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Adjustable Contiguity of Run-Time Task Allocation in Networked Many-Core Systems

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Outline

- Introduction.
- Motivation.
- Contiguity Adjustable Square Allocation.
- Results.

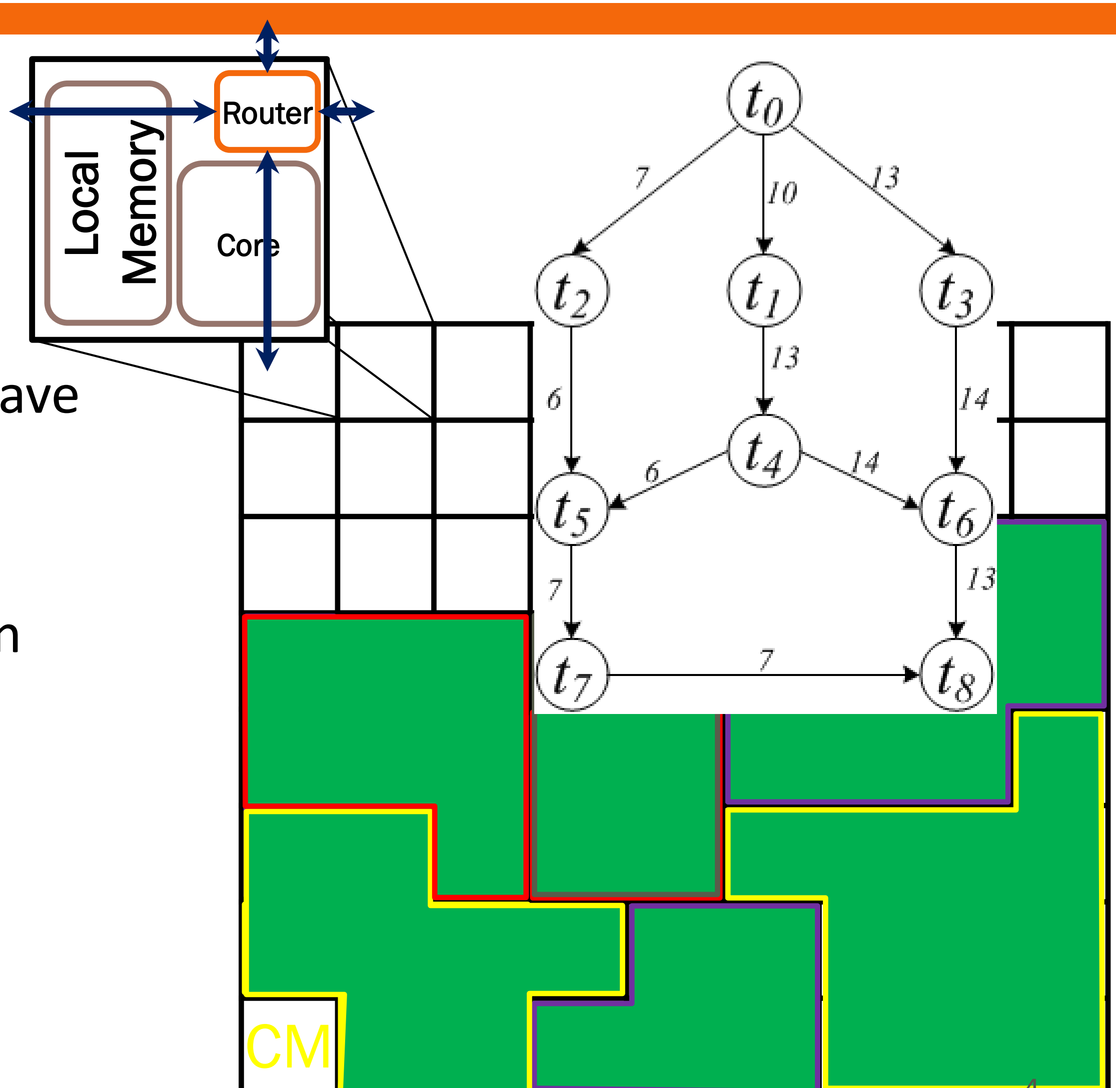
Introduction

Source code: http://users.utu.fi/mofana/CASqA.html

Introduction

- Many-Core Systems
  - Connected via NoC
- Applications: set of communicating tasks.
- Applications enter and leave the system at Run-Time.

- **Question:** How to map an Application?
- **Answer:** Contiguously
  - Less network power
  - Less network congestion



Source code: http://users.utu.fi/mofana/CASqA.html

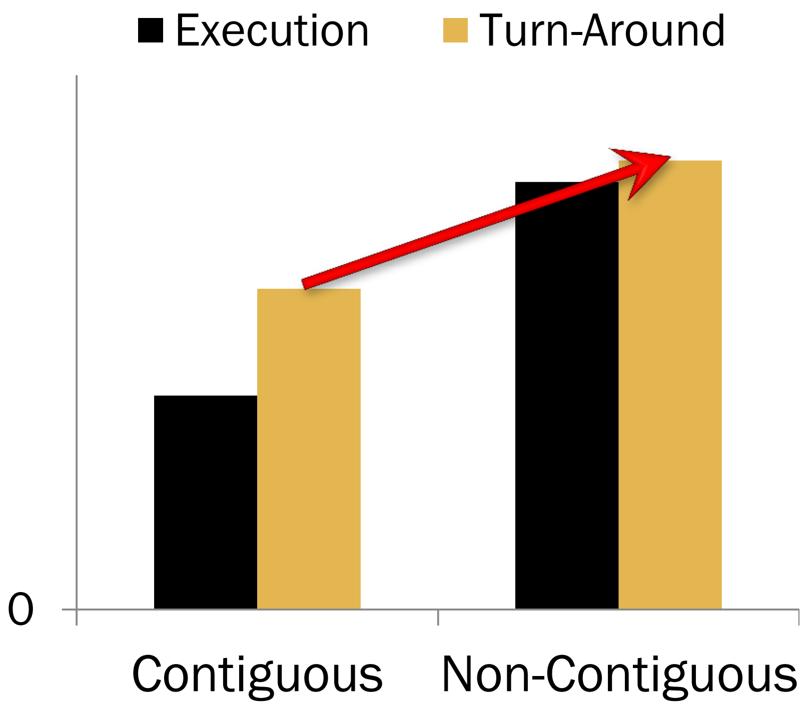
Motivation

Source code: http://users.utu.fi/mofana/CASqA.html

Motivation

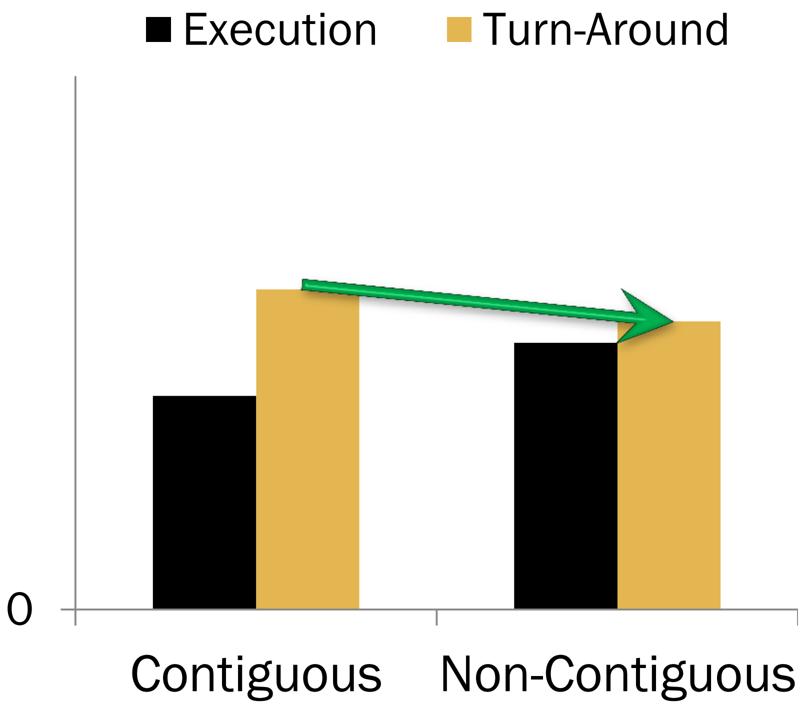
Store-and-Forward

Forced to limit the system to **only contiguous** allocations.



Wormhole

Non-contiguous allocation: **higher throughput** with **more network power**



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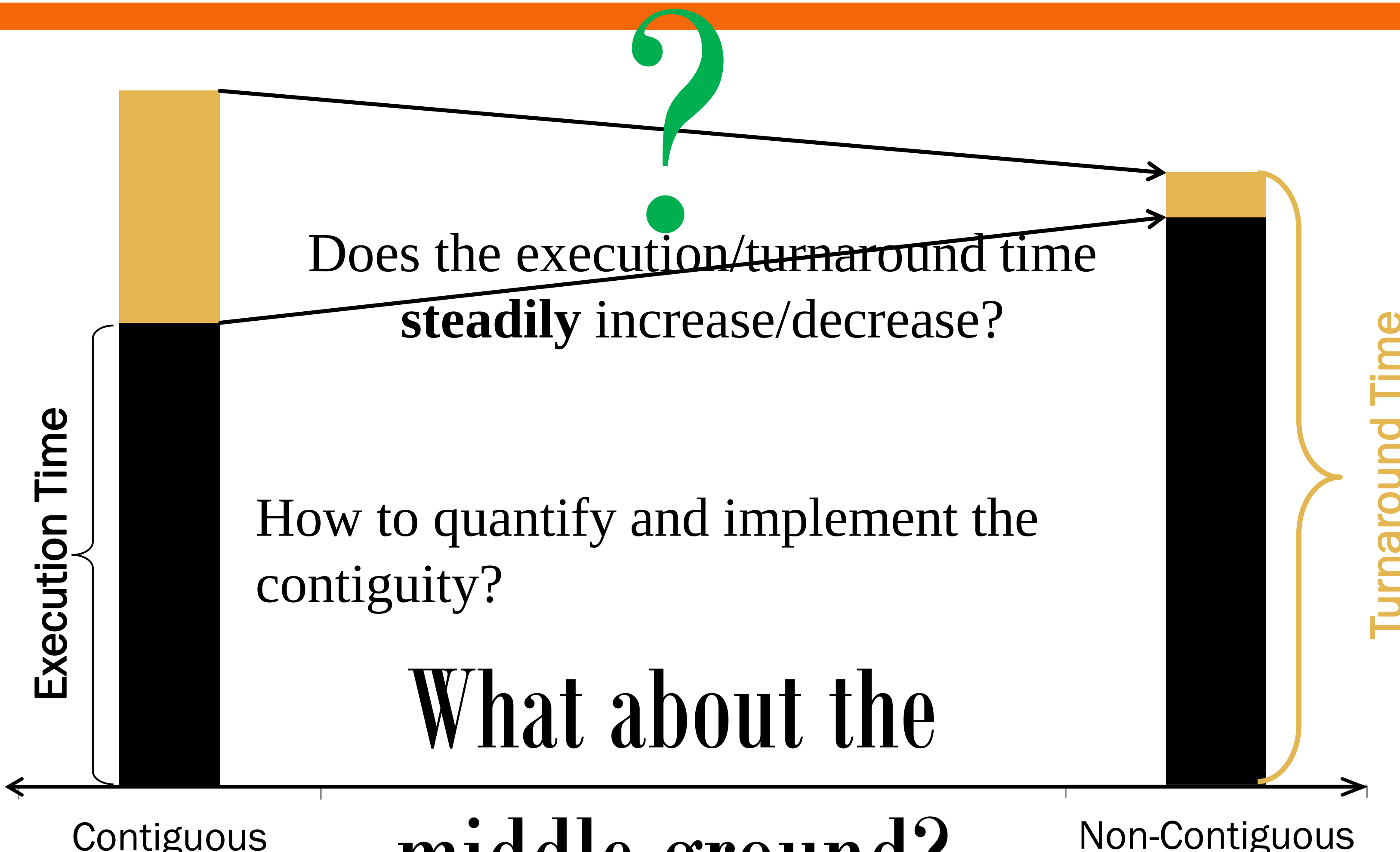
Motivation



Does the execution/turnaround time **steadily** increase/decrease?

How to quantify and implement the contiguity?

What about the middle ground?

Source code: http://users.utu.fi/mofana/CASqA.html

CASqA^{α}

Contiguity Adjustable Square Allocation

Source code: http://users.utu.fi/mofana/CASqA.html

CASqA$^{\alpha}$

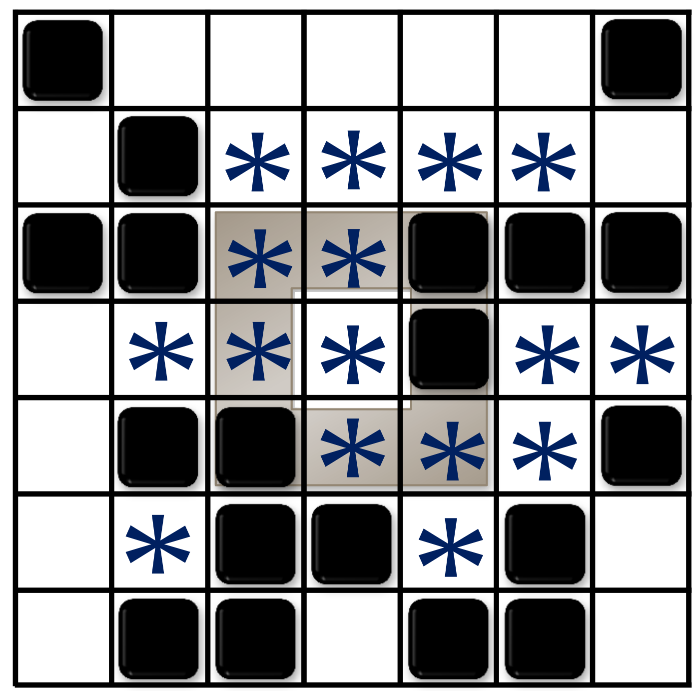
- $0.0 \leq \alpha \leq 1.0$:
  - level of “desired contiguity” / “allowed

α adaptively determines the maximum exploration radius.

contiguous solutions:

For an application with $|T|$ tasks:

1. Start from a first node
2. until $|T|$ available nodes are found:
   - Increase the exploration radius (allocation dispersion)



CASqA$^{\alpha}$

- R_{max}:
  - Maximum allowed exploration radius.
  - Initial value:

$$R_{max} = \left\lfloor \frac{\left\lceil \sqrt{|T|} \right\rceil}{2} \right\rfloor$$

- τ (expansion threshold):
  - Initial value: $|T| \times \alpha$.
  - **if** less than τ nodes are needed: R_{max} ++
  - τ ×= α on each increase.
- α=0 → τ=0 → don't explore beyond initial R_{max}.
- α=1 → τ=|T| → expand exploration until allocated.

Source code: http://users.utu.fi/mofana/CASqA.html

CASqA$^{\alpha}$- example

A 9-task application enters the system with the following run-time configuration.

- Initial

$$R_{max} = \left\lfloor \frac{\left\lceil \sqrt{|9|} \right\rceil}{2} \right\rfloor = 1$$

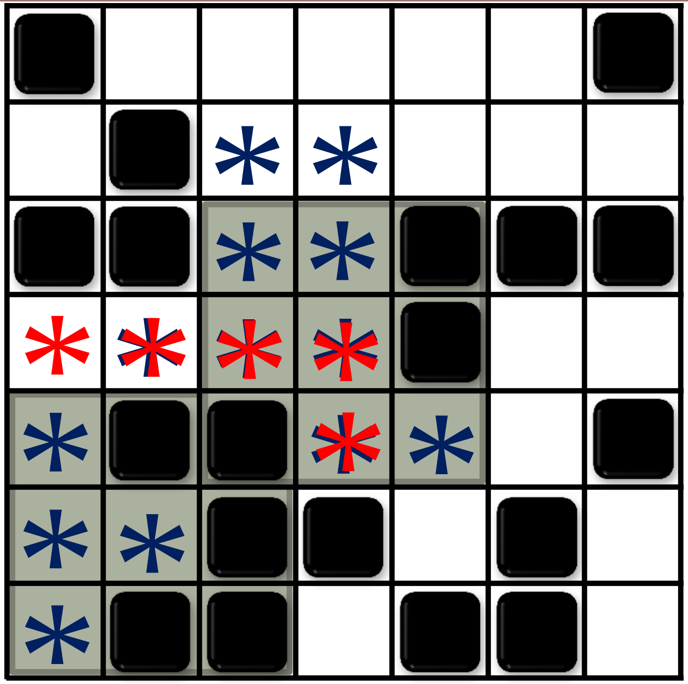
If $\alpha \geq 0.56$

➔ τ>5

nodes.

- α=0.5, initial τ=4.5.

R_{max}	τ	#alloc	#unalloc	expand
1	4.5	4	5	NO



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CASqA$^{\alpha}$- details

- ICEB is defined as a unified metric to model both congestion and energy dissipation of the network.
- ICEB metric is used by CASqA to arrange task placement within a selected area.
- First node of allocation is selected using our previous approach, SHiC.
- The source code can be downloaded at: : http://users.utu.fi/mofana/CASqA.html

Experimental Results

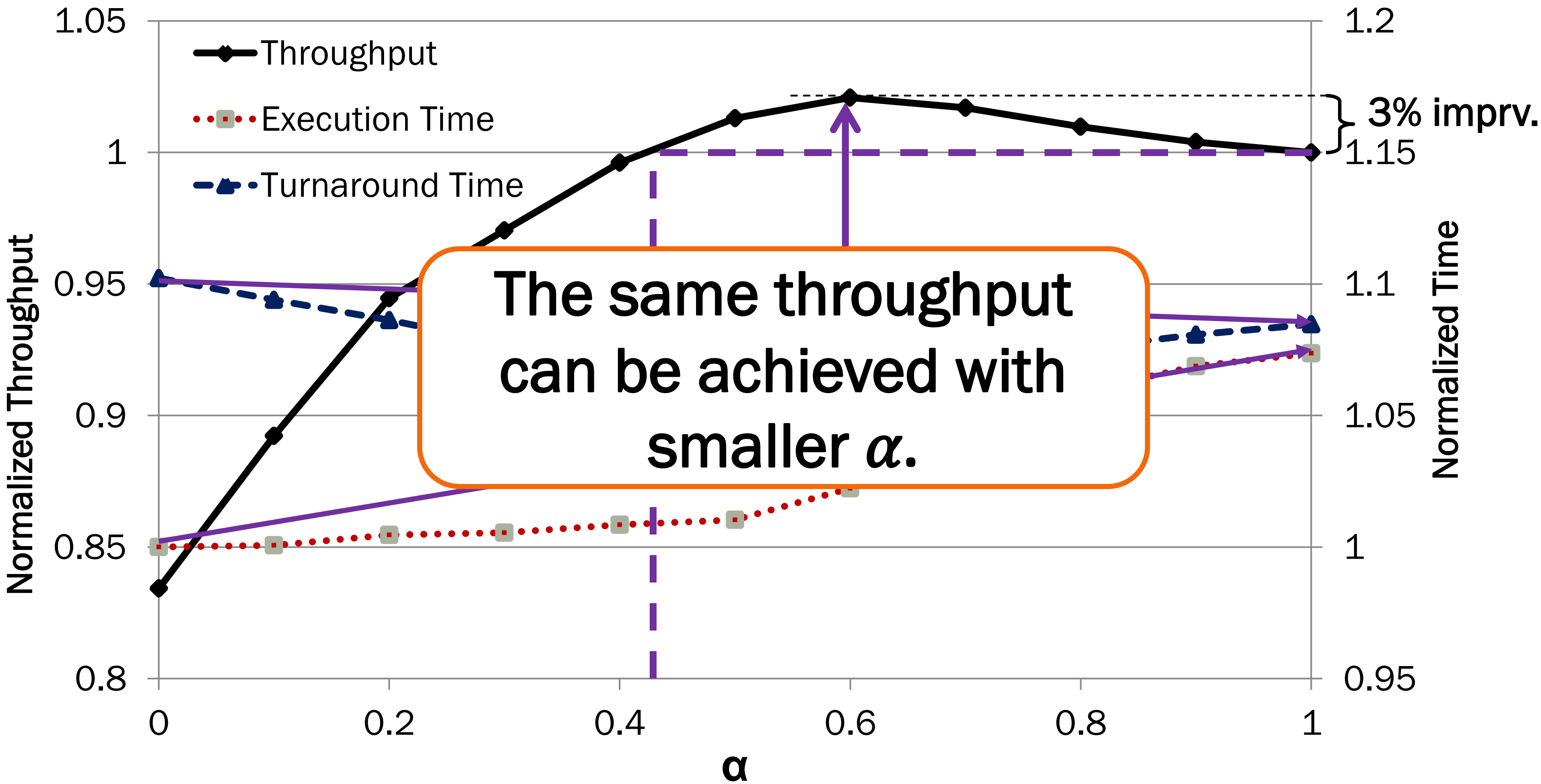
Source code: http://users.utu.fi/mofana/CASqA.html

Setups

- A 16x16 mesh interconnect.
- Cycle-Accurate System-C network model.
- Message-Passing.
- Communication-Intensive applications with 4 to 35 tasks.
- Random sequence of application.
- Upon a mapping failure, new *first nodes* are selected until the current application being mapped.

Source code: http://users.utu.fi/mofana/CASqA.html

Results- Throughput



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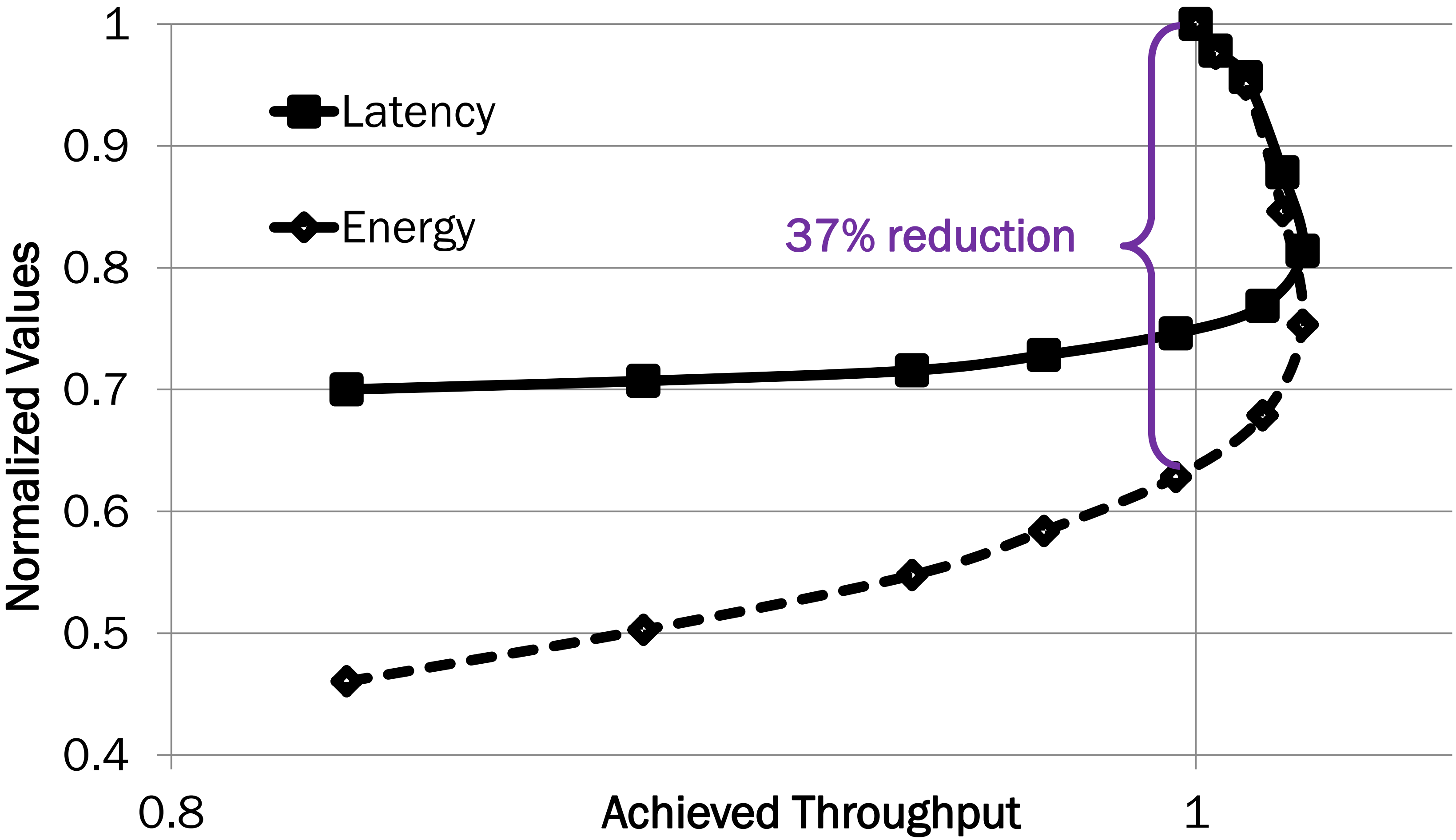
Results- Network Metrics



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Results- Comparison

Mapping	NMRD	E_{norm}	L_{avg}	%Congestion
$CASqA^{0.5}$	1.13	1	41	30.52
$CASqA^{0.5**}$	1.13	1.25	48.23	37.7
CoNA	1.69	1.48	50.32	38.4
NN	1.97	1.56	55.53	41.98

** arbitrary task placement within the selected area (without ICEB).

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Conclusion

- Investigation of the middle ground of the spectrum between strictly contiguous and unlimited non-contiguous allocation.
- The communication distance is yet a matter in todays on-chip networks.
- CASqA provides the tune to adjust the power/throughput optimal dispersion level, α.
- The optimum α depends on the application specifications.

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