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An OS Service for Transparent Remote Memory Accesses in NoC-Based Lightweight Manycores

Pedro Henrique Penna ^{1 2}, Matheus Souza ², Emmanuel P. Júnior ³, Bruno Nascimento ³, Márcio Castro ³, François Broquedis ⁴, Henrique Freitas ² and Jean-François Méhaut ¹

Introduction

- **Lightweight Manycores Are Substantially Different**
 - Integrate up to thousands of simple and low-power cores
 - Feature rich, fast and reliable interconnects
 - Present a constrained distributed memory configuration
- **Current Runtime Systems Miss Rich Abstractions**
 - The engineer should implement all by himself
 - A fully-featured OS would make software design easier

Goals and Contributions

- **Target Challenges That Arise from the Distributed Memory**
 - Data accessing, tiling and migration
 - Address space expansion
 - Secure data sharing
- **Propose the Remote Memory (RMem) Service**
 - New OS facility that provides a shared memory abstraction
- **Introduce Communication Primitives on Top of RMem**
 - Rely on a one-sided programming paradigm
 - Enable applications to share data in a secure fashion
- **Present a Prototype of RMem for the MPPA-256 Processor**
 - Integration with Nanvix (<https://github.com/nanvix>)

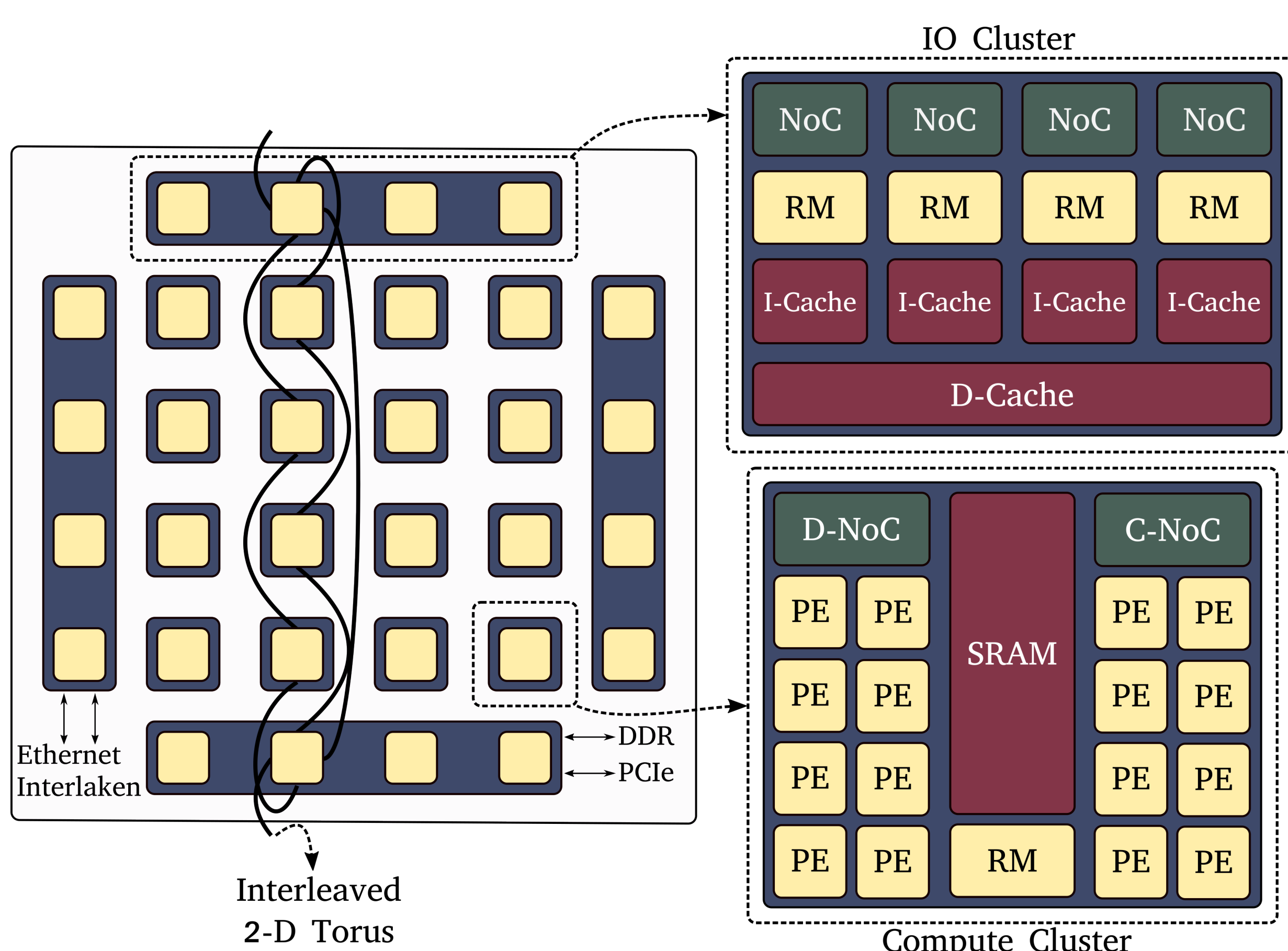


Figure 1: Architectural overview of MPPA-256.

The RMem Service

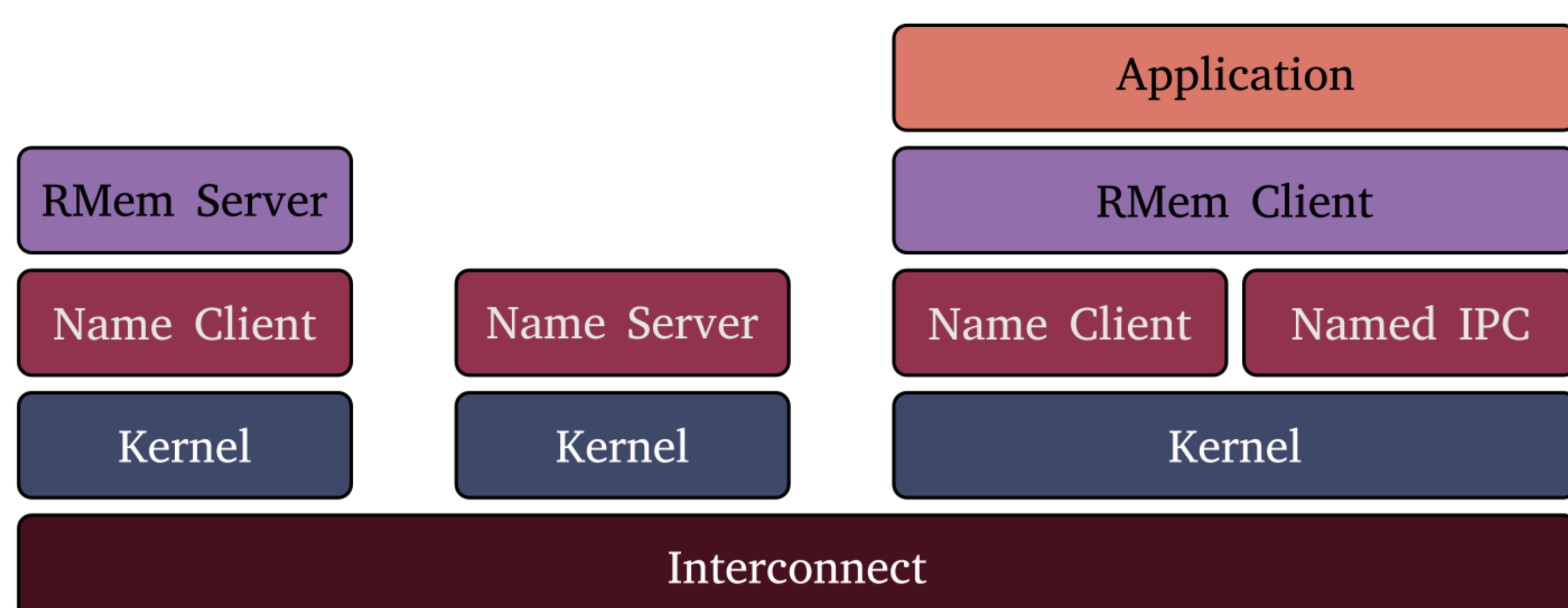


Figure 2: RMem Service architectural overview.

- **Name Service:** provides name resolution protocol
- **Named IPC:** mailbox (1:N) and portal (M:N)

`memread(void *local, off_t remote, size_t size)`

1. Parse the remote address
2. Resolve location of target RMem server
3. Send read request to the server through a mailbox
4. Enable remote portal reads from the RMem server
5. Receive data from the RMem server via a portal

`memwrite(void *local, off_t remote, size_t size)`

1. Parse the remote address
2. Resolve location of the target RMem server
3. Send write request to the server through a mailbox
4. Send data to the RMem server via a portal

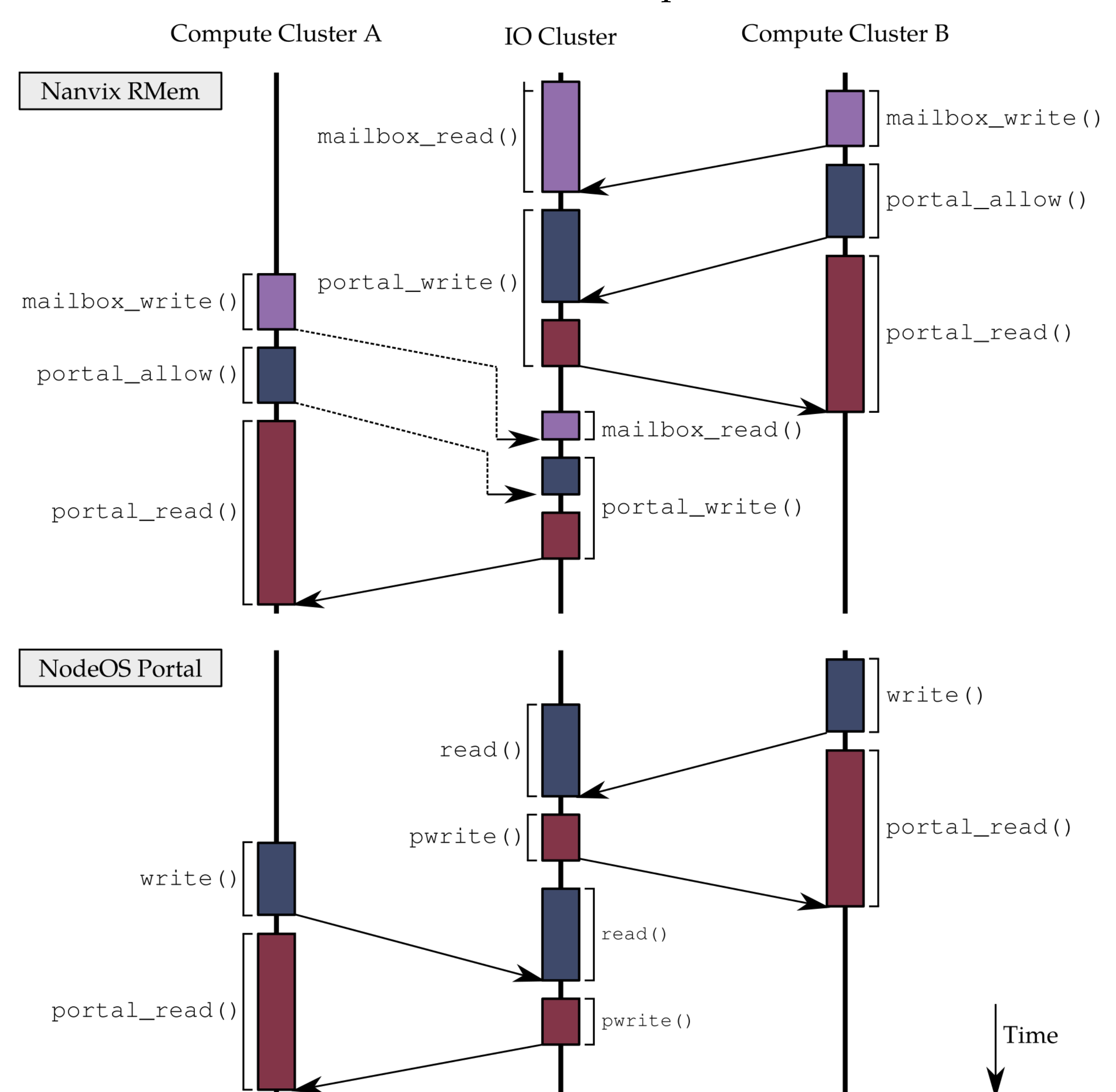


Figure 3: Breakdown of remote reads by 2 peers.

Experimental Results

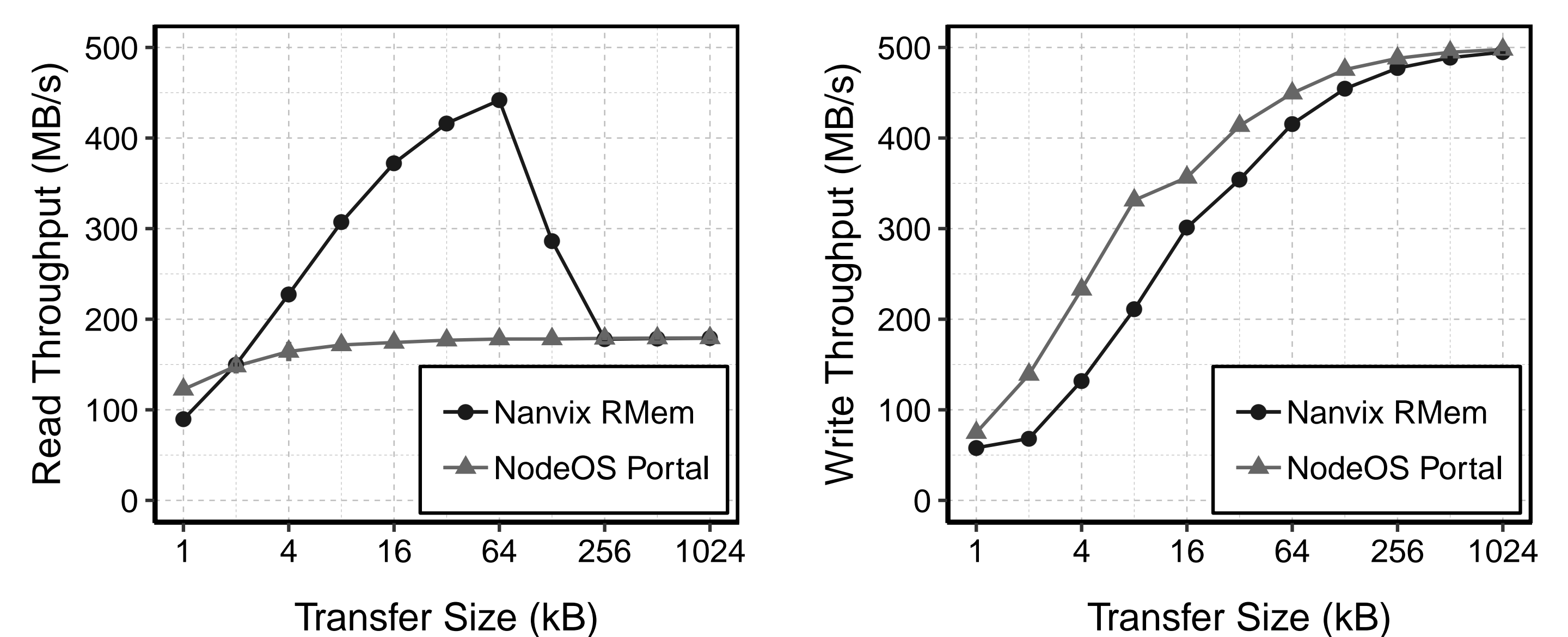


Figure 4: Experimental results for synthetic kernel.

Conclusions

- RMem Service and NodeOS have similar write performance
- Read protocol maximizes concurrency
- Results encourage a native implementation of our service

¹Université Grenoble Alpes (UGA), Grenoble, France

²Pontifícia Universidade Católica de Minas Gerais (PUC Minas), Brazil

³Universidade Federal de Santa Catarina (UFSC), Brazil

⁴Institut National Polytechnique de Grenoble (Grenoble INP), France