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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, Máricio 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)

The RMem Service

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

```c
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
```

```c
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
```

Experimental Results

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

Conclusions

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