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A spaceborne advanced storage system for remote sensing microsatellites

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Key words: Microsatellite; Spaceborne advanced storage system (SASS); Scalability; Performance; Reliability

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Motivation

- Recent advances in satellite miniaturization technology have directed efforts in remote sensing towards microsatellite constellations. In particular, the application of compact commercial off-the-shelf (COTS) components breaks through the limitations of microsatellites in terms of size, weight, and power (SWaP) consumption, and computing and storage performance.

- As the core of remote sensing missions, remote sensing payload technology is developing rapidly, which brings an explosion in the volume of remote sensing data, and a spaceborne storage system with high performance is urgently necessary.

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Main idea

- Modules of spaceborne advanced storage system (SASS), the multiple-input multiple-out (MIMO) cache and the NAND flash controller, have excellent scalability to accommodate different missions and payloads. The NAND flash controller provides smaller configurable functional particles for greater system flexibility and robustness.
- The performance of SASS is strong, and the dynamic programming method and queue scheduling method can effectively improve the efficiency of data scheduling to meet the requirements of high-speed multichannel data storage.
- The proposed data remapping method can reduce the retention and NAND flash program disturbance errors. It partially compensates for the limitations of the error correction algorithm, improves the reliability, and extends the system service life.

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Hardware architecture

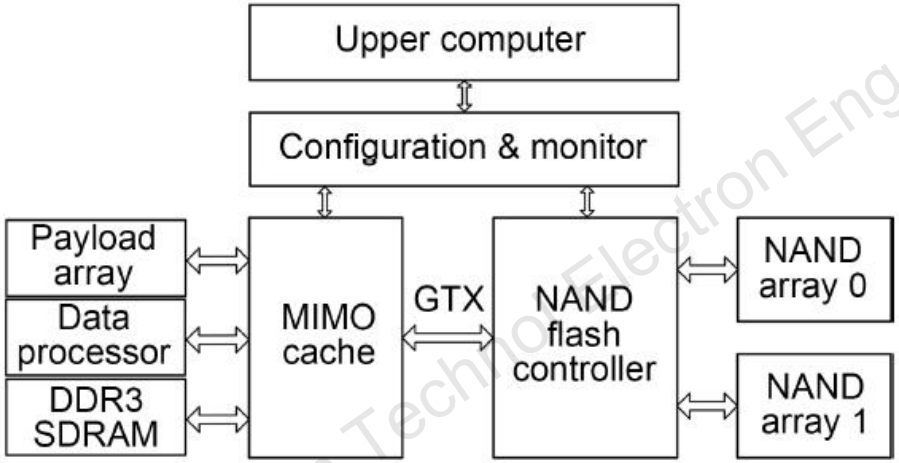

Fig. 1 Architecture of the spaceborne advanced storage system

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MIMO cache

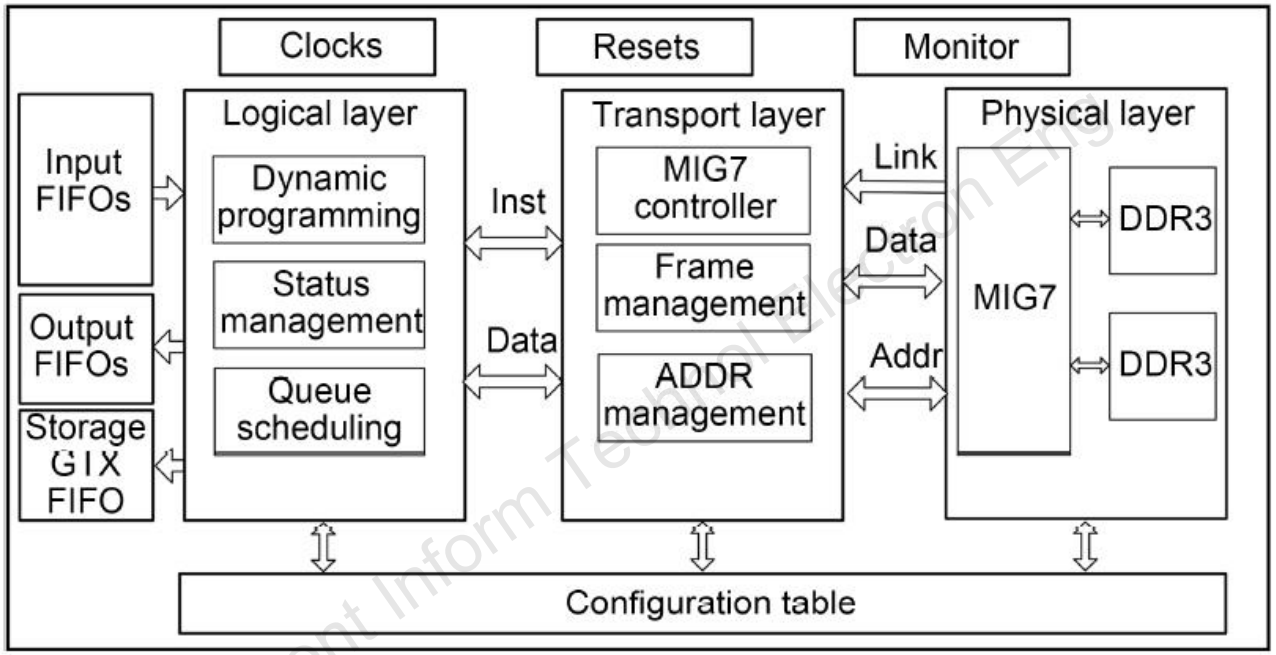

Fig. 2 Hardware architecture of the proposed cache

- **Modular and standardized MIMO cache**
- **Dynamic programming method for data input**
- **Queue scheduling method for data output**

NAND flash controller

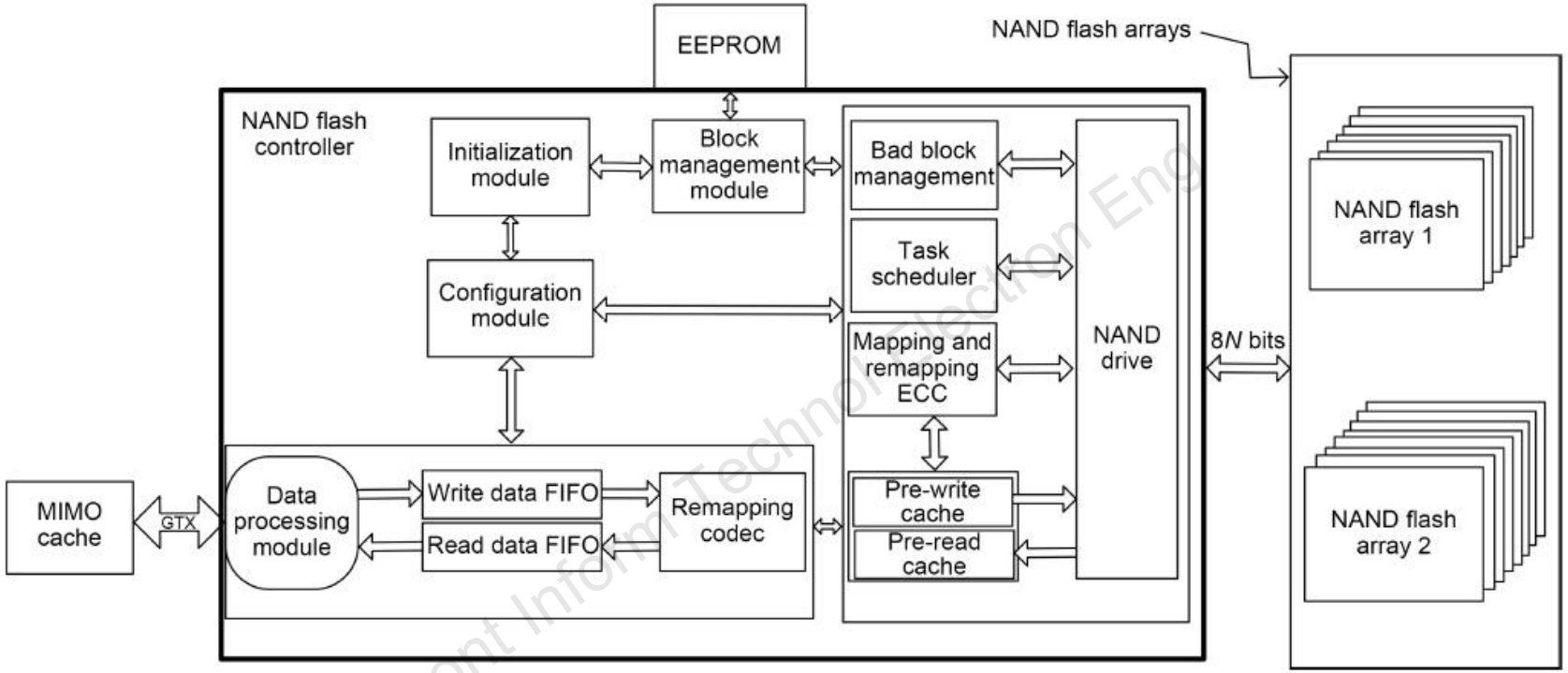

Fig. 4 The hardware architecture of the NAND flash controller

- Array programmable NAND flash controller
- Zero-delay configurable error correction scheme
- Data remapping method for reducing retention error and program disturbance error
- Block management scheme

Conclusions

In this paper, SASS is proposed and implemented with COTS devices for remote sensing microsatellites. It provides a dynamic programming, queue scheduling MIMO cache technique and a high-speed, high-reliability NAND flash controller for multiple microsatellite payload data. Experimental results show that SASS has outstanding scalability with a maximum write rate of 2429 Mb/s and preserves at least 78.53% of the performance when a single NAND flash fails. The scheduling technique effectively shortens the data scheduling time, and the data remapping method of the NAND flash controller can reduce the retention error by at least 50.73% and the program disturbance error by at least 37.80%.

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