

Cashmere-2L:

Software Coherent Shared Memory on a
Clustered Remote-Write Network

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Background & Motivation

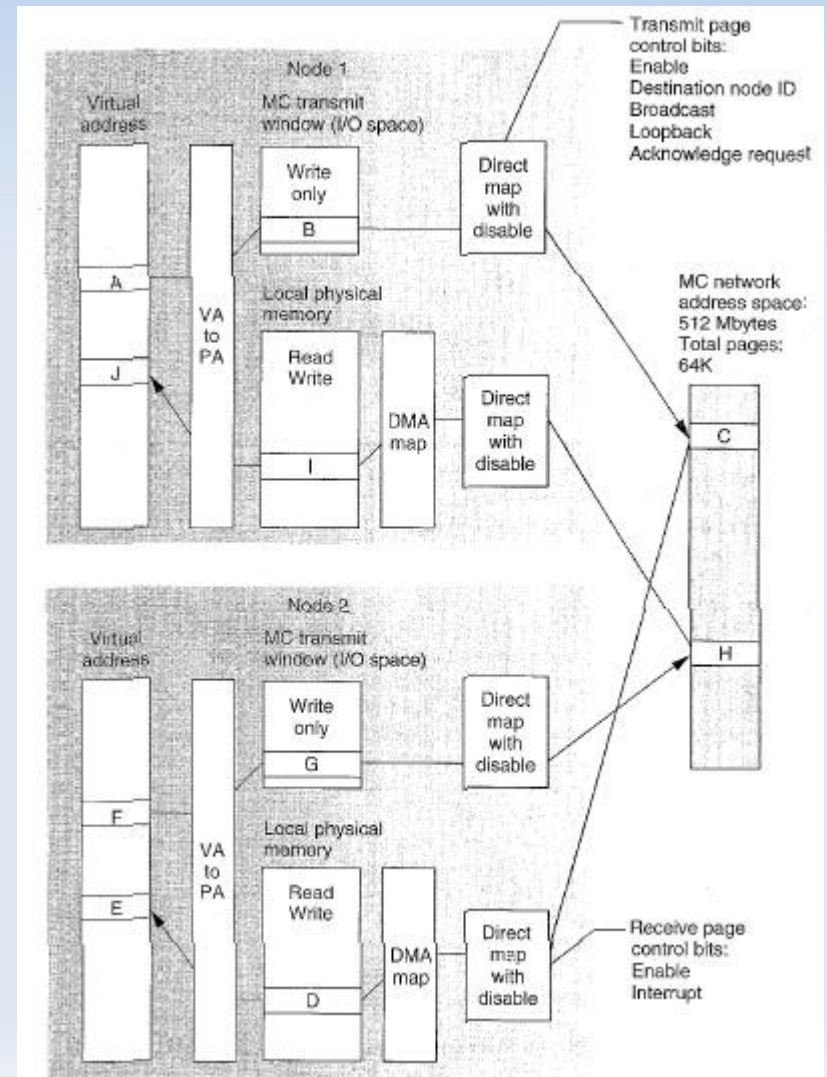
- Shared-memory programming model
- Hardware-coherent machines
- Software techniques
- Low-latency remote-write networks
 - DEC Memory Channel

Cashmere-2L

- Coherence Algorithm for SHared MEmory aRchitectures
- Primary Goals
 - Exploit hardware shared memory locally
 - Software overhead for only necessary communication
- Hardware Interface
 - 8-node, 32-processor DEC AlphaServer
 - DEC Memory Channel

Memory Channel

- Low-latency remote-write network
- Memory mapping
 - MC adapter & network
 - Mappings
 - Loop-back
- Synchronization Req.

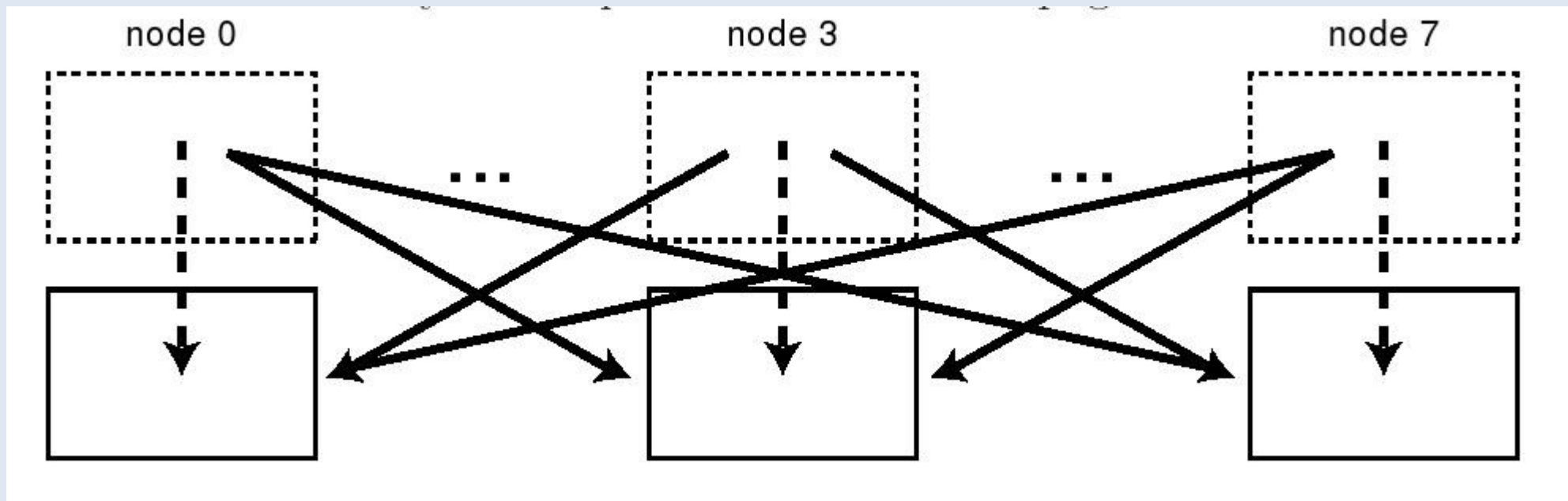


Overview

- Moderately lazy RC
- Home-based protocol
- Directory-based coherence
- Exclusive mode
- Hardware Coherence exploitation
- Hardware-Software coherence interaction
 - Timestamp
 - Two-way diffing & shutdown

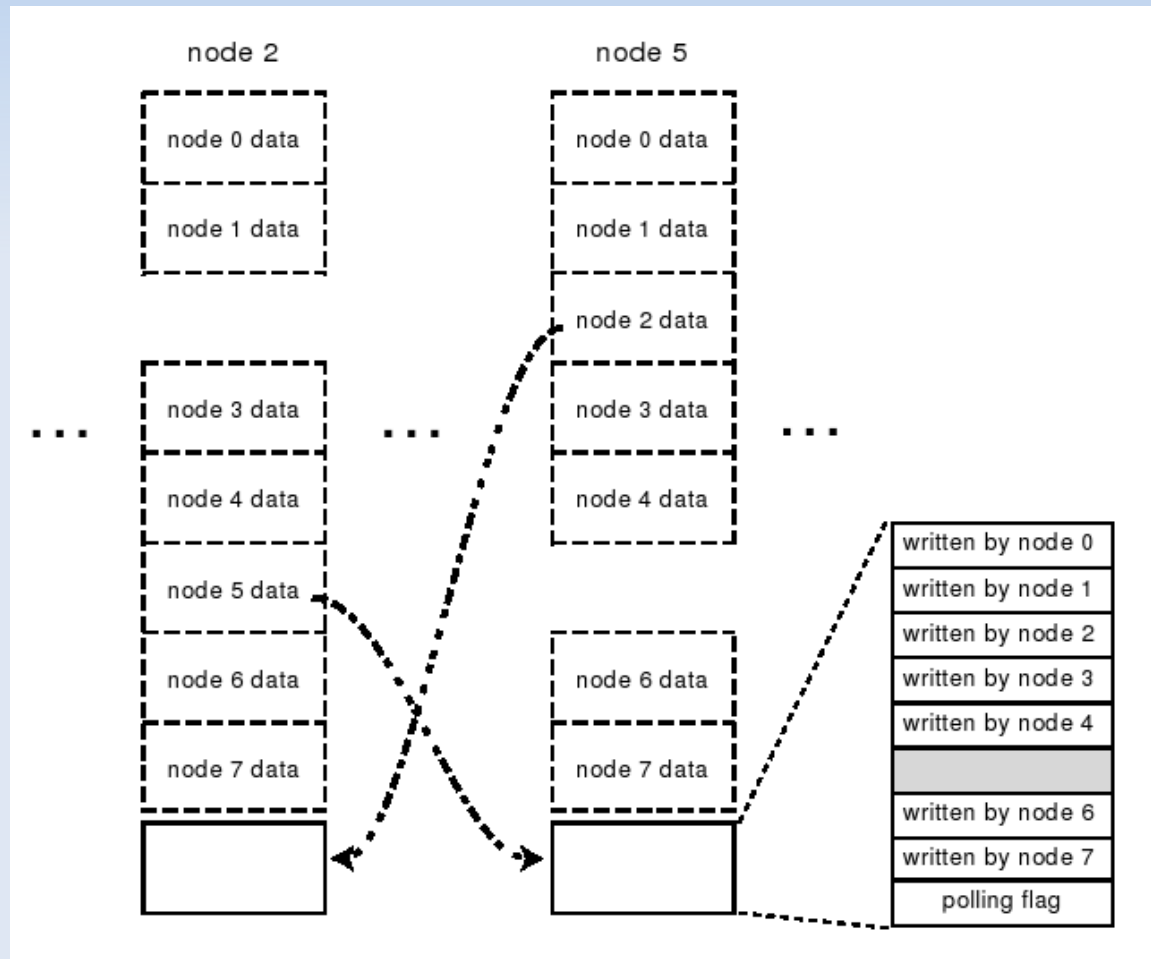
Directory-Based Coherence

- Global directory
- Synchronization objects
- Second-level directory



Directory-Based Coherence

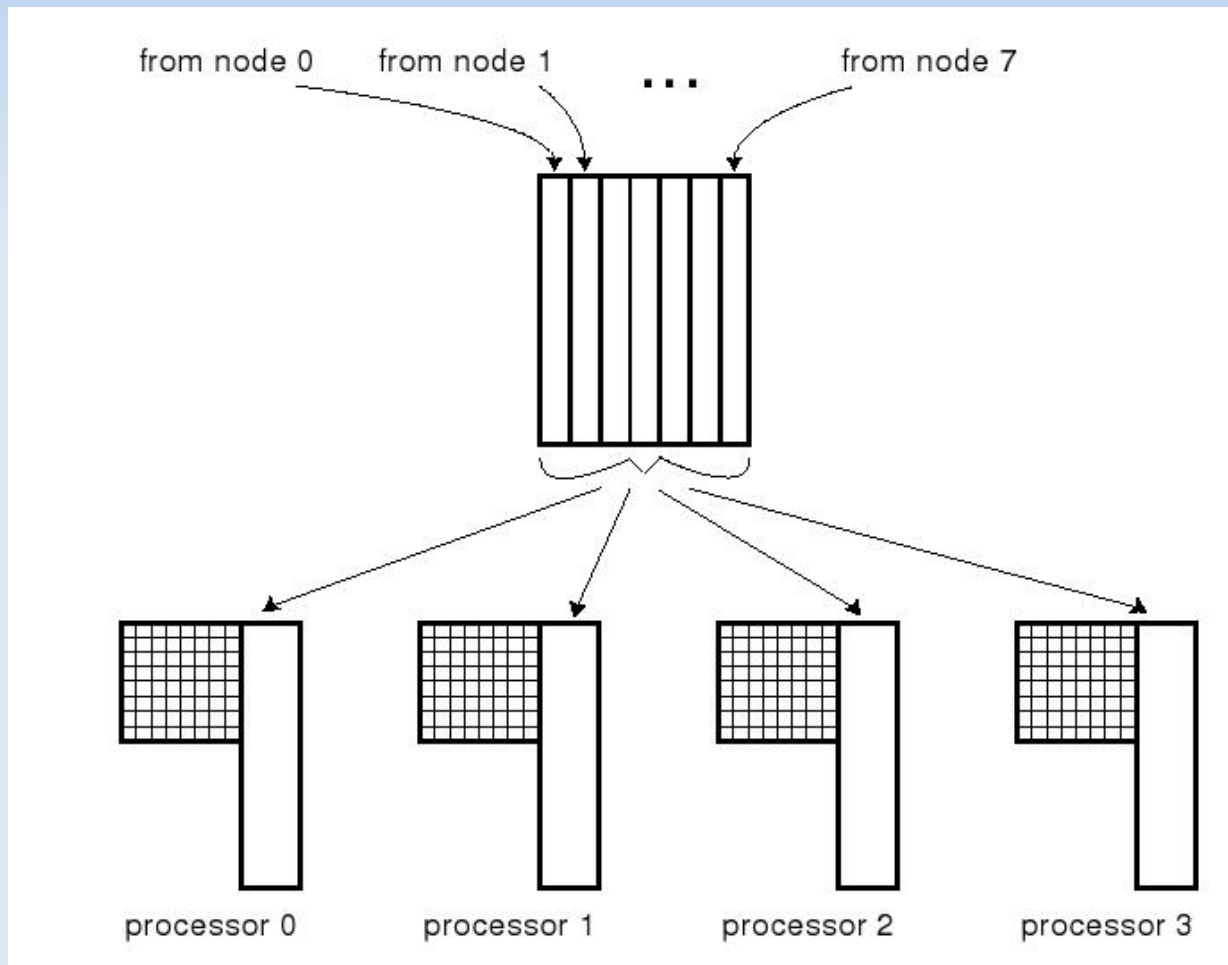
- Other global meta-data



- Private to node

Directory-Based Coherence

- Write notice lists



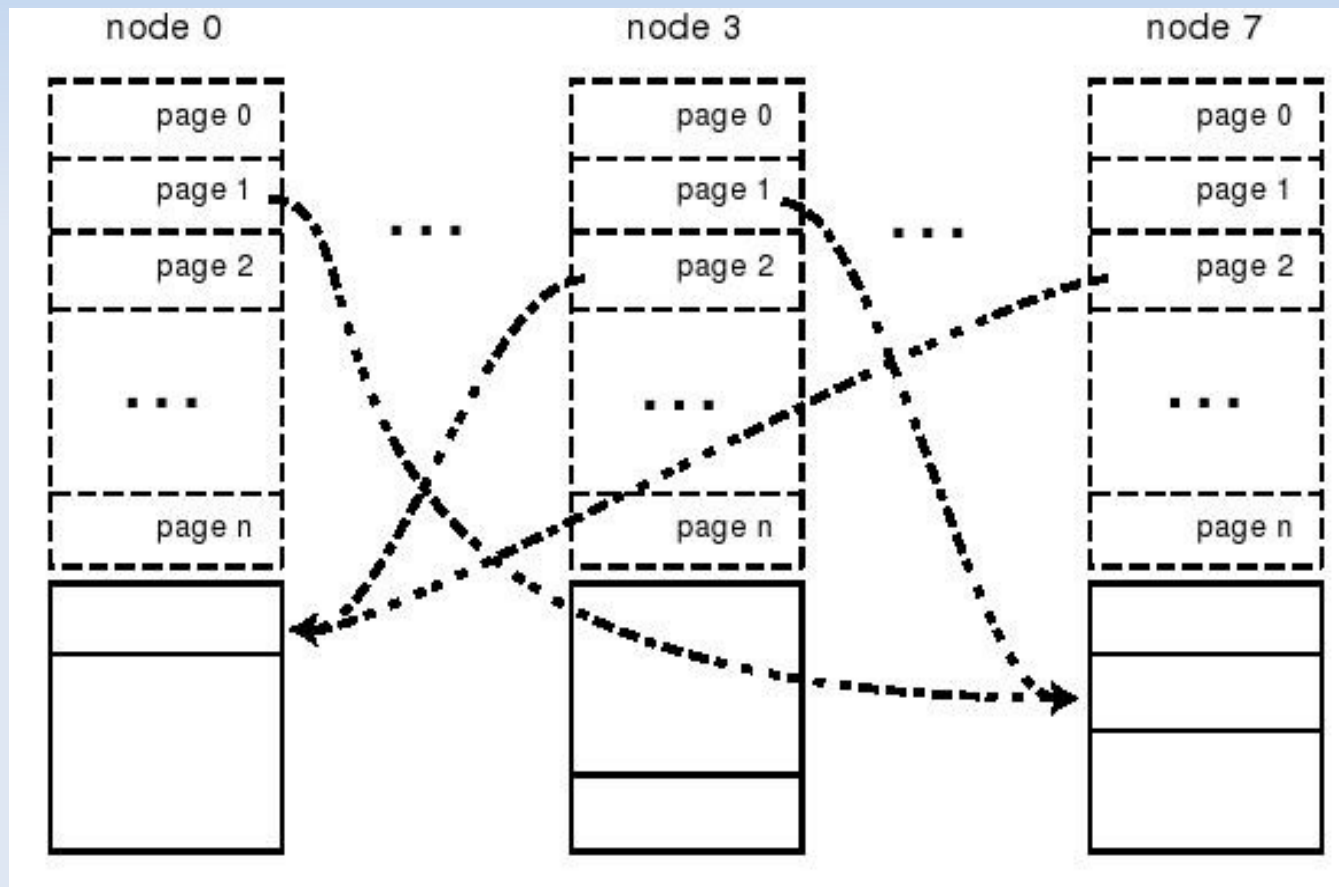
Directory-Based Coherence

- Explicit requests
 - Interrupt
 - Polling
 - Code

```
label:
    ldq    $7, 0($13)        ; Check poll flag.
    beq    $7, nomsg         ; If message,
    jsr    $26, handler      ; call handler.
    ldgp   $29, 0($26)       ; restore global pointer.
nomsg:
```

Home-Based Protocol

- Implementation



Home-Based Protocol

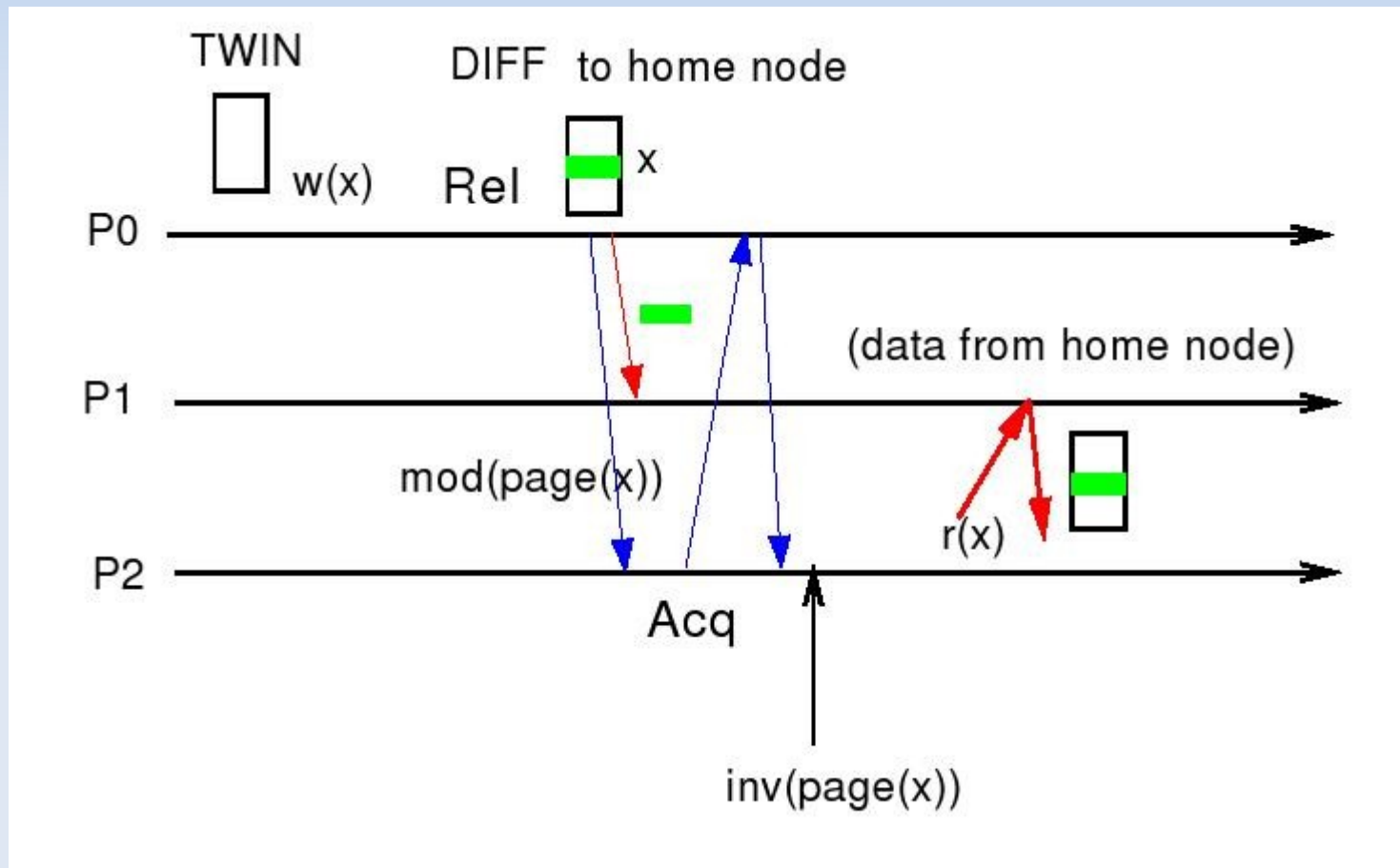
- Home node selection
 - Initialize
 - Relocate
- Superpage

Protocol Actions

- Page Faults
 - Directory update
 - Read & Write faults
- Acquires
 - Invalidation
 - Process write notices
- Releases
 - Page flush
 - Send outgoing diffs and write notices

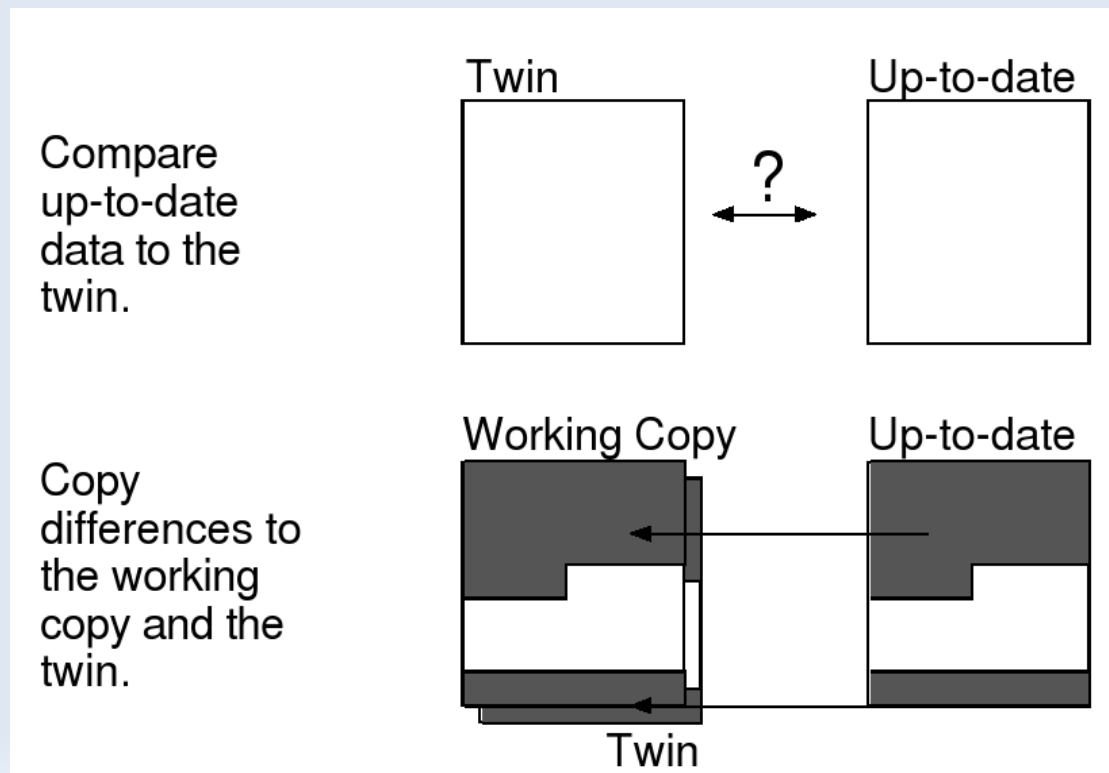
Protocol Actions

- Example



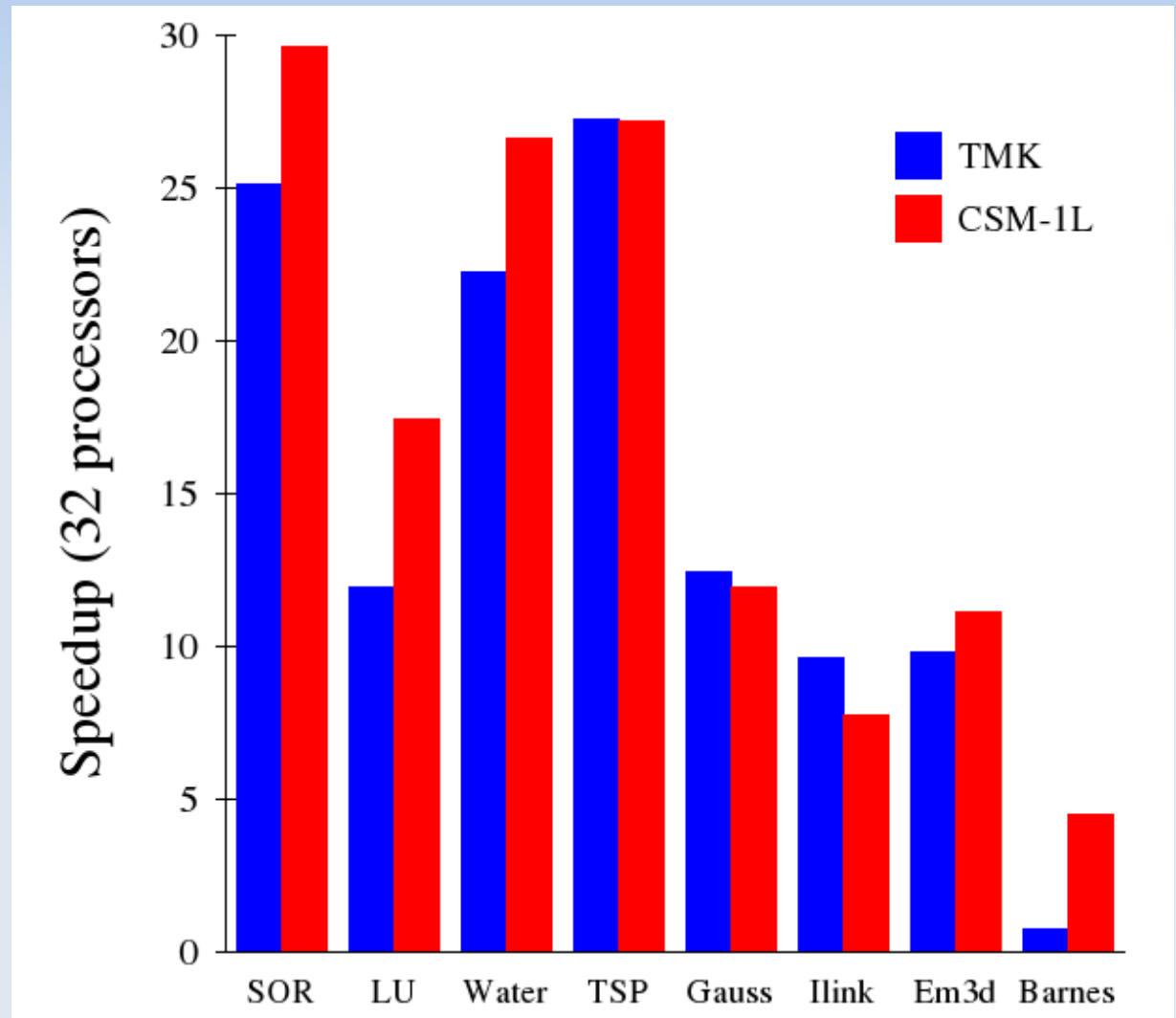
Protocol Actions

- Twin Maintenance
 - Outgoing diffs
 - Incoming diffs

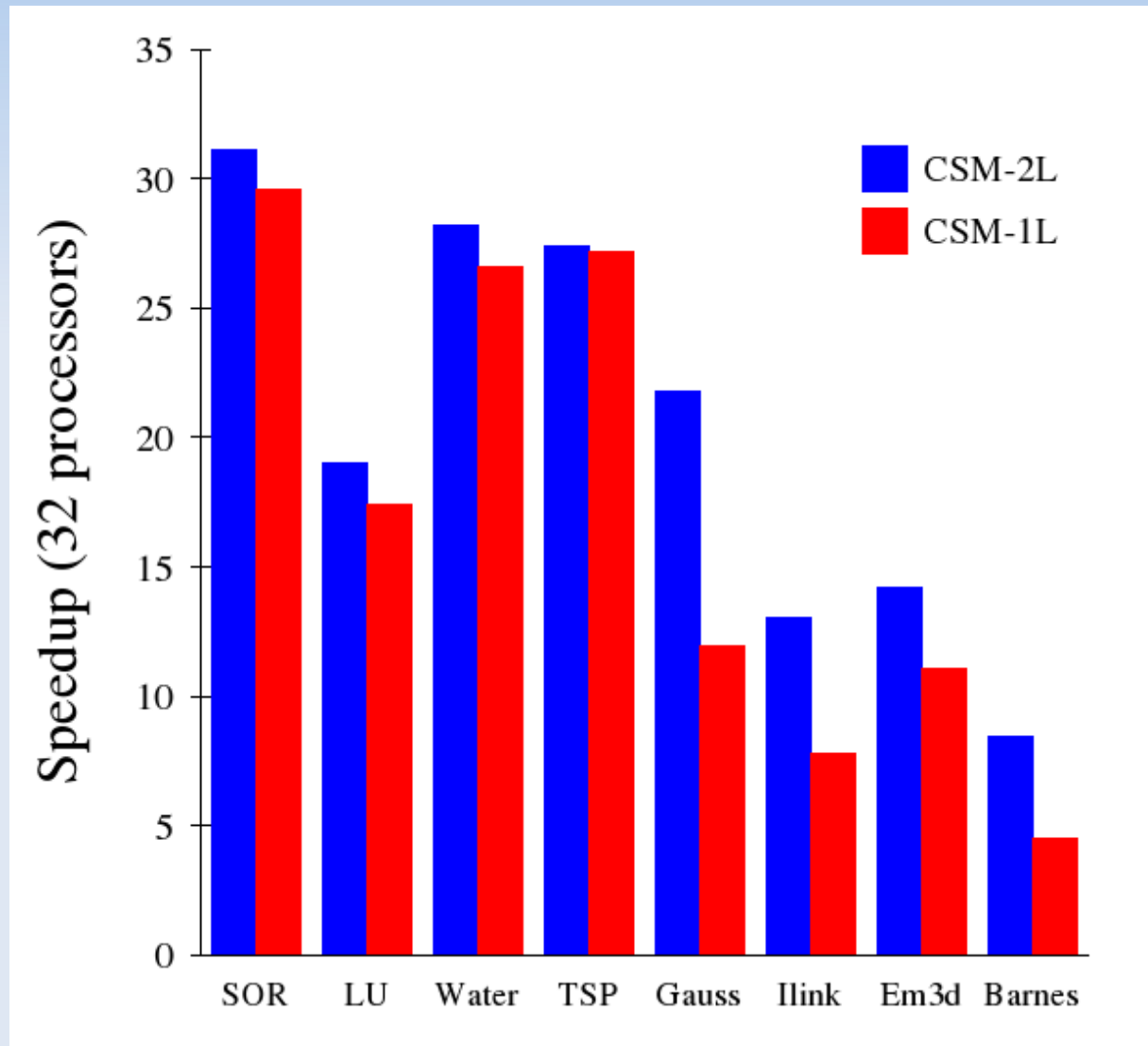


Cashmere-1L VS TreadMark

- Cashmere-1L
- Performance Comparison
- Reasons



Effect of Clustering



Summary

- Motivation and Background
- Hardware Interface (MC)
- Implementation Details
 - Home-based
 - Directory-based
 - Protocol Actions
 - Highly asynchronous
- Comparison to TreadMarks