

SPACE SYSTEMS SYMPOSIUM (D1)
Enabling Technologies for Space Systems (2)

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INNOVATIVE REED-SOLOMON CODING-DECODING COMPONENT FOR FLASH MEMORY
BASED SOLID STATE RECORDER FILE SYSTEMS

Abstract

The use of flash memory for large capacity solid state recorders (SSR) has many advantages for space applications. NAND flash memory is becoming cheaper and more dense allowing for large capacities, high data rates, and lower mass. However, NAND flash has several characteristics that create challenges for the design and implementation of reliable SSR's, especially when used in conjunction with off-the-shelf file systems. Flash memory is less reliable than other forms of memory, and errors in a single bit tend to propagate to adjacent areas in the memory. Thus single bit error detection and correction (EDAC) is less than ideal for this application. Reed-Solomon EDAC protects blocks of symbols (bytes) and thus is most suited for this application.

However the use of Reed-Solomon codes introduces several challenges when used in conjunction with an operating system's standard file system or other commercial, off-the-shelf software. Such file systems are designed for block oriented storage devices and make assumptions about the "geometry" of the SSR's storage structure. Hardware Reed-Solomon codecs produce code block sizes that are usually incompatible with the file system's intrinsic block sizes and, to be efficiently implemented, are not even powers of two in length. This requires modifications to the file system software that are rarely easy, and sometime not possible, to make. In addition, a hardware implementation does not generally allow the flexibility of selecting the degree of protection to be applied to specific types of data, requiring that all data stored to the recorder be protected at to the degree required by the most severe case.

This paper describes the design, implementation and integration strategies for an innovative software component allowing flexible Reed-Solomon EDAC protection of NAND flash memory. This software allows easy integration with existing file system, both designed specifically for NAND flash memory and those employing a "flash translation layer," in such a way that high speed data capture and downlink may be maintained without hardware acceleration. The software is parameterized so that various code block sizes can be selected at run time, allowing the degree of protection to be tailored to the requirements of the type of data, thus reducing over-all overhead. Strategies for possible hardware acceleration are also discussed.