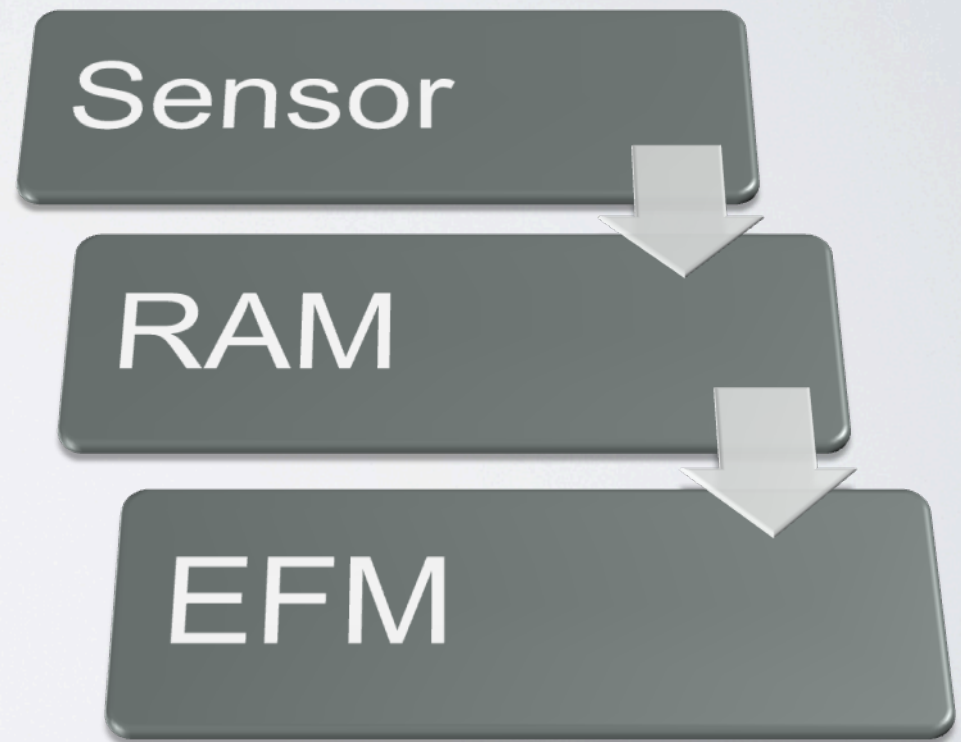


Data Hierarchy



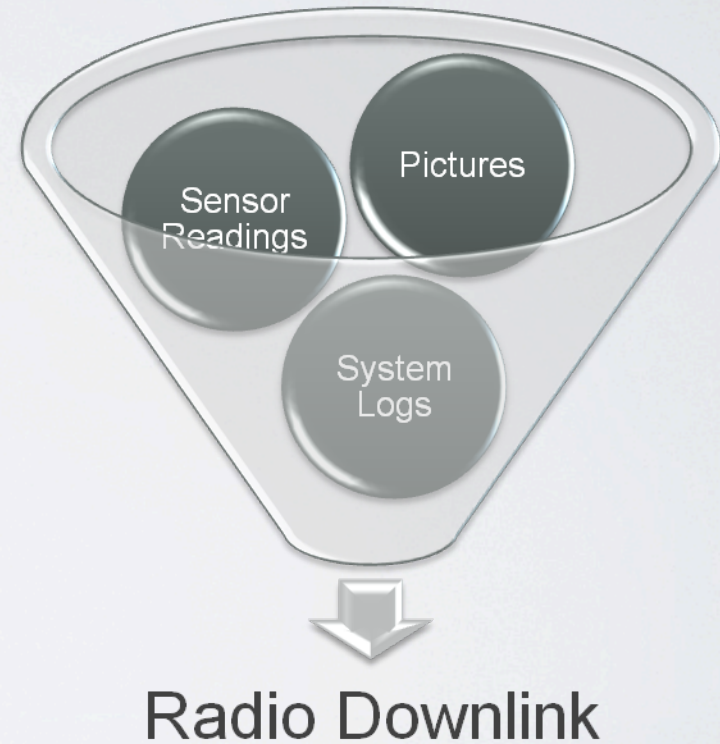
Data Acquisition

- The act of retrieving data should be fast and simple
- Data should be sent to a RAM buffer
- When the buffer reaches a full page (2KB), the DMA writes to flash in one single page burst

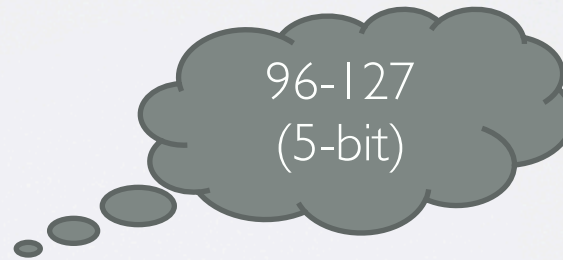
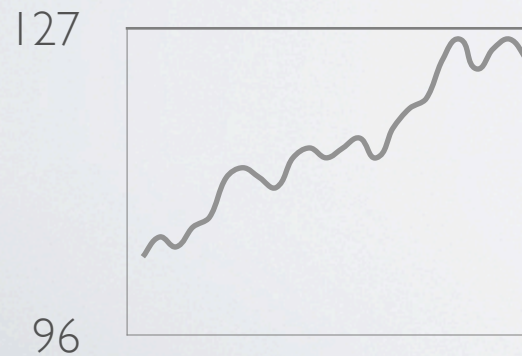
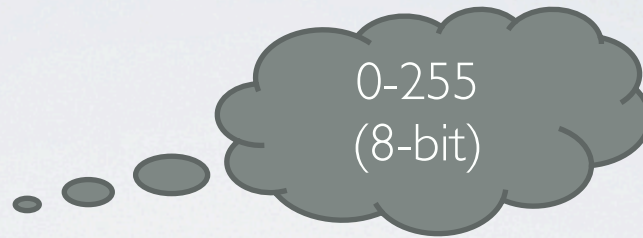
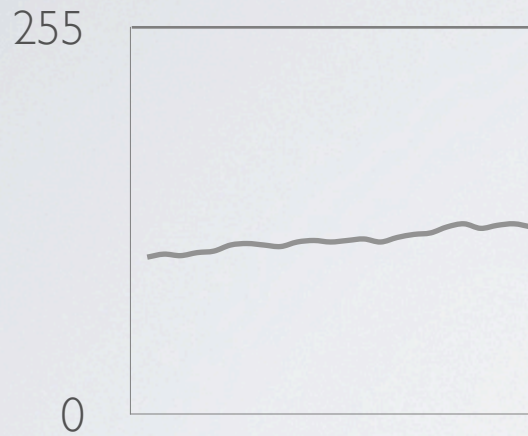


Data Compression

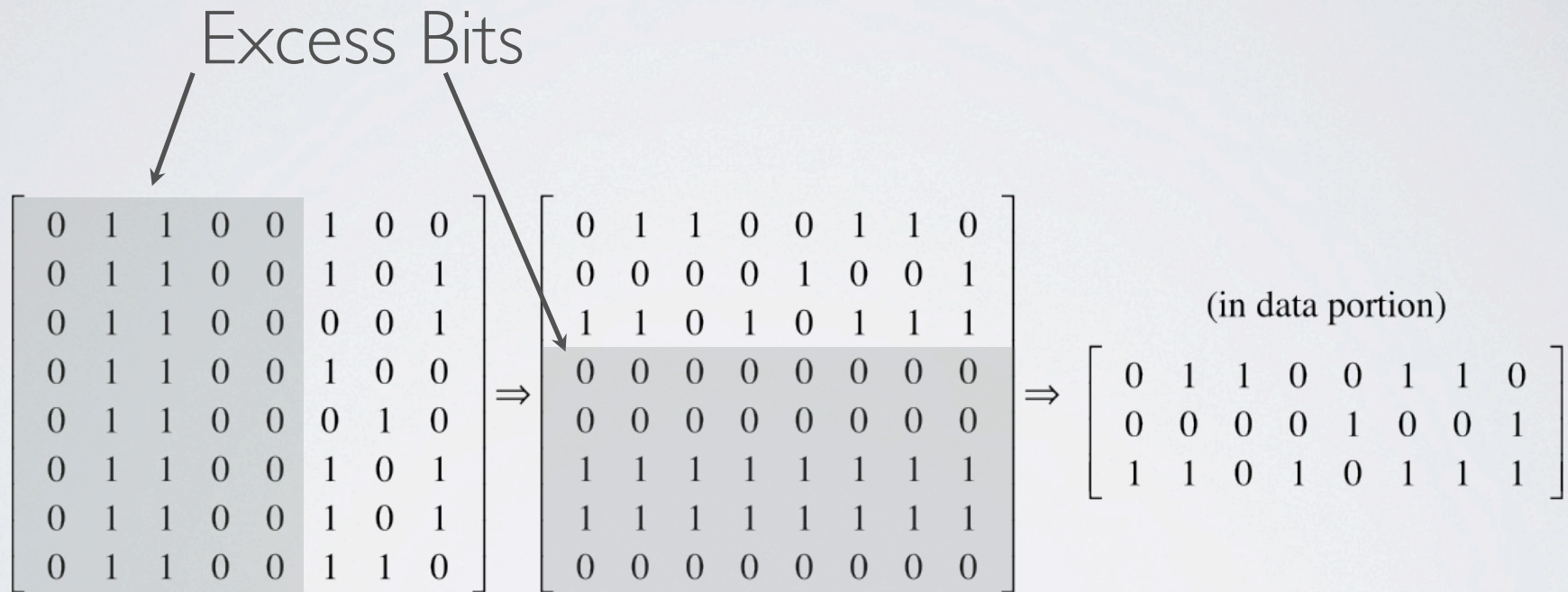
- Due to radio transmission limitations (9.6k baud), it is important to shrink data sizes as much as possible
- Data compression can be performed after data acquisition has finished as a low-priority CPU process



Data Truncation



Common Bit Truncation Encoding (CBTE)



(In file header)

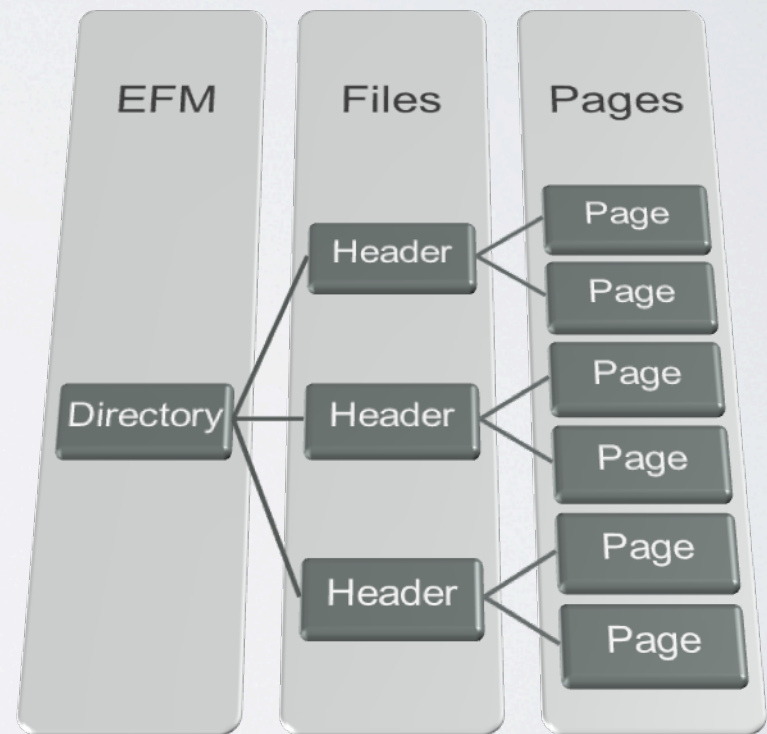
$$\begin{bmatrix} 1 & 0 & 0 & 1 & 1 & 0 & 0 & 0 \\ 0 & 1 & 1 & 0 & 0 & 0 & 0 & 0 \end{bmatrix} \Rightarrow 01100XXX$$

CBTE Advantages

- This algorithm can be implemented on any size of data (8, 12, 16 bit can all work on the same system)
- Data is always transmitted in as few bits as possible
- Any unexpected results can be handled gracefully without any software recalibration

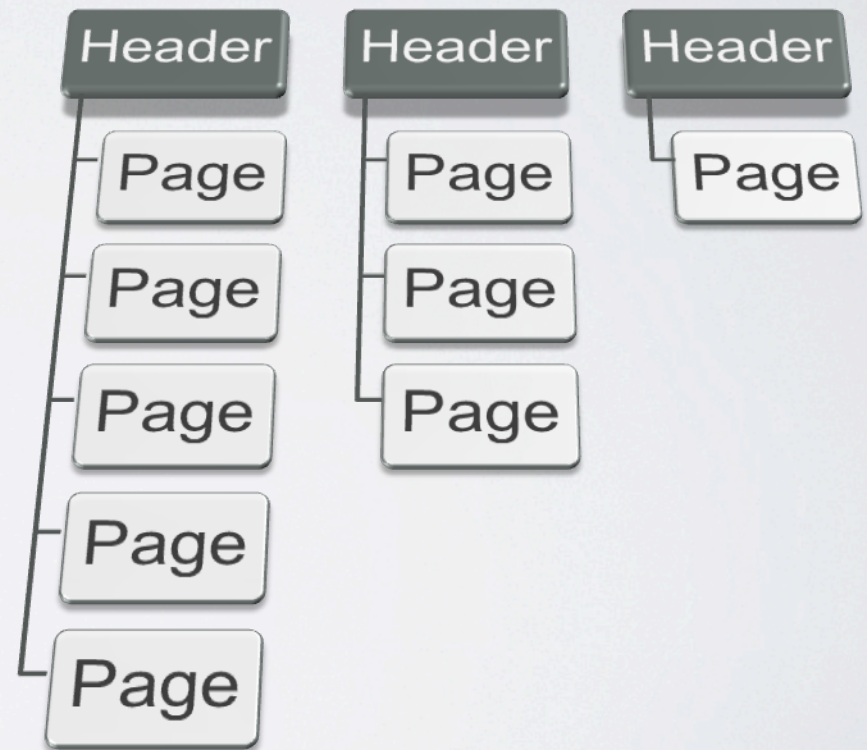
File System

- Software abstractions for handling access to flash memory module drivers
- Provides RAM buffering for each open file allowing for multi-file access
- Each buffer can write in burst once it reaches the size of one full page (2kB)



Page-Based Operation

- Each file can be described in discrete pages (2KB)
- The first page shows the location of every page in order
- Each file can be up to 2048 pages (4MB)



Directory System

- Seen as an array of file header address pointers
- Allows for fast, array-speed access



Review

- Parallel memory access with asynchronous DMA bursting
- RAM buffered filing system with timed DMA triggering
- Array of file header addresses for fast access
- File header for showing location of each page in the file
- Compression for decreased data sizes

Acknowledgements

- University of Alabama in Huntsville
- Alabama Space Grant Consortium
- National Space Science and Technology Center

For more info, go to spacehardware.uah.edu

References

- Atmel Corporation — 8/16-bit AVR XMEGA AI MCU
- Micron Technology, Inc. — MT29F4G08XXX
- Texas Instruments, Inc. — CCI1XX