Design of MPI Passive Target Synchronization for a Non-Cache-Coherent Many-Core Processor

27th PARS Workshop, Hagen, Germany, May 5 2017

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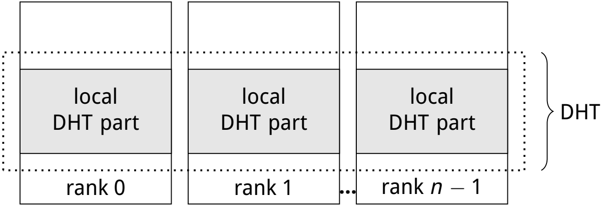

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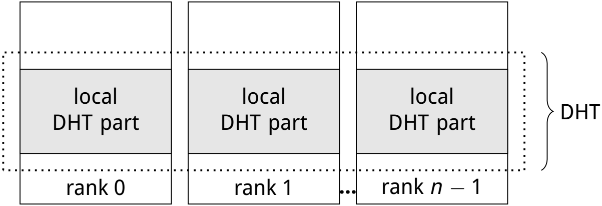

- accessing distributed data:
  - hash function returns arbitrary process and address
  - difficult to program with two-sided message passing
  - MPI passive target one-sided communication to the rescue
  - **synchronization required**

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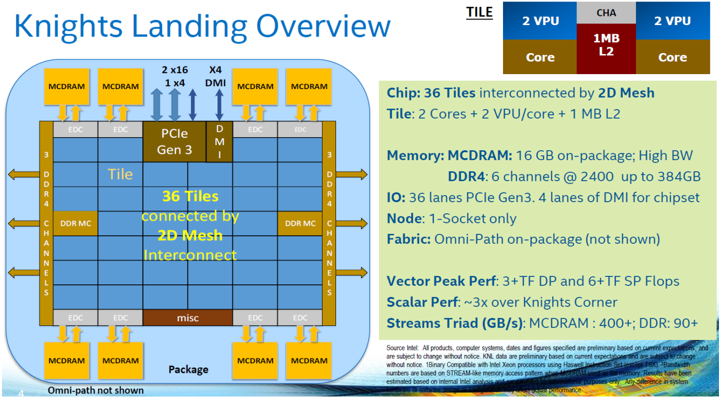

https://www.extremetech.com/wp-content/uploads/2016/04/KnightsLanding.png

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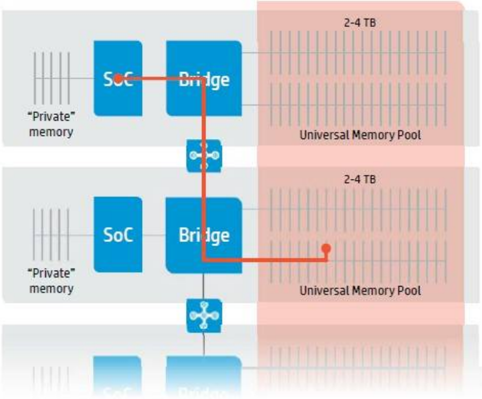
  - Intel Knights Landing: coherent multi-socket systems not feasible
  - HPE "The Machine", EuroServer: coherence islands



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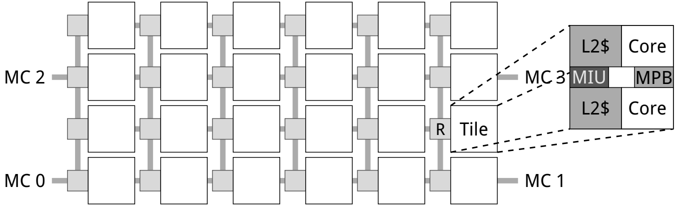
Research Platform

- nCC many-core research system: Intel SCC
  - 48 Pentium cores with L1/2 caches
  - **no HW cache coherence**



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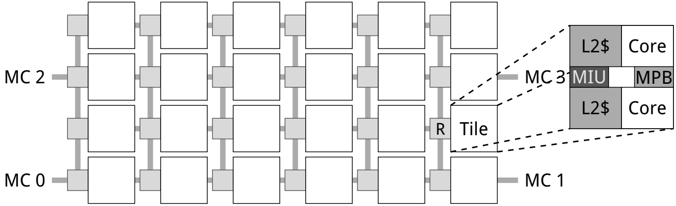


- This talk: **design of synchronization** on nCC platform.

Agenda

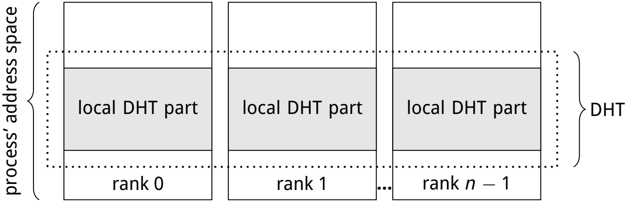
MPI Passive Target One-Sided Communication

Design for Passive Target Synchronization on the SCC
- Data Structures and Algorithms
- Data Placement

Outlook and Future Work

MPI One-Sided Communication

- process memory exposed via **windows**



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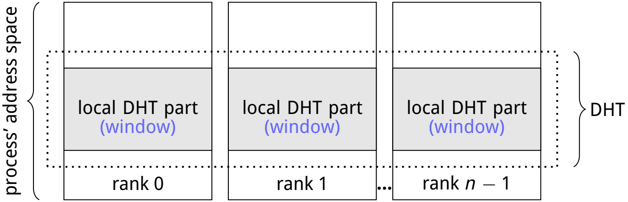

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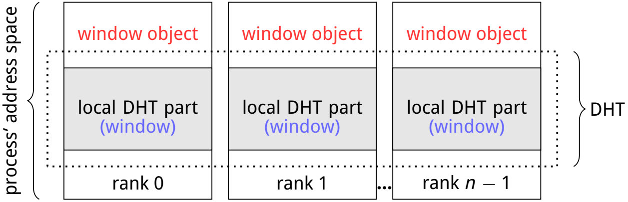

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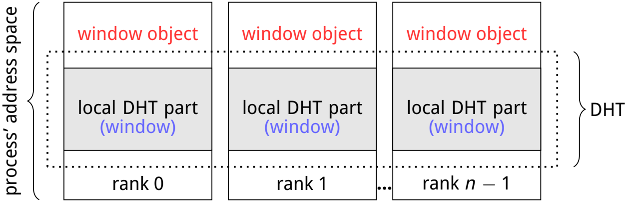

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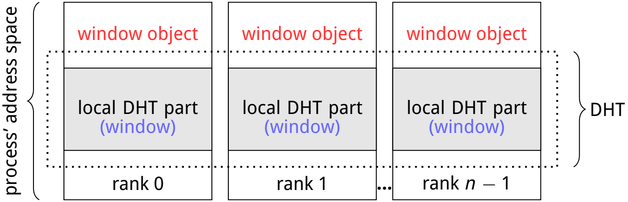

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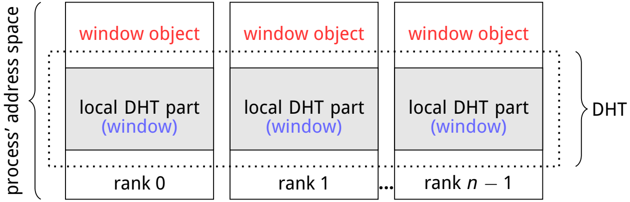

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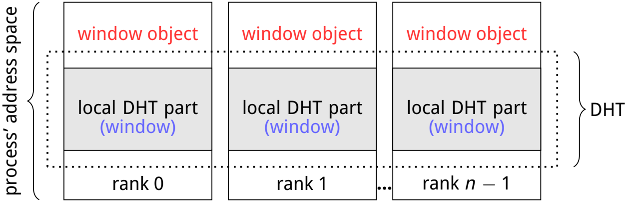

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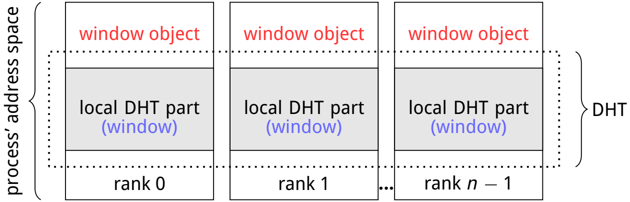

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  - explicit synchronization required

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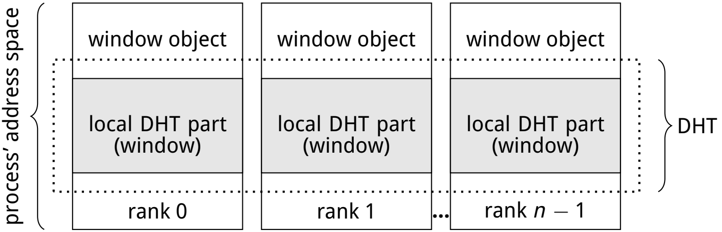
MPI defines two lock types:

shared concurrent accesses on target window allowed

exclusive prevent concurrent accesses on same target window

Distributed Hash Table with MPI OSC



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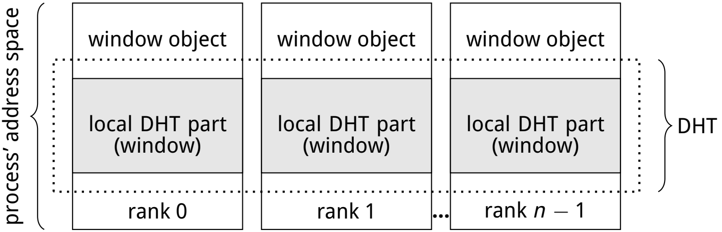

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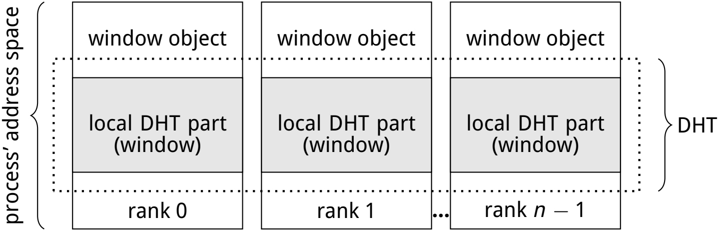

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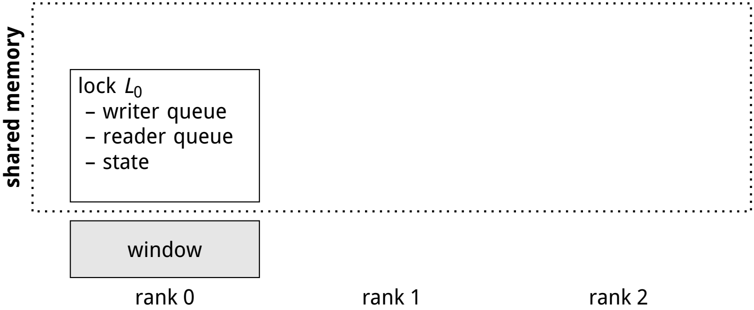
→ design of MPI passive target synchronization scheme with R&W semantics for SCC

Data Structures for Synchronization

use lock data structure as proposed by Mellor-Crummey/Scott ('91)



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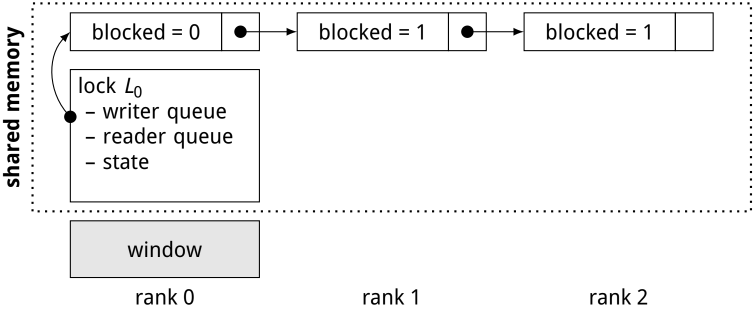

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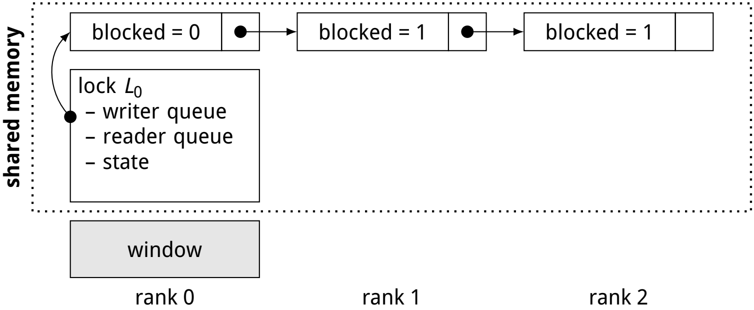

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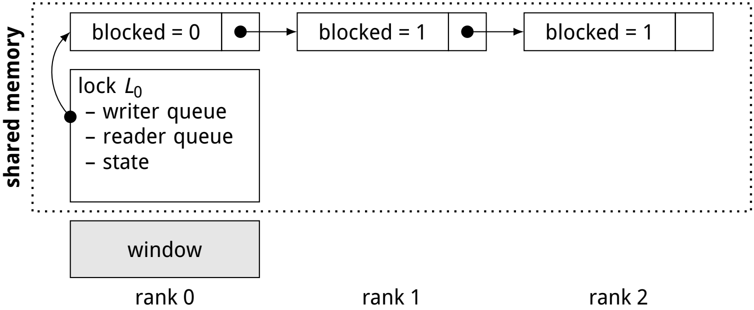

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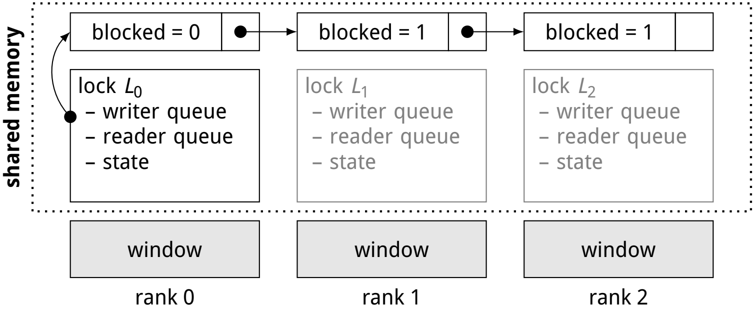
- one lock variable per process and window



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Writers

start_write	blocks when readers are active
end_write	wake up next writer (if any) or all waiting readers

R&W Synchronization inside MPI Library

```
MPI_Win_lock(type, target_rank, win_obj)
{
  entry = alloc_list_entry();

  win_obj.entry[target_rank] = entry;
  win_obj.entry[target_rank].lock_type = type;

  if (type == SHARED)
    start_read(win_obj.lock[target_rank], entry);
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unlock operation straight forward

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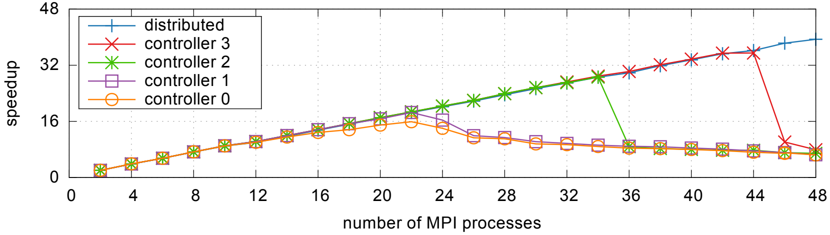

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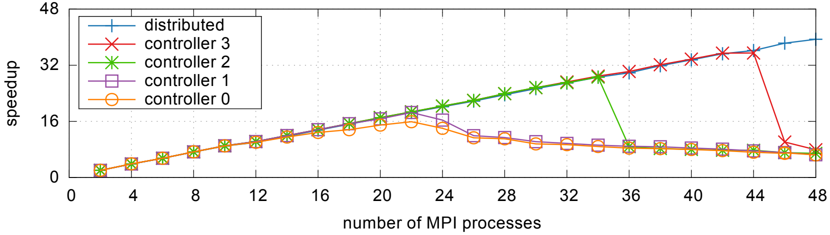

- bring spinning object close to process/core → allocate list entry in closest memory controller → **local uncached spinning**

Discussion

design characteristics:

- **concurrent window access**: one lock per window and process
- **per-window Readers & Writers semantic**
- **contention avoidance**: spin on local object only
- **truly passive**: no participation of the remote process in synchronization operations and communication
  Christgau, Schnor: Exploring One-Sided Communication and Synchronization on a non-Cache-Coherent Many-Core Architecture. Concurrency and Computation: Practice and Experience. 2017

Summary and Outlook

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