CharmROSS

Empowering PDES with an Adaptive Runtime System

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Overview

Charm++ Model

- Asynchronous objects
  - Migratable
  - Communicate via remote method invocation
  - Over-decomposition: many objects per core
  - Location and naming managed by RTS
- Message-driven communication
  - Only objects with work get scheduled
  - Overlap of computation and communication

Motivation and Goals

- Achieve similar performance to MPI ROSS
- Add new capabilities
  - Asynchrony (GVT)
  - Load balancing
  - Fault tolerance
  - Checkpoint restart
  - Fine-grain message aggregation

Port Status

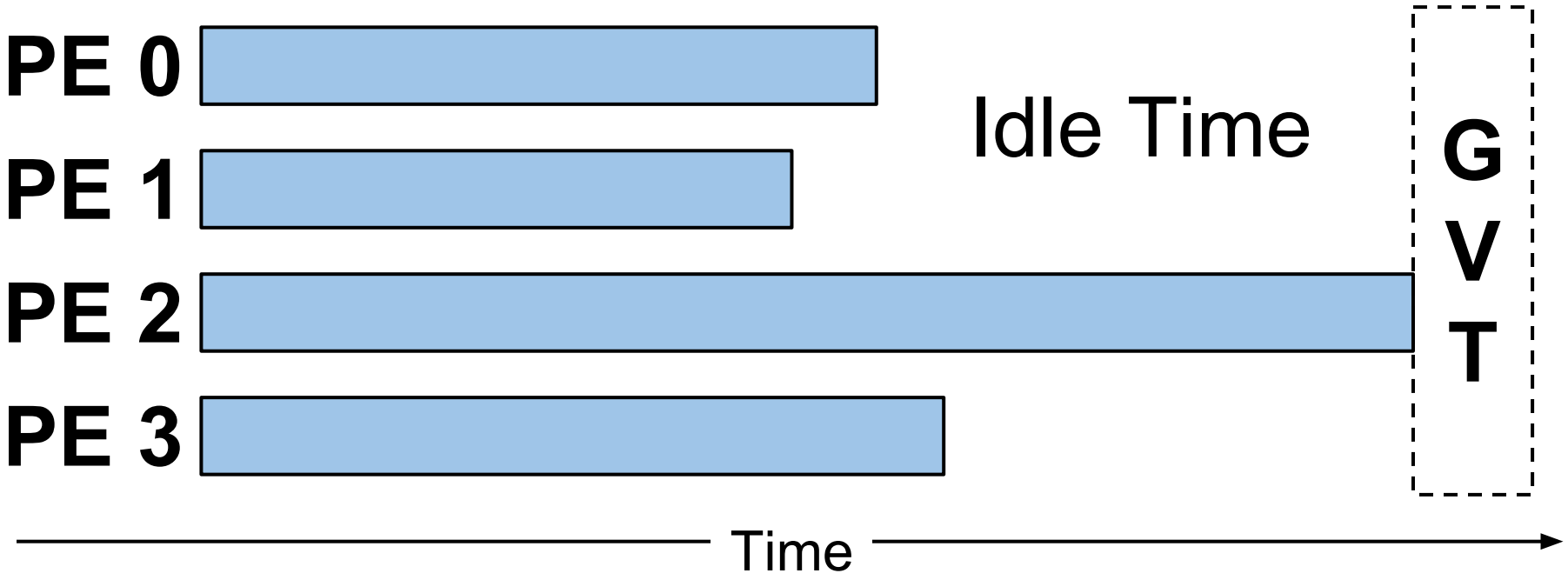
- Sequential, Conservative, Optimistic all work
- Deterministic and consistent with original
- 3 models (PHOLD, PCS, Dragonfly)
- Charm: 4k SLOC, MPI: 8.8k SLOC
- Some extra features implemented

Features

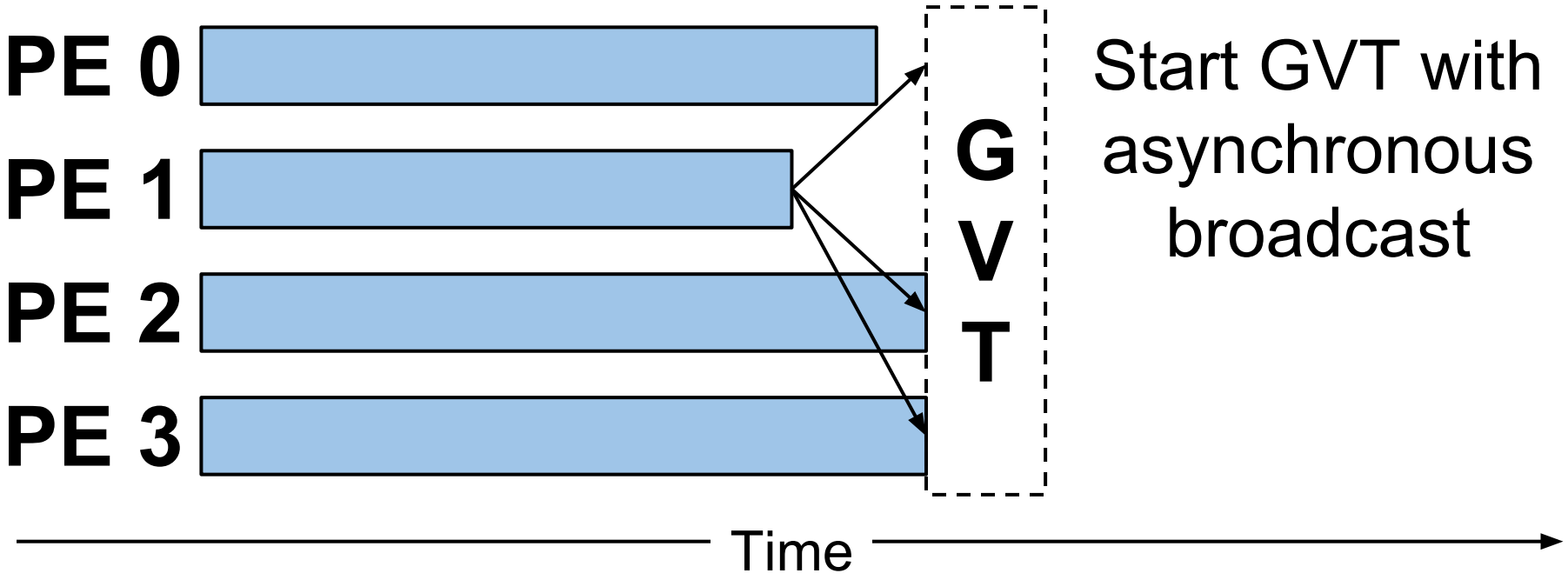
New Features

- GVT Asynchrony
  - Async broadcasts
  - Async reductions
  - Fully async GVT
- Migratability
  - Load balancing
  - Checkpoint/Restart
  - Fault tolerance

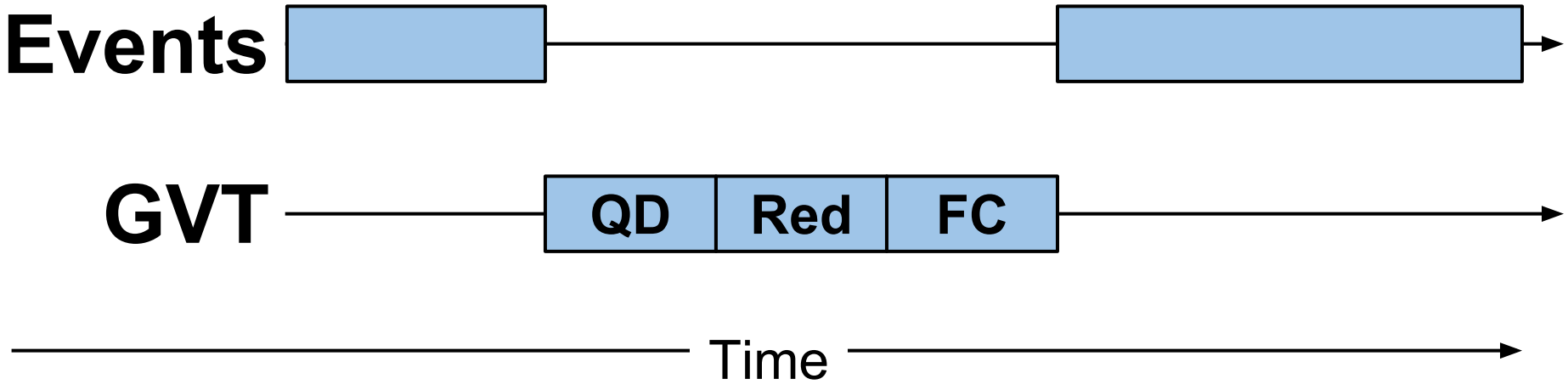
Asynchronous Start



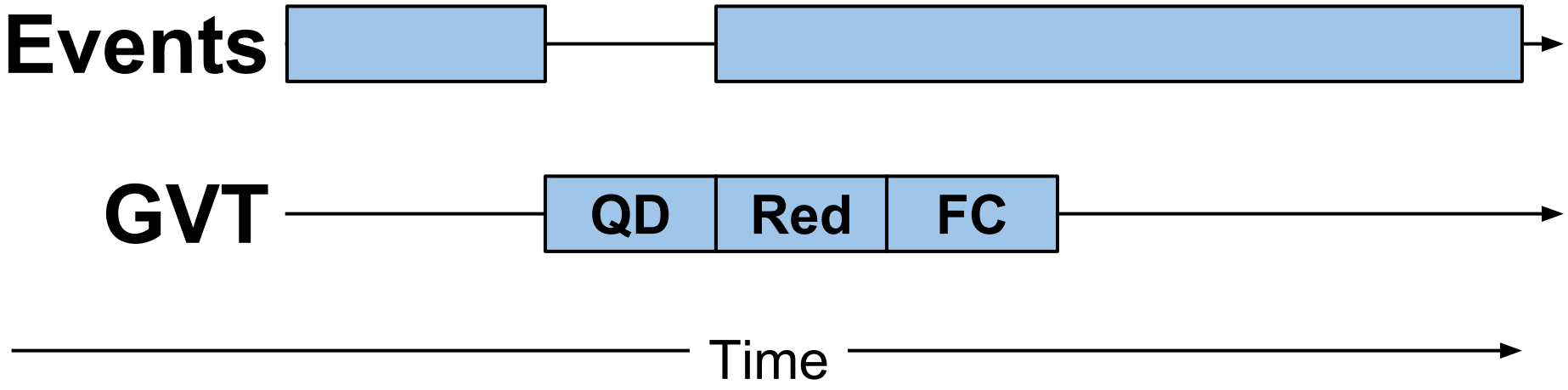
Asynchronous Start



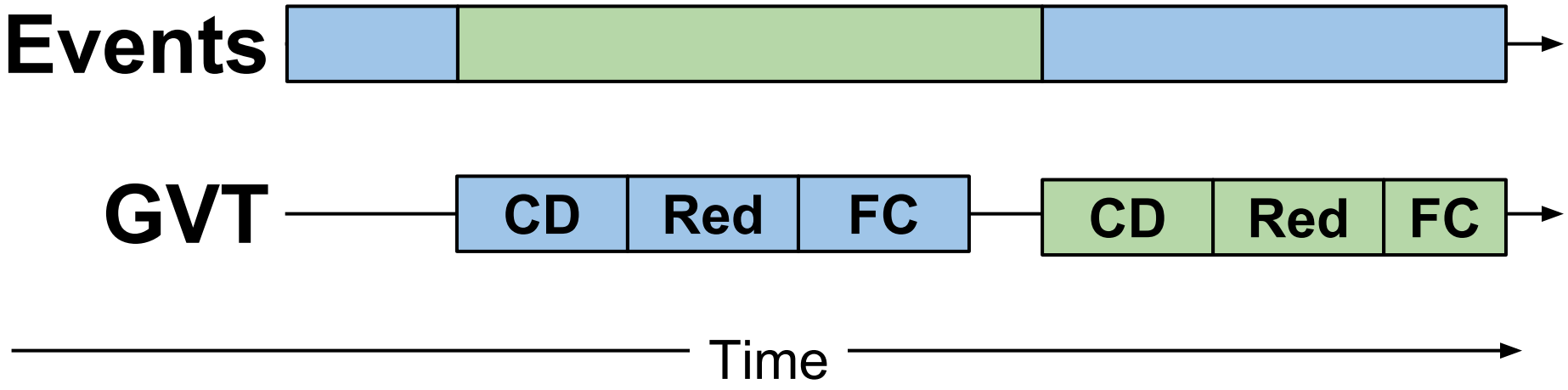
Asynchronous Reductions



Asynchronous Reductions



Fully Asynchronous GVT



Migratability

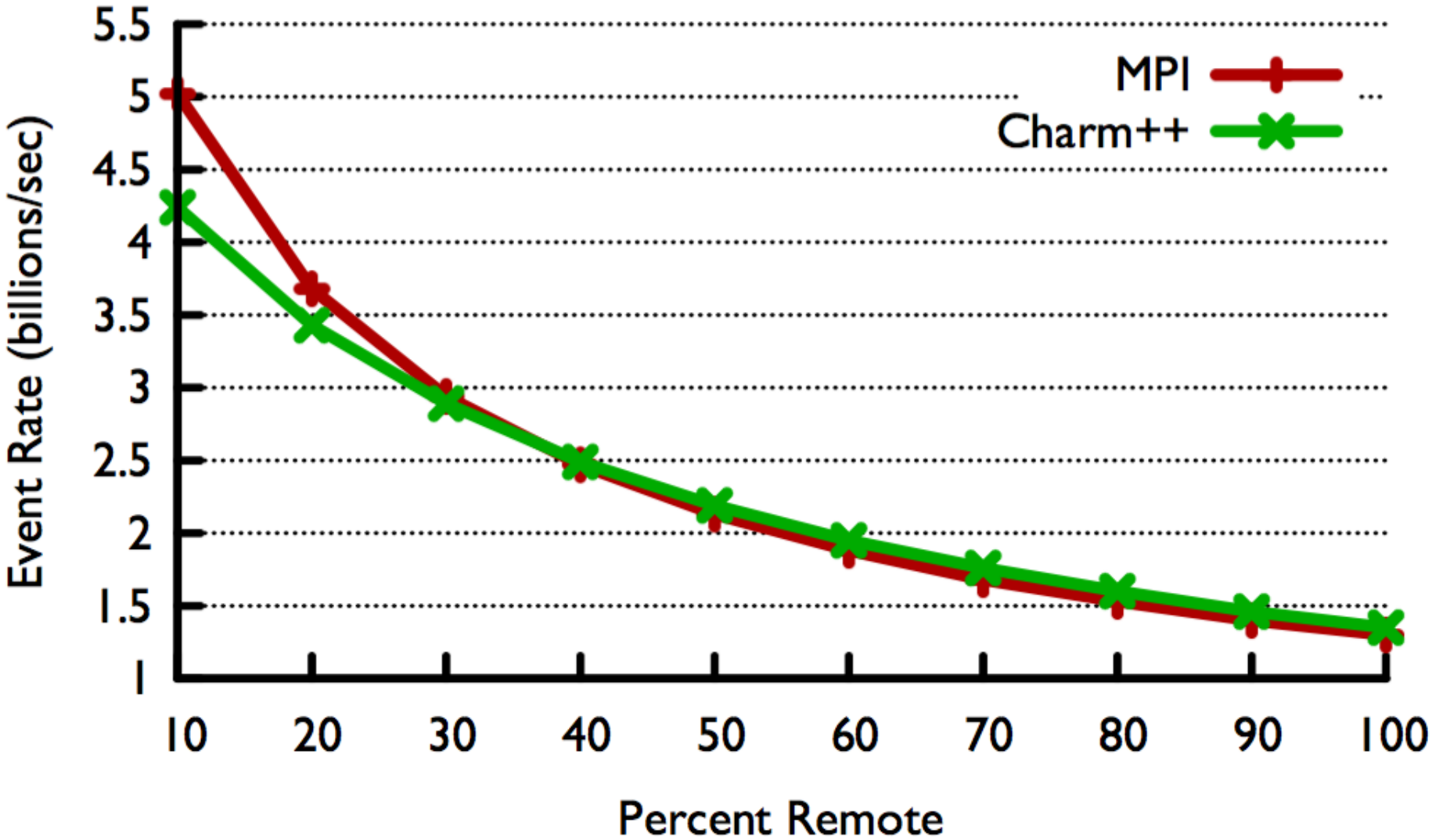
- LPs are migratable
- Load balancing
- Checkpoint/Restart
- Fault Tolerance

Performance

Initial Performance

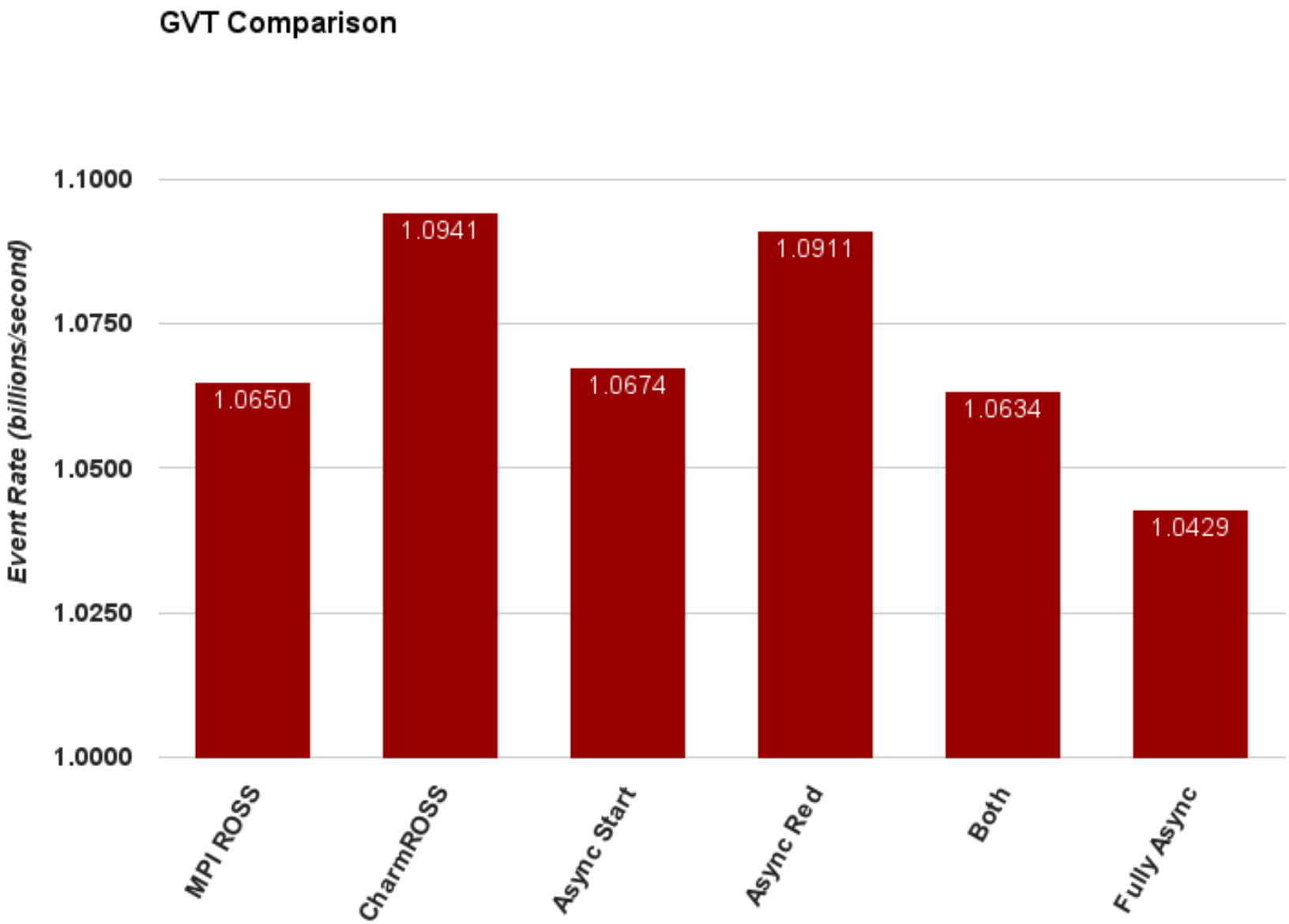
- Runs done with PHOLD benchmark
- 1 rack of Vesta (1024 BG/Q nodes)
- 64 threads per node
- No new features included

Varying Remote Communication



Async GVT Comparison

- Runs done with PHOLD benchmark
- 512 nodes on Vesta
- 64 threads per node
- 50% remote event rate


GVT Comparison
Event Rate (billions/second)
1.1000
1.0750
1.0500
1.0250
1.0000
1.0650
1.0941
1.0674
1.0911
1.0634
1.0429
MPI ROSS
CharmROSS
Async Start
Async Red
Both
Fully Async

Conclusion

Future Work

- Tuning/optimization of async features
- PDES specific load balancing
- Topological Routing and Aggregation Module