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Versionized process based on non-volatile random-access memory for fine-grained fault tolerance

Key words: Non-volatile memory; Byte-persistence; Versionized process; Version number

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Introduction

1. New non-volatile memory (NVRAM) device offers new features such as byte-addressability and non-volatile, which offers new opportunities for fault tolerance.

2. Current hardware architectures do not support natively.

3. This paper proposes a new process model that relies on NVRAM to achieve fault tolerance natively.

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Process model

A new intermediate layer that abstracts underlying hardware resources and redefine the process running model.

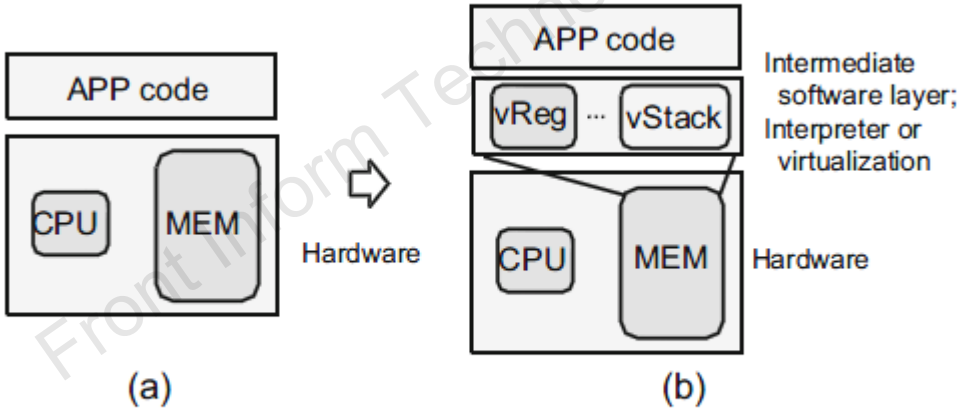

Fig. 2 VerP process model: (a) traditional process; (b) our new process model

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Running model

Versionize all process data and rely on version number to achieve consistent update of any data.

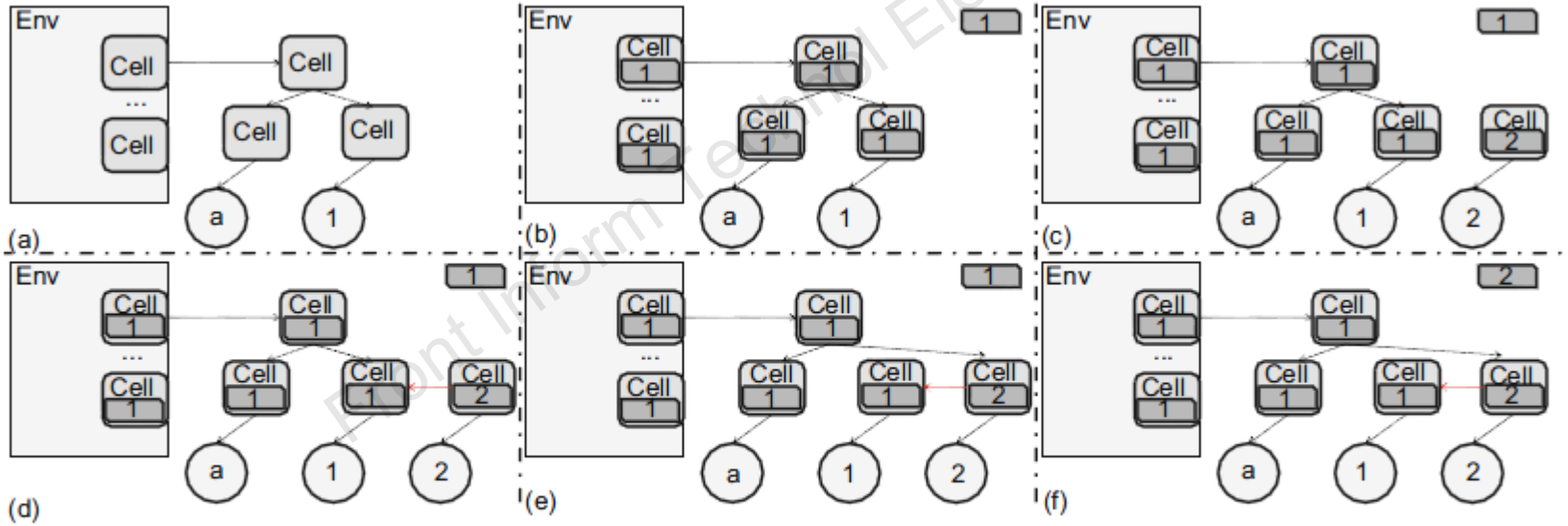

Fig. 5 Versionlized variable update: (a) organization of code; (b) introduction of a version number; (c) changing the variable 'a' from '1' to '2'; (d) maintaining a link to the old-version data; (e) updating the variable 'a' from '1' to '2'; (f) increasing the global version number by 1 (References to color refer to the online version of this figure)

Memory management overhead

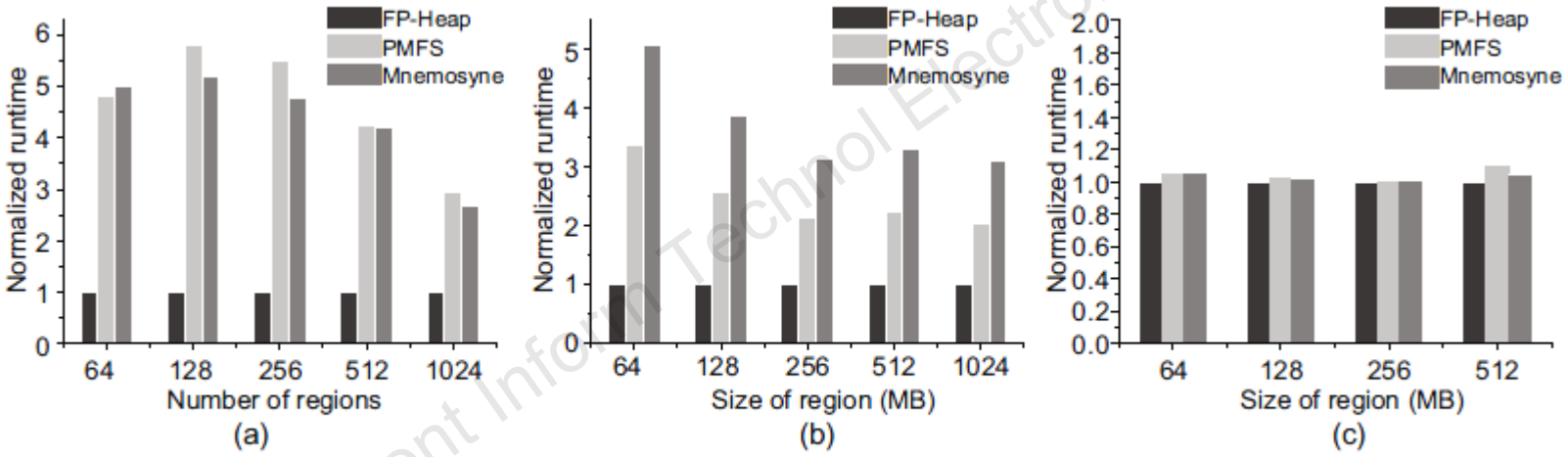

Fig. 10 Results of the stress tests: (a) region_creation; (b) page_fault_test; (c) access_test

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Overhead of achieving fault tolerance

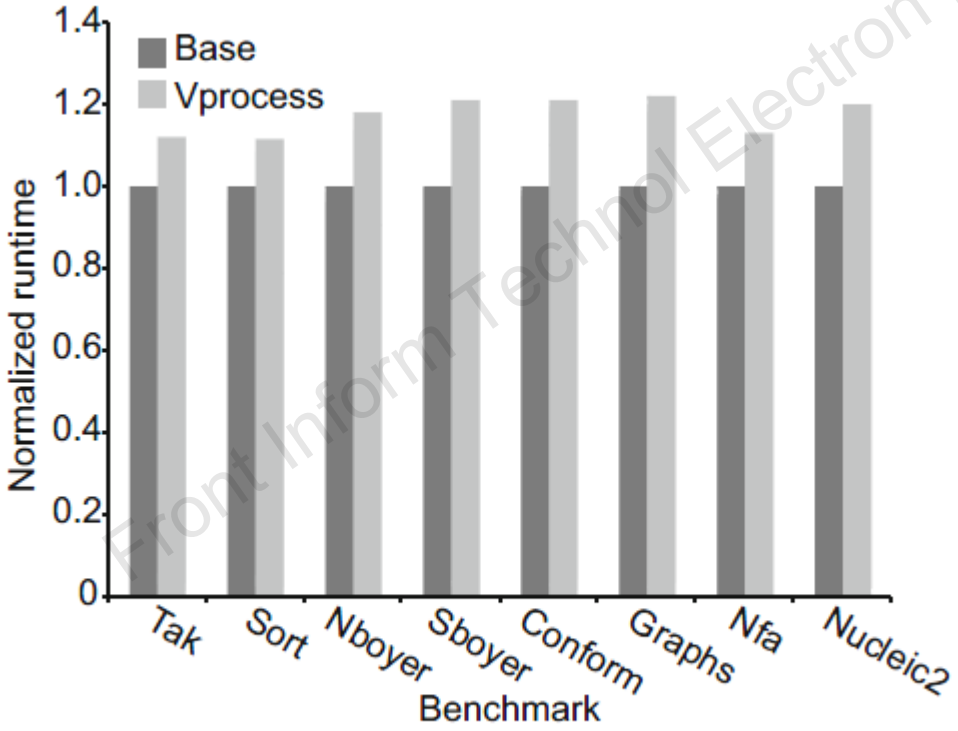

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Fig. 12 Runtime overhead with write latency of 100 ns

Conclusions

1. This paper proposed versionized process, a new process model for fault tolerance based on NVRAM.

2. New process model to help reorganize all process data in NVRAM.

3. Running model which relies on version number to make consistent update of process data.

4. Fine-grained fault tolerance achieved with little overhead.

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