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GVT-Guided Demand-Driven Scheduling in Parallel Discrete Event Simulation

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A New Thread Scheduling Approach: GVT-Guided PDES

1. Up to 50% performance improvements.
2. Over-subscription scenarios.

Presentation Outline

1. Background
2. Motivation
3. GVT-Guided PDES
4. Experimental Results

1) Background: PDES

Parallel Discrete Event Simulation (PDES):

- A Simulation Methodology
- High-Performance & High-Fidelity

R. M. Fujimoto et al. 2017. Parallel Discrete Event Simulation: The Making of a Field. Winter Simulation Conference (WSC).

2) Background: GVT

Global Virtual Time (GVT) Algorithms:

- Snapshot of a Parallel System
- Synchronous/Asynchronous

Alessandro Pellegrini and Francesco Quaglia. Wait-Free Global Virtual Time Computation in Shared Memory Time Warp Systems. In Proceedings of the 2014 IEEE 26th International Symposium on Computer Architecture and High Performance Computing (SBAC-PAD '14).

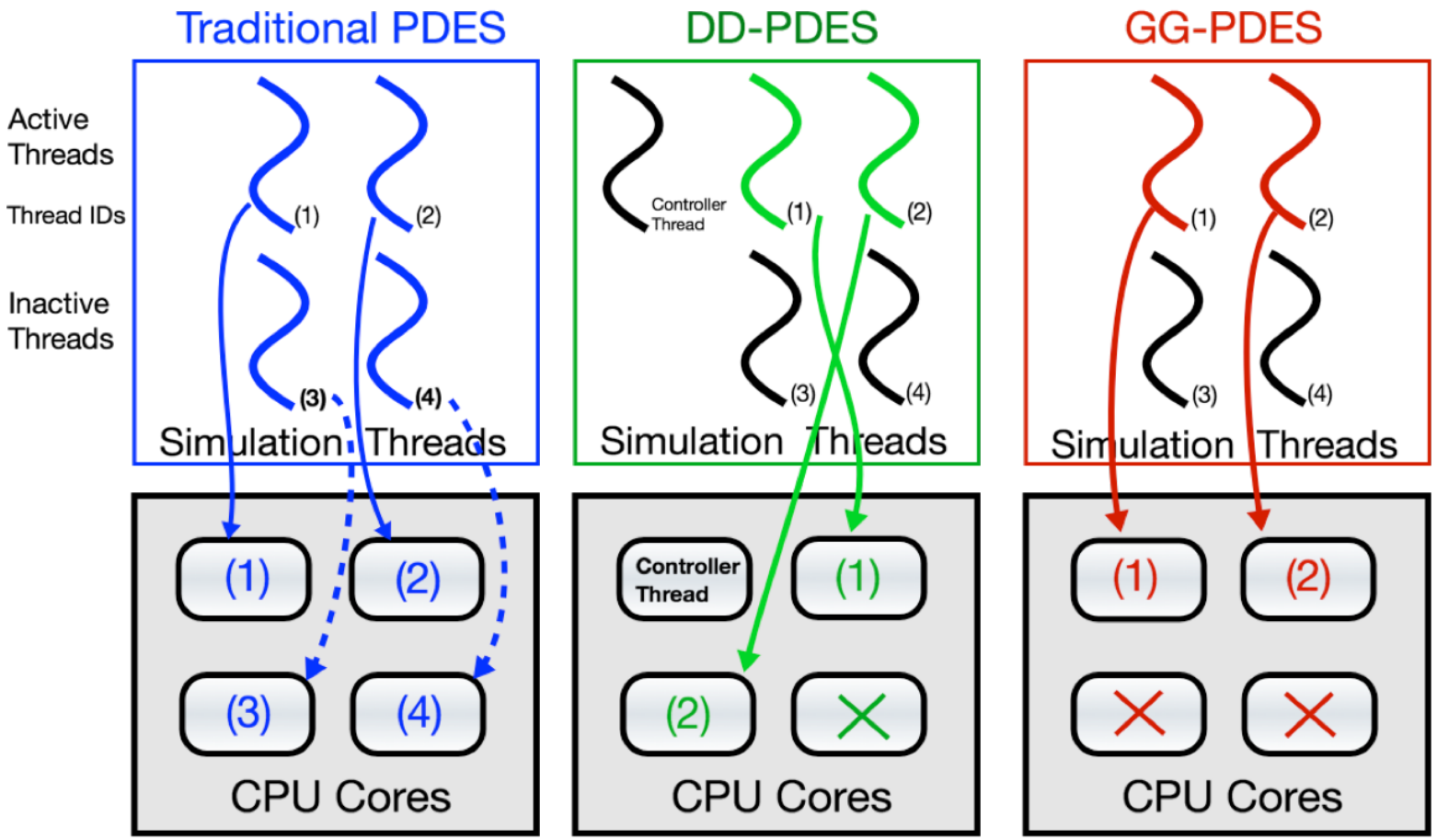
3) Background: DD-PDES

Demand-Driven (DD) Scheduling:

- Identify Threads as Active/Inactive
- Schedule Out Inactive Threads

Ali Eker et al. Demand-Driven PDES: Exploiting Locality in Simulation Models. In Proceedings of the 2020 ACM SIGSIM Conference on Principles of Advanced Discrete Simulation (SIGSIM-PADS '20).

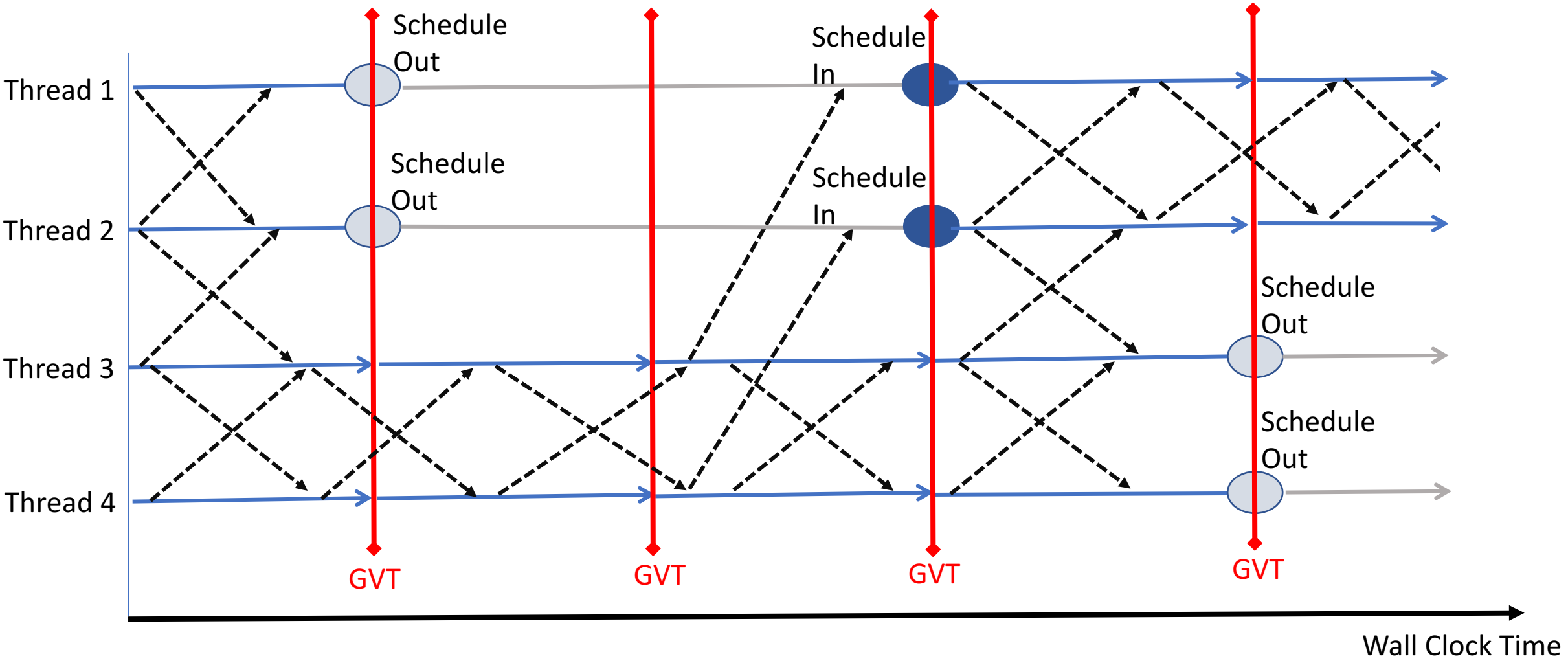
Motivation


Traditional PDES
DD-PDES
GG-PDES
Active Threads
Thread IDs
Inactive Threads
(1)
(2)
(3)
(4)
Controller Thread
Simulation Threads
CPU Cores

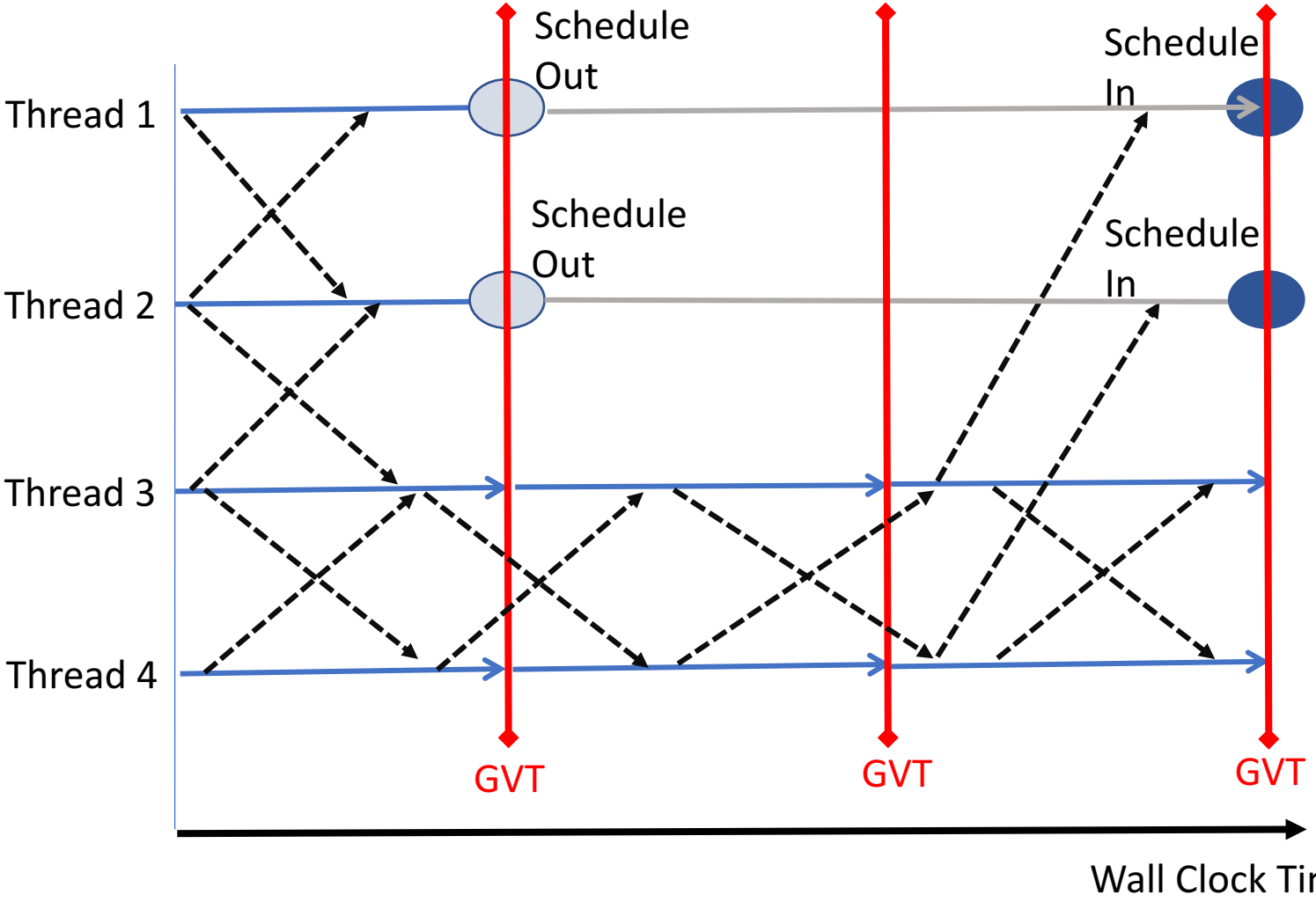
GVT-Guided PDES

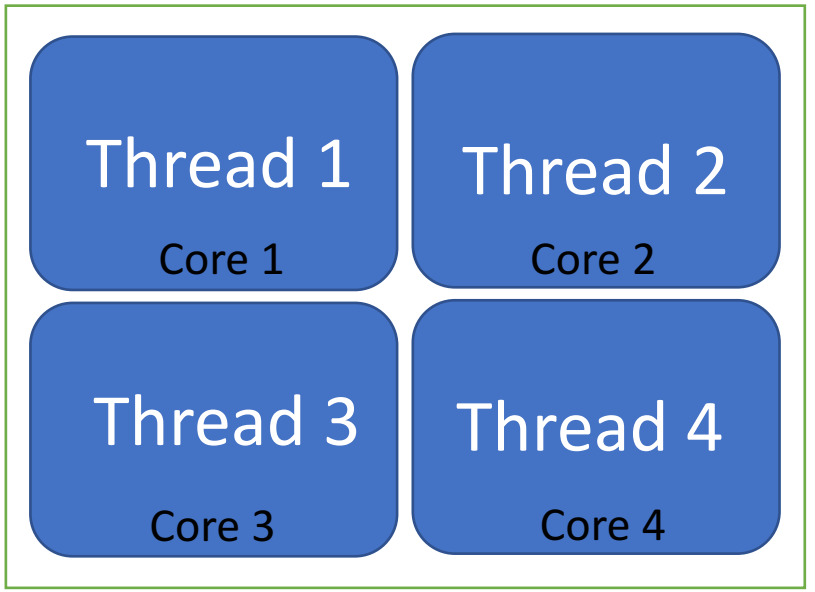
1. GVT-Guided Scheduling
2. Dynamic CPU Affinity

1) GVT-Guided PDES: Scheduling



2) GVT-Guided PDES: CPU Affinity





CPU Cores

Experimental Setup

- ROSS PDES Engine
- Intel's Knights Landing (KNL) Processor
- CentOS 7.2 with CFS Algorithm

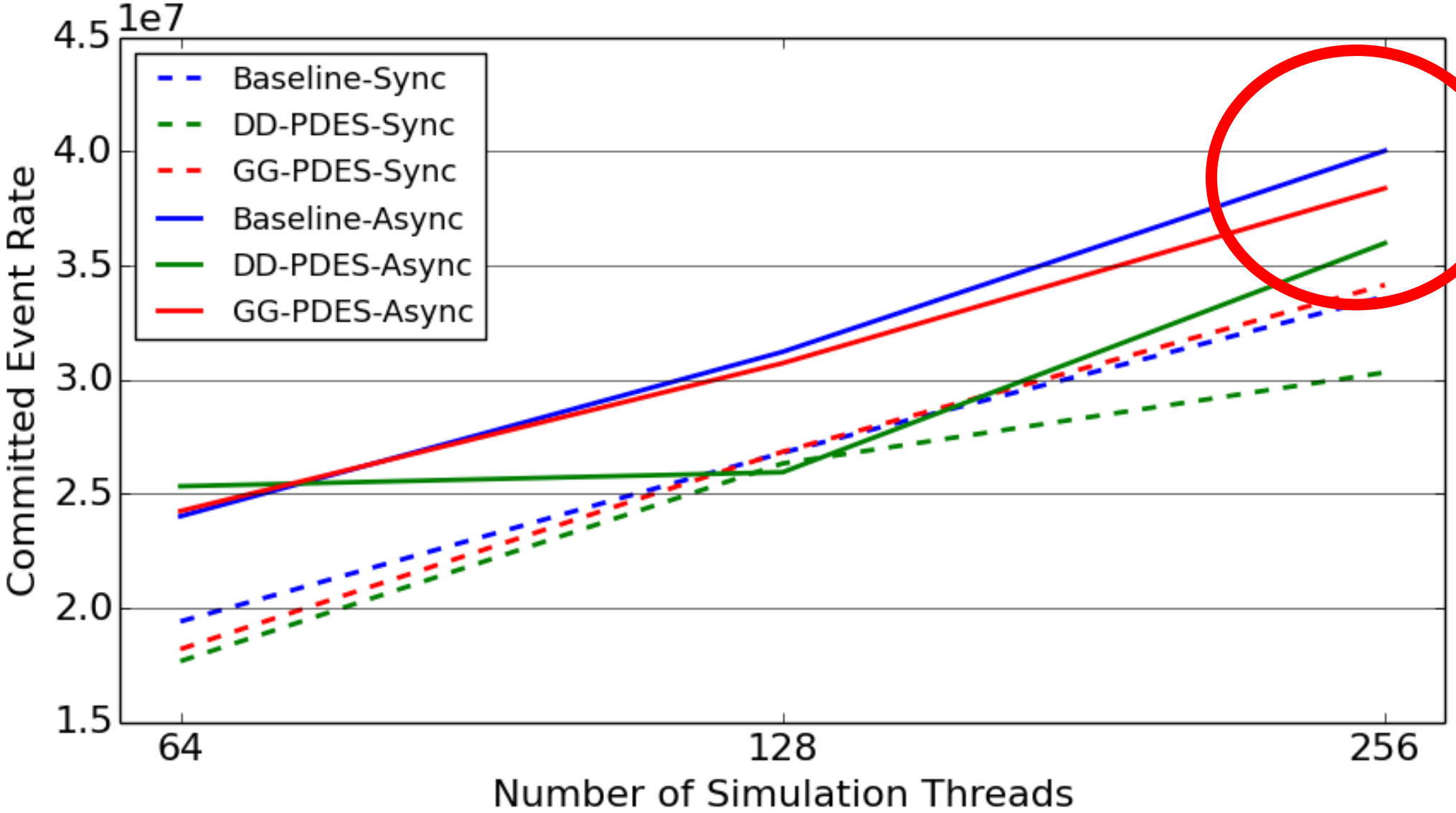
C. D. Carothers et al. 2002. ROSS: A High-Performance, Low-Memory, Modular Time Warp System. Journal of Parallel and Distributed Computing, Volume 62, Issue 11, Pages 1648-1669.

Experimental Results

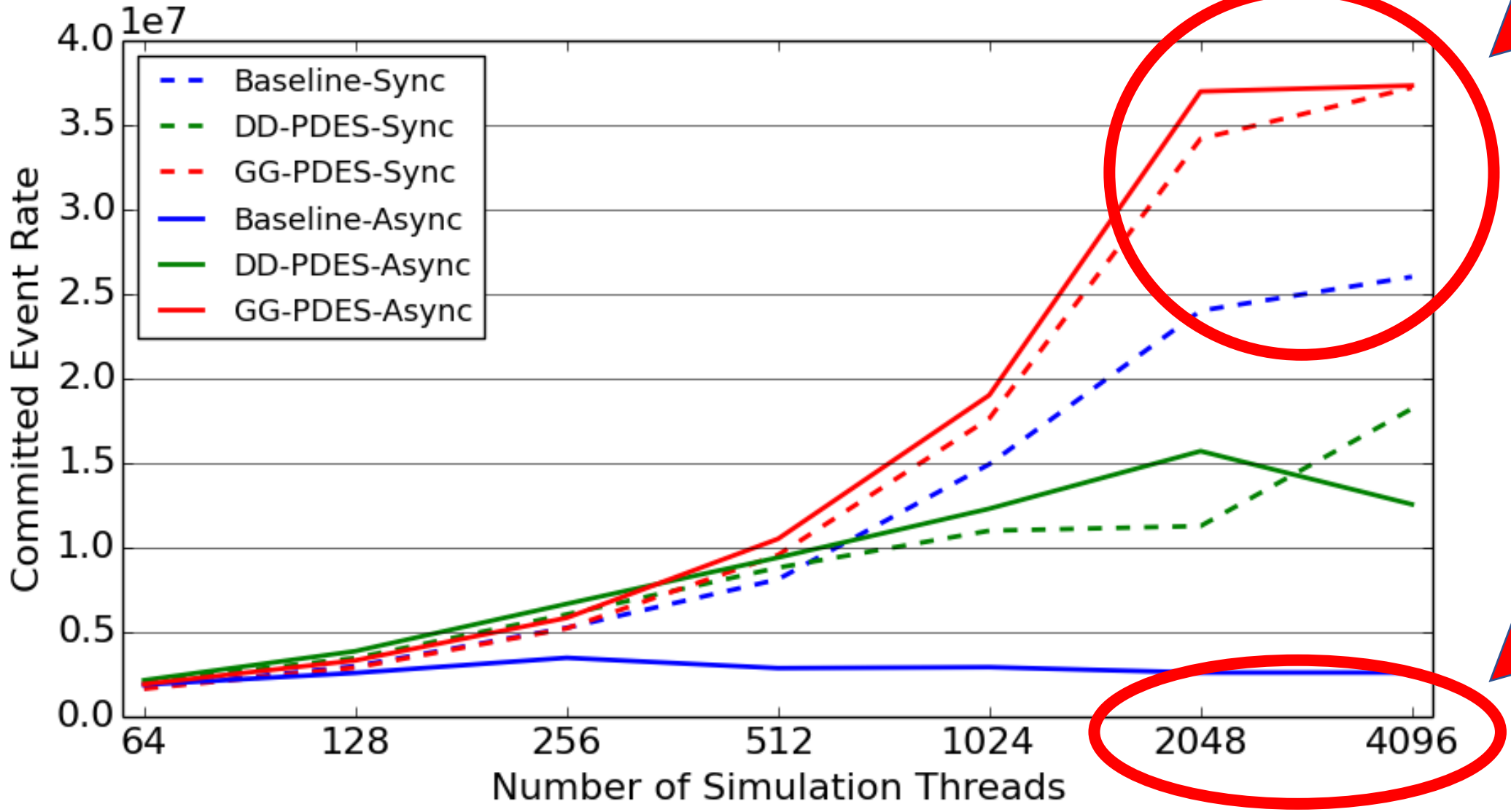
Simulation Models

- Phold
- Epidemics
- Traffic

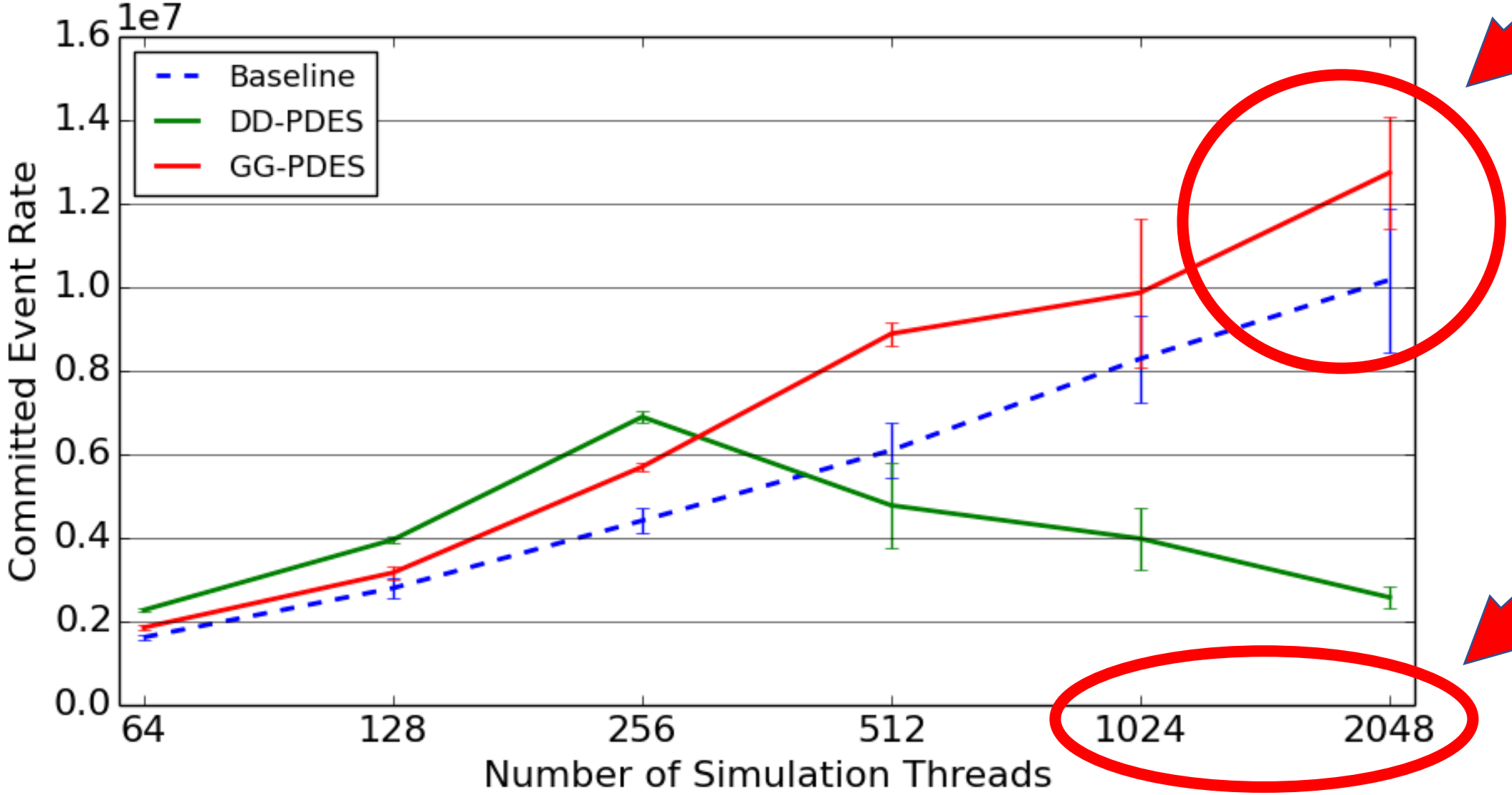
Balanced Phold Model



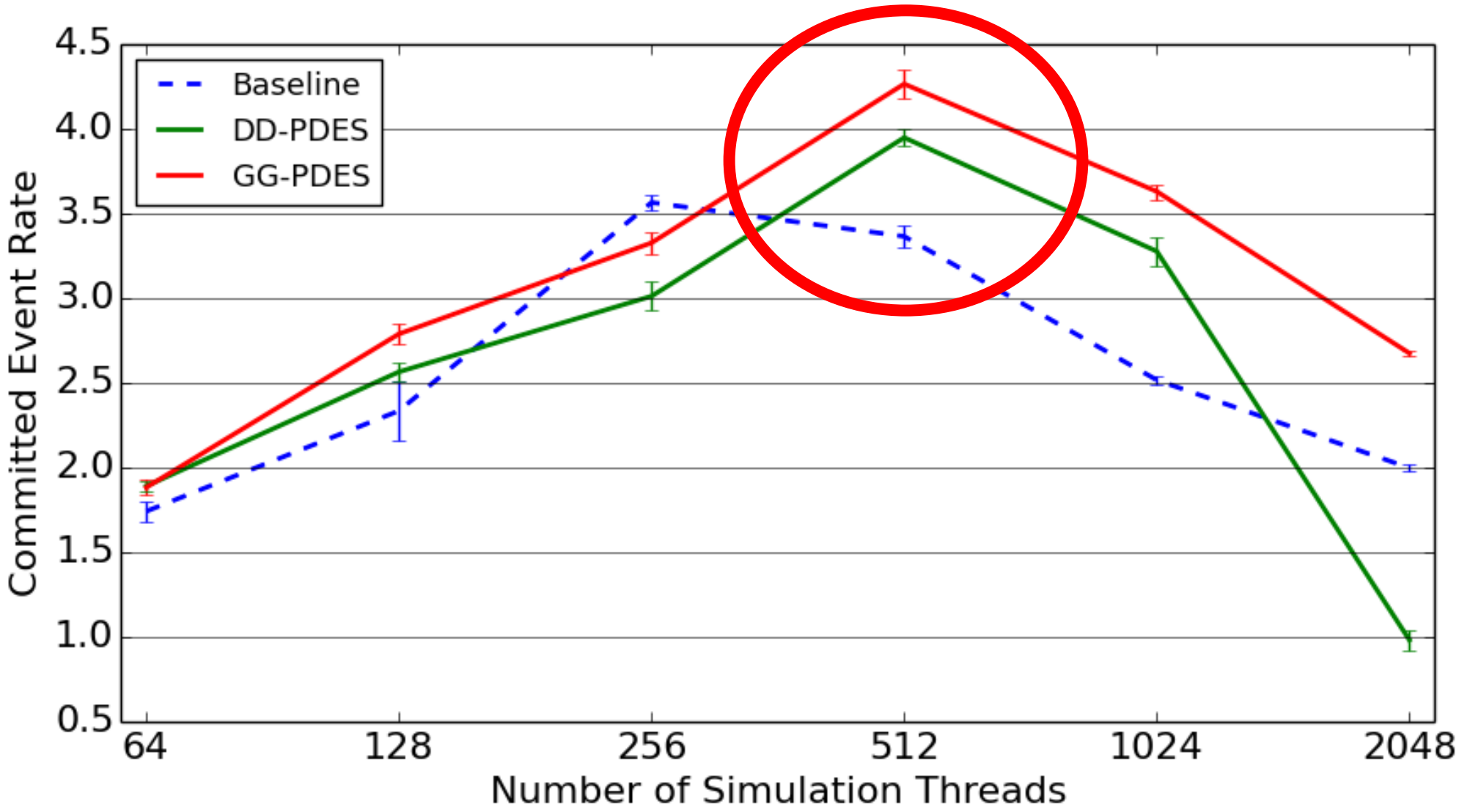
Imbalanced Phold Model



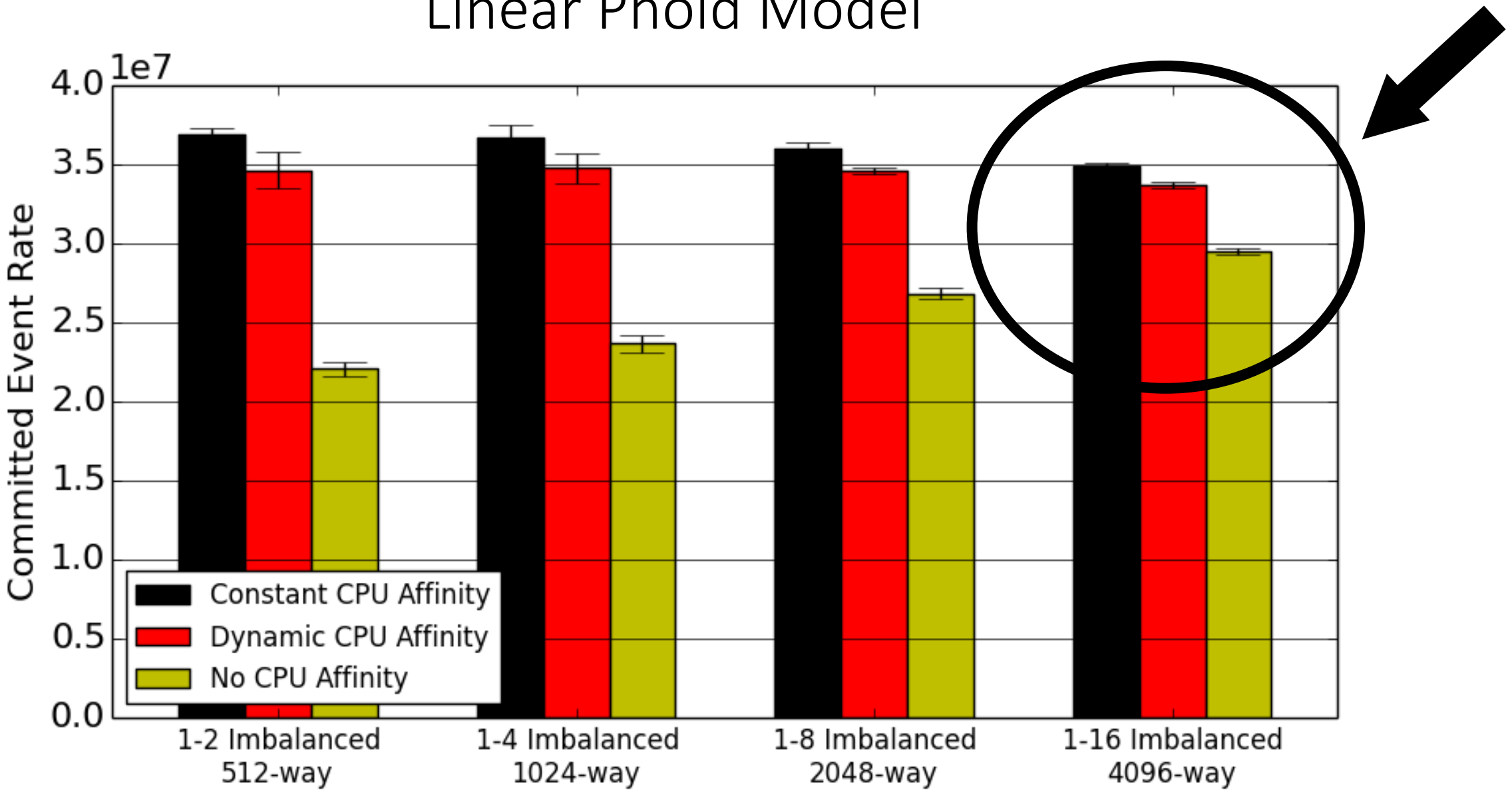
Epidemics Simulation Model



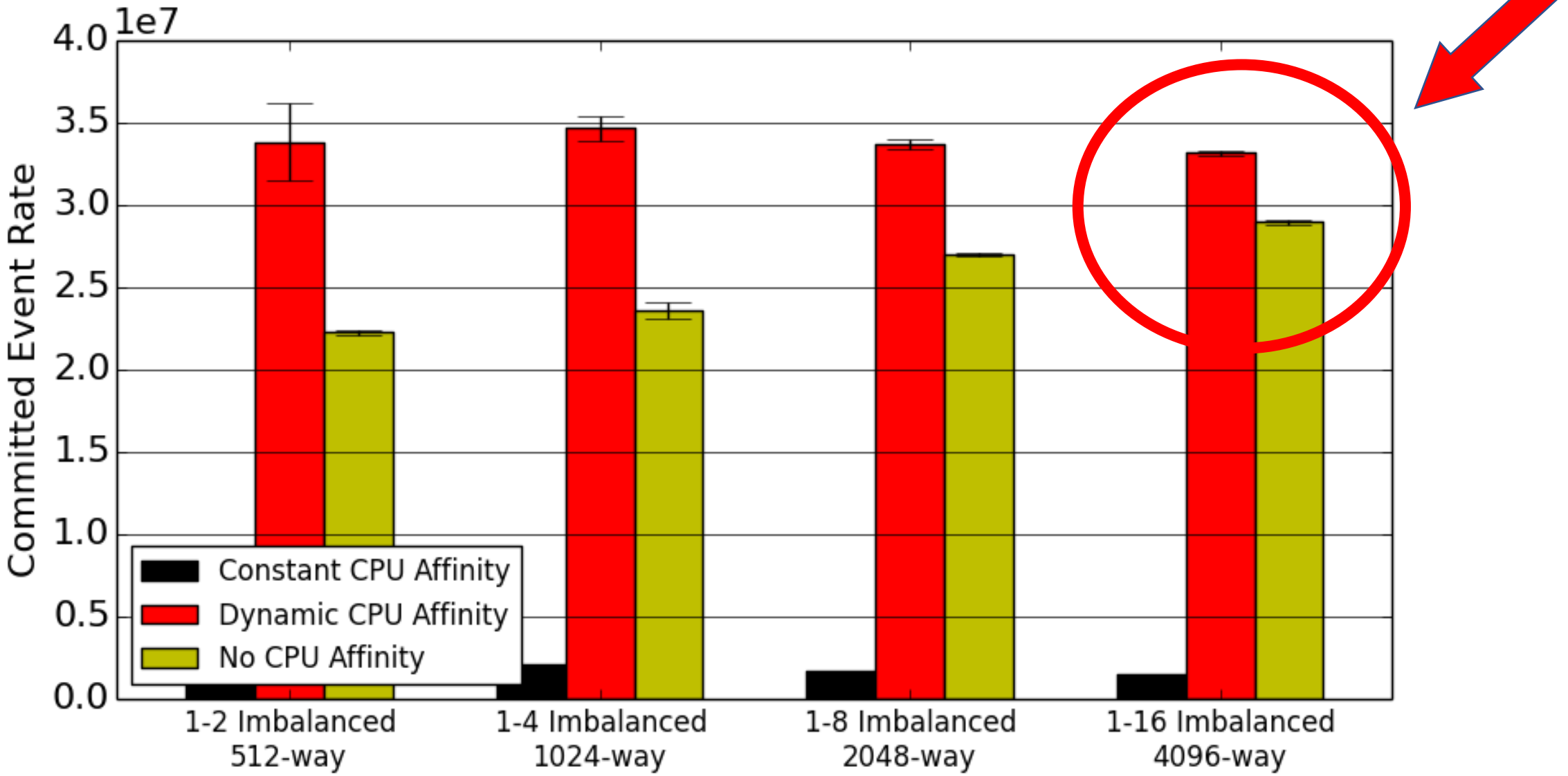
Traffic Simulation Model



Linear Phold Model



Non-Linear Phold Model



Thank You!

Any Question?