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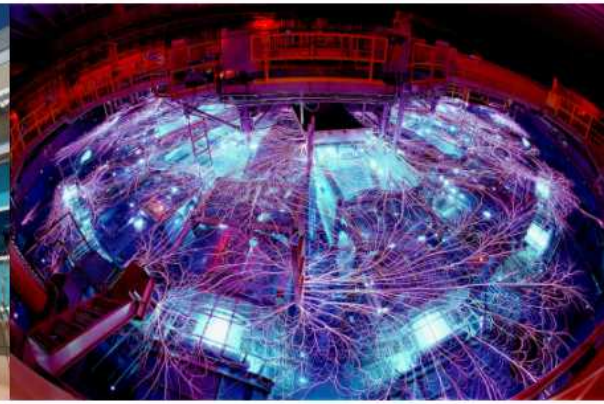

Reducing E3SM Communication through Task Mapping

J. Austin Ellis & Karen D. Devine

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Task Mapping Background

Objective: Minimize *distance* messages must travel by "mapping" frequently communicating MPI tasks to nearby nodes in allocation.

Extreme-scale systems:

- Allocations may be sparse and spread far across the network
- Communication messages can travel long routes
- Network links may become congested by competing traffic

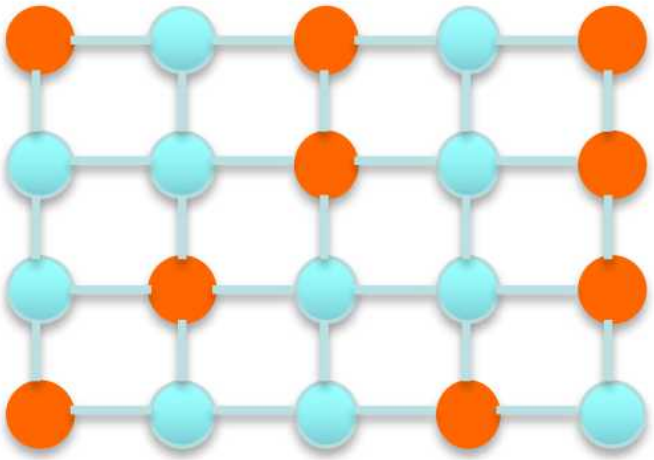

Figure: Non-contiguous node allocation in a mesh network.

Previous Results I

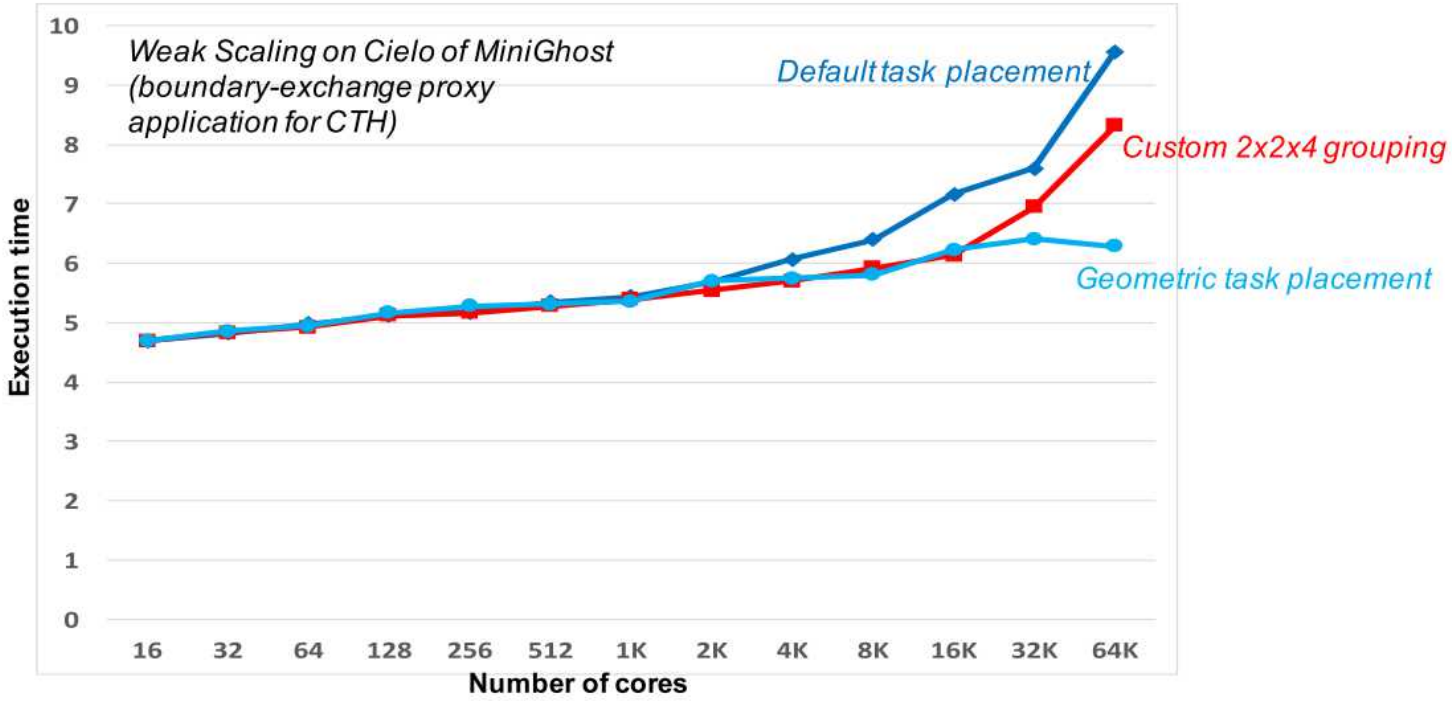

Figure: Scaling study of task mapping for the miniapp MiniGhost on Cielo (torus).

Previous Results II

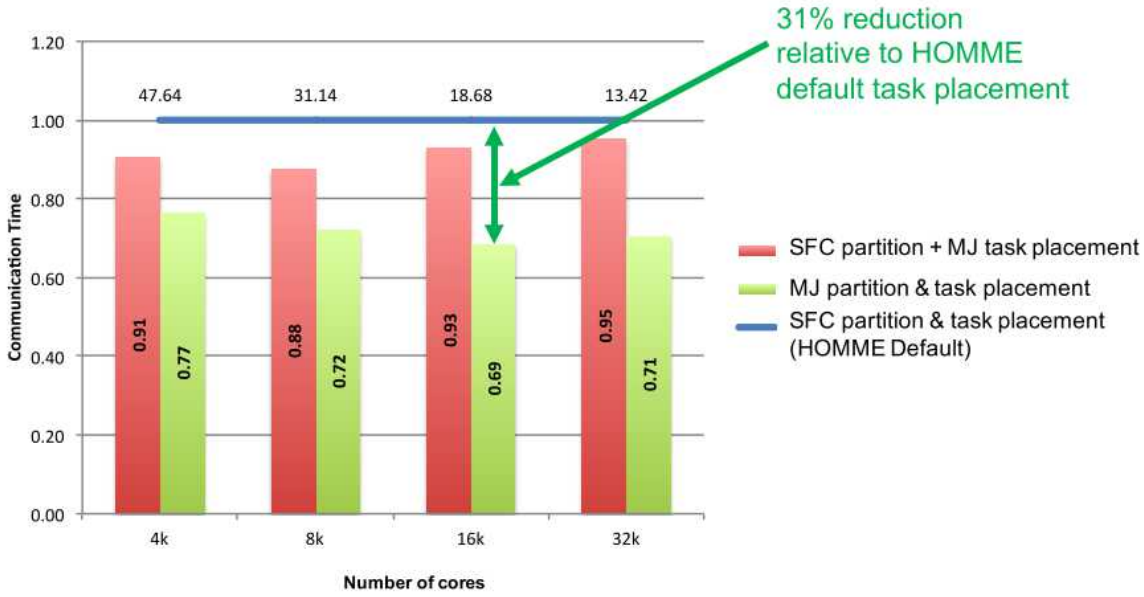

Figure: Communication reduction in HOMME through task mapping on Mira (contiguous torus).

- Reduced HOMME communication by 18% on Titan (torus) with 86k cores [Deveci et al., 2019]

Zoltan(2) and Partitioning [Boman et al., 2012]

Zoltan(2):

- Trilinos package for partitioning, load balancing, ordering, coloring, and other graph/combinatorial algorithms

Task Mapping Method:

- Represent both the processor allocation and the application communication as graphs or set of coordinates
- Partition both representations using Zoltan
- Map application parts to processor parts for reduced communication

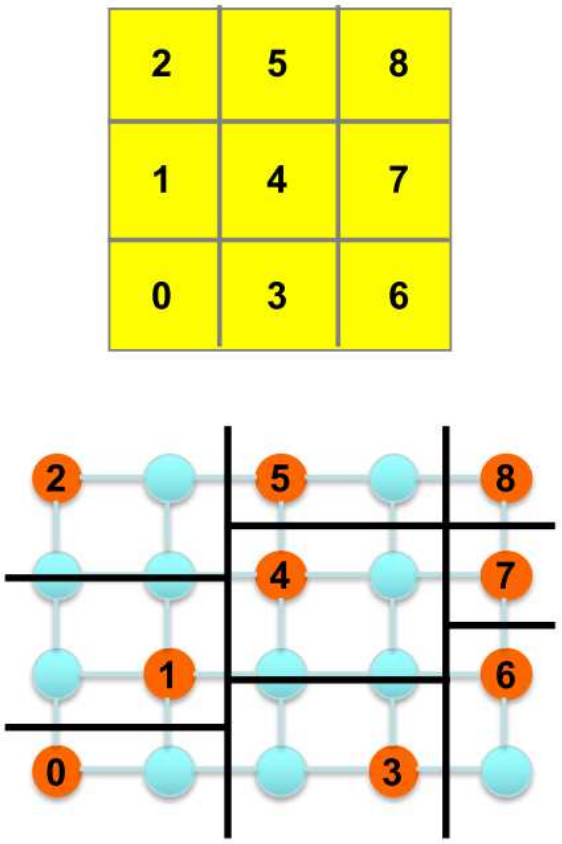

Figure: Partitioning of tasks (above) and processor allocation (below).

Cray Aries Interconnect (Dragonfly) and Coordinate Representation

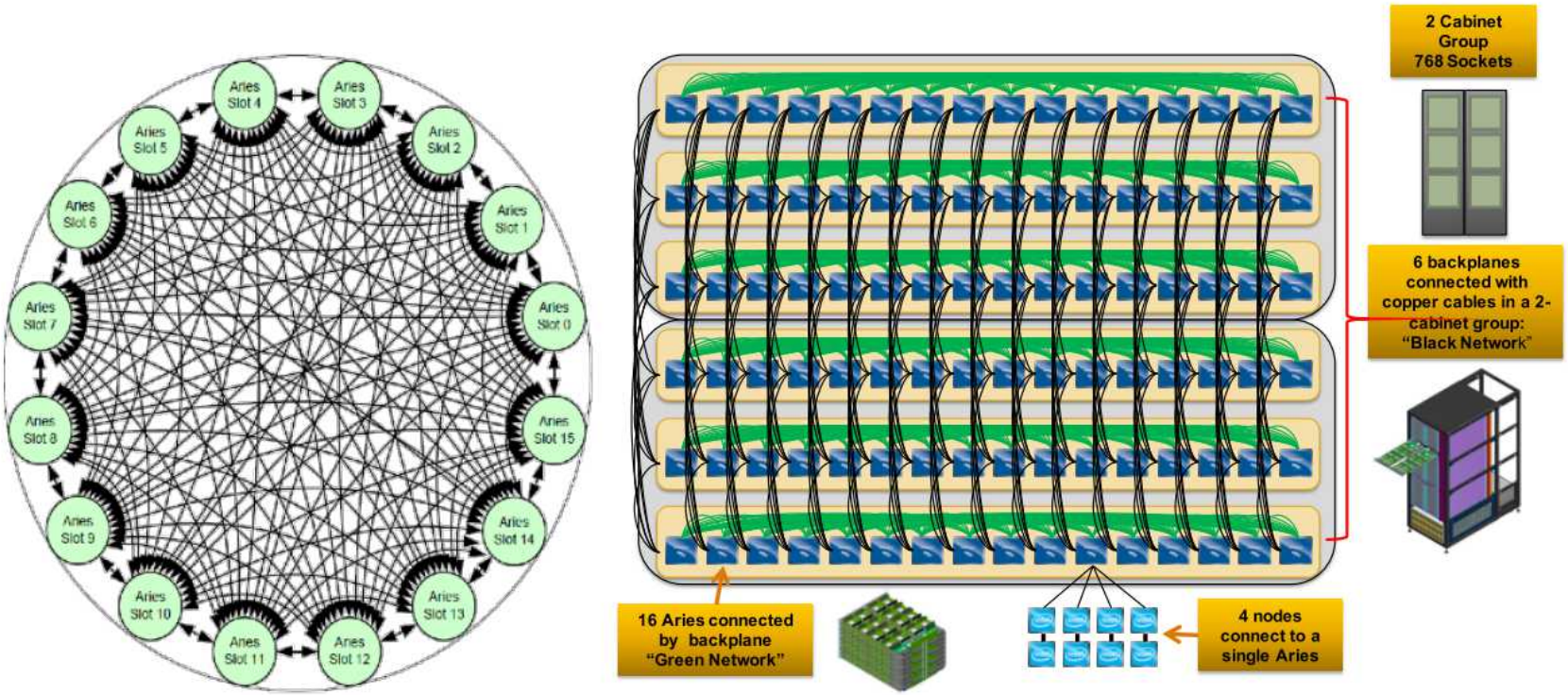

Figure: Group all-to-all **(x)** and intergroup connection **(y, z)** of dragonfly network. *Image Credit: Jeff Brooks, Cray Inc.*

E3SM Task Mapping

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Coupled compset method:

- Use AChax [Roth, 2018] tool (ORNL) to recover application communication graph (during "short" independent E3SM run)
- During full E3SM run:
  - Load application graph
  - Obtain and transform `rcalib` network coordinates
  - Partition both representations and perform mapping
  - Reorder global communicator with mapping solution

Advantages:

- Application and configuration agnostic
- Diagnostic application run can be done offline
- Non-invasive

References

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