PARA DIME

Speculative Concurrent Processing with Transactional Memory in the Actor Model

OPODIS 2013
December 17, 2013

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This project and the research leading to these results has received funding from the European Community's Seventh Framework Programme [FP7/2007-2013] under grant agreement n° 318693

A bit of background: The Actor Model

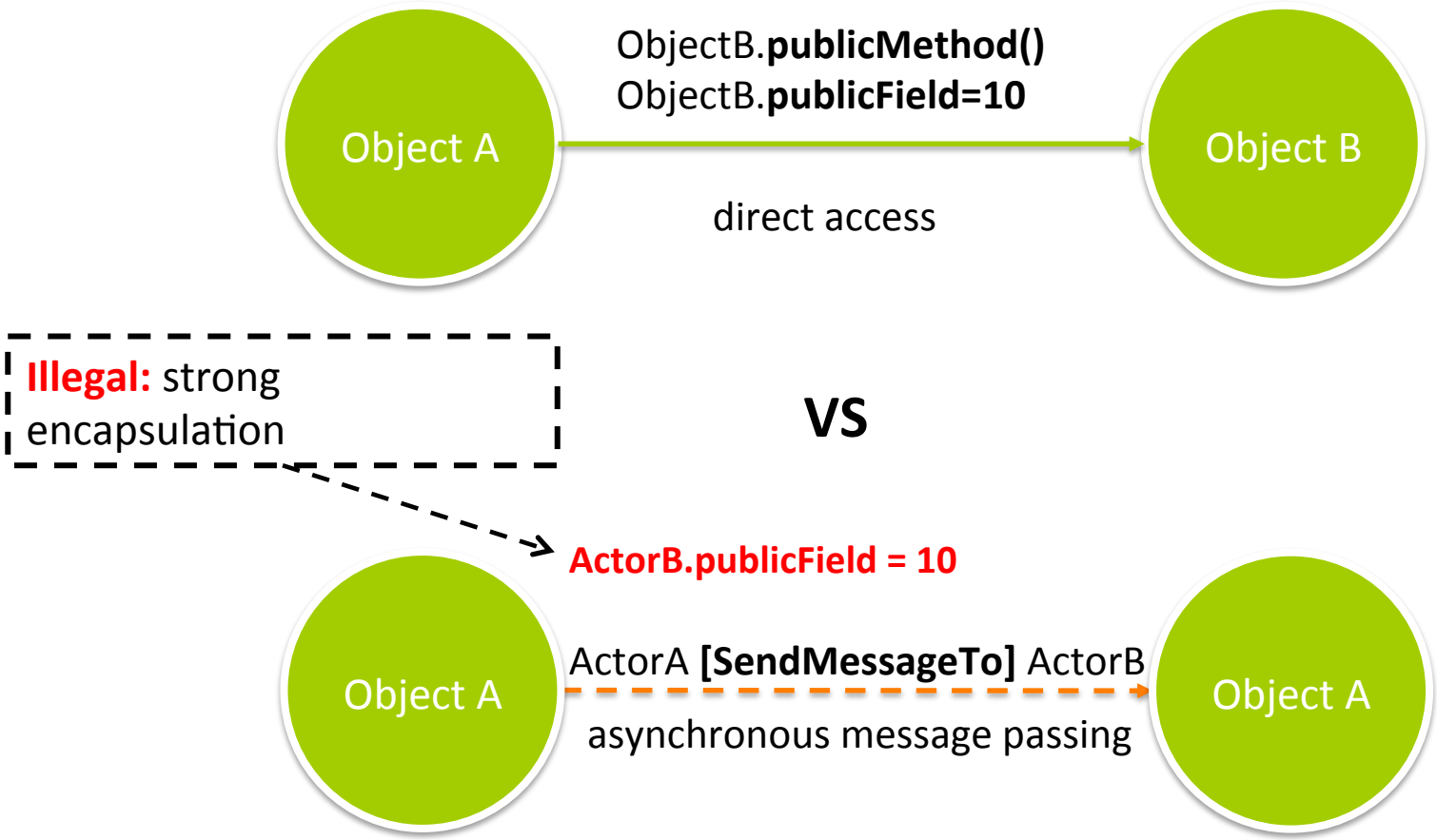
- **Hewitt & Baker (IFIP Congress'77) – „Laws for Communicating Parallel Processes“**

Motivated by the prospect of highly parallel computing machines with many microprocessors + own local memory

OOP and actors: Communication

- Everything is an actor (VS an object)
- **Asynchronous** message passing
- Has access to its local state only
- Strong encapsulation
- Inherently concurrent

OOP and actors: Communication



Problem statement

- Sequential processing of messages limits performance & throughput
- Multiple actors participating in the same coordinated transaction block, causing message processing delays

Main contributions

- A method for processing many messages concurrently using STM, and
- A method for removing excessive blocking, associated with the processing of coordinated transactions

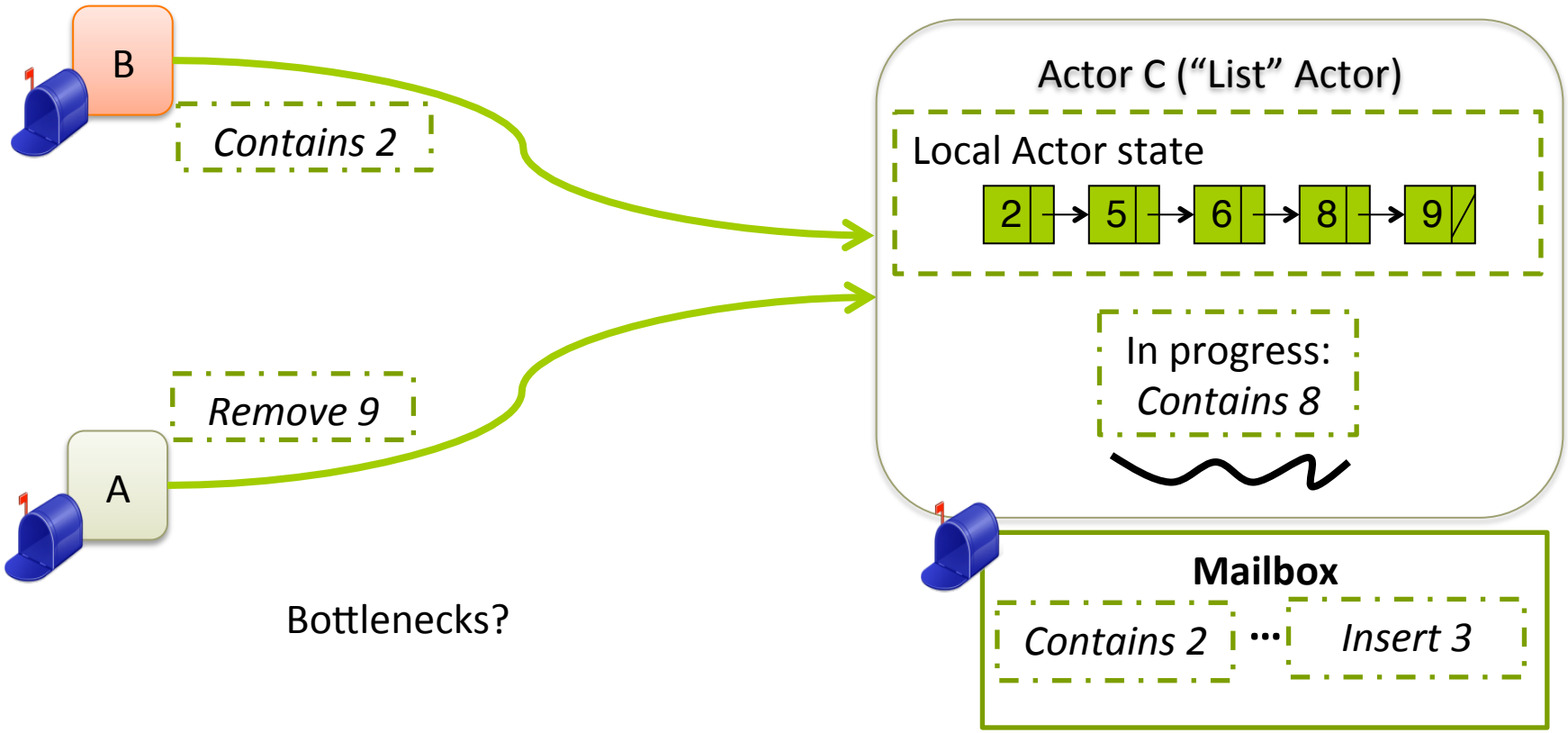
  ⇒both methods preserve the semantics of the Actor Model

A current solution

- Habanero Scala - Shams et al. (Scala Days'12) – Habanero Scala

  ⇒async-finish programming model
- Main strength: processes parts of one message concurrently

Case 1: Concurrent message processing



Concurrent message processing

- Possible issues?

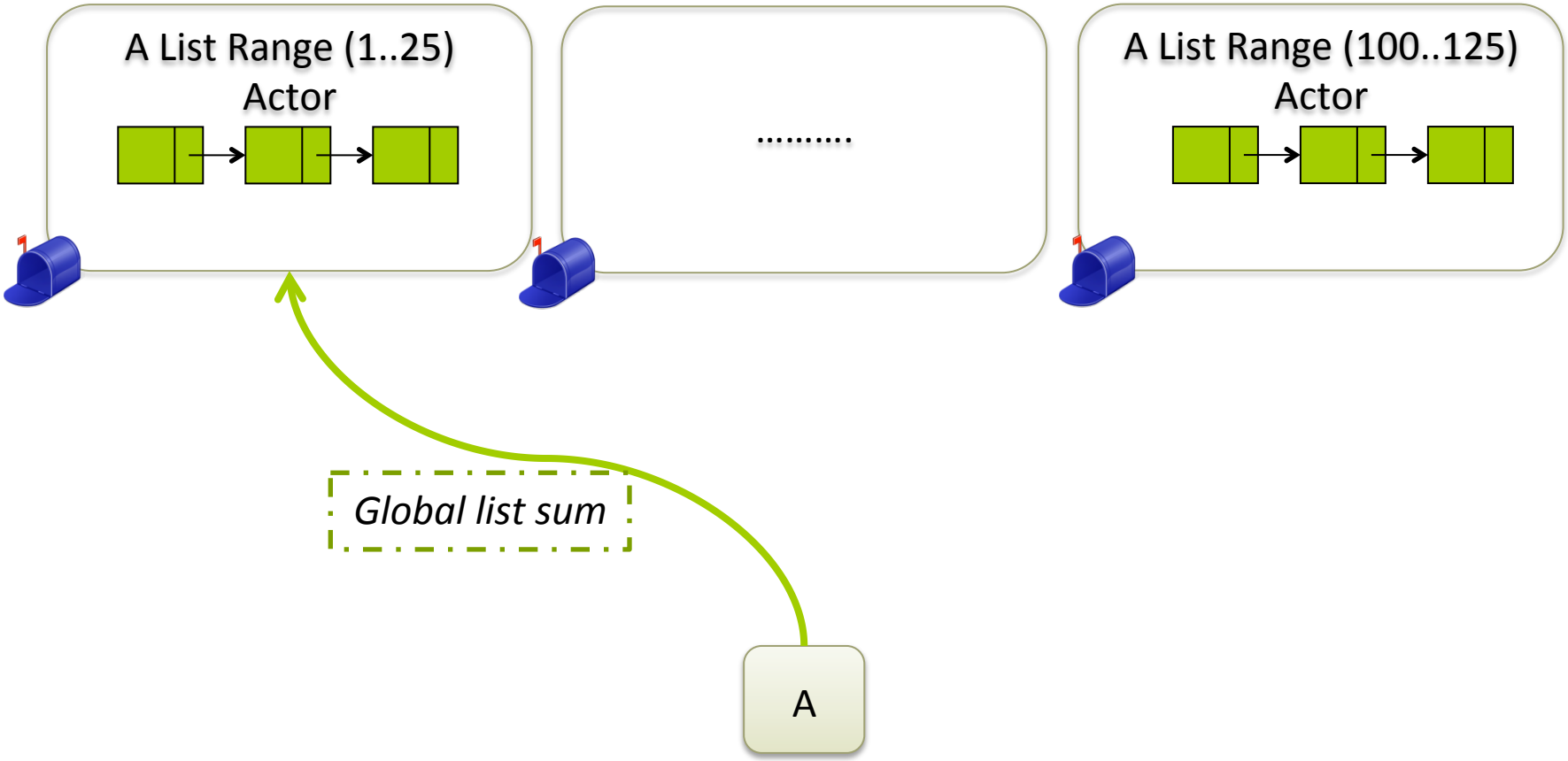
- *List corruption*

  ⇒wrap message processing in an STM transaction.

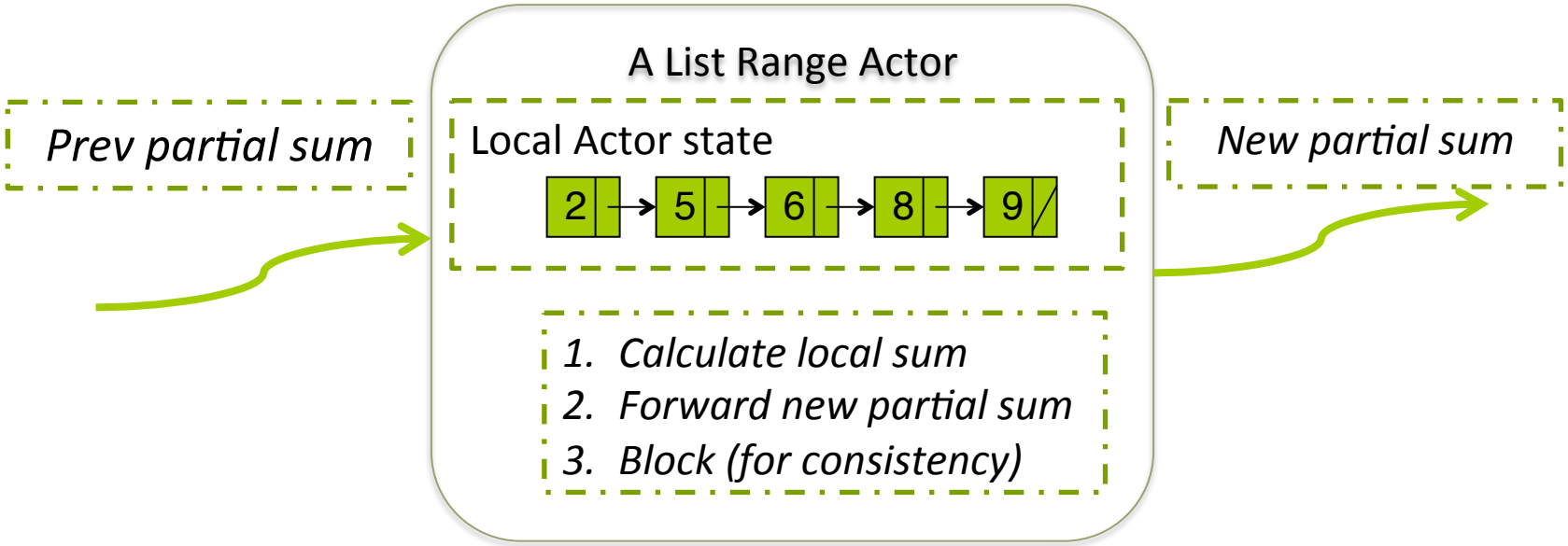
- *Altered message ordering*

  ⇒messages are *not guaranteed* to arrive in order because they are sent asynchronously

Case 2: Coordinated message processing



Global list sum – actor operations magnified

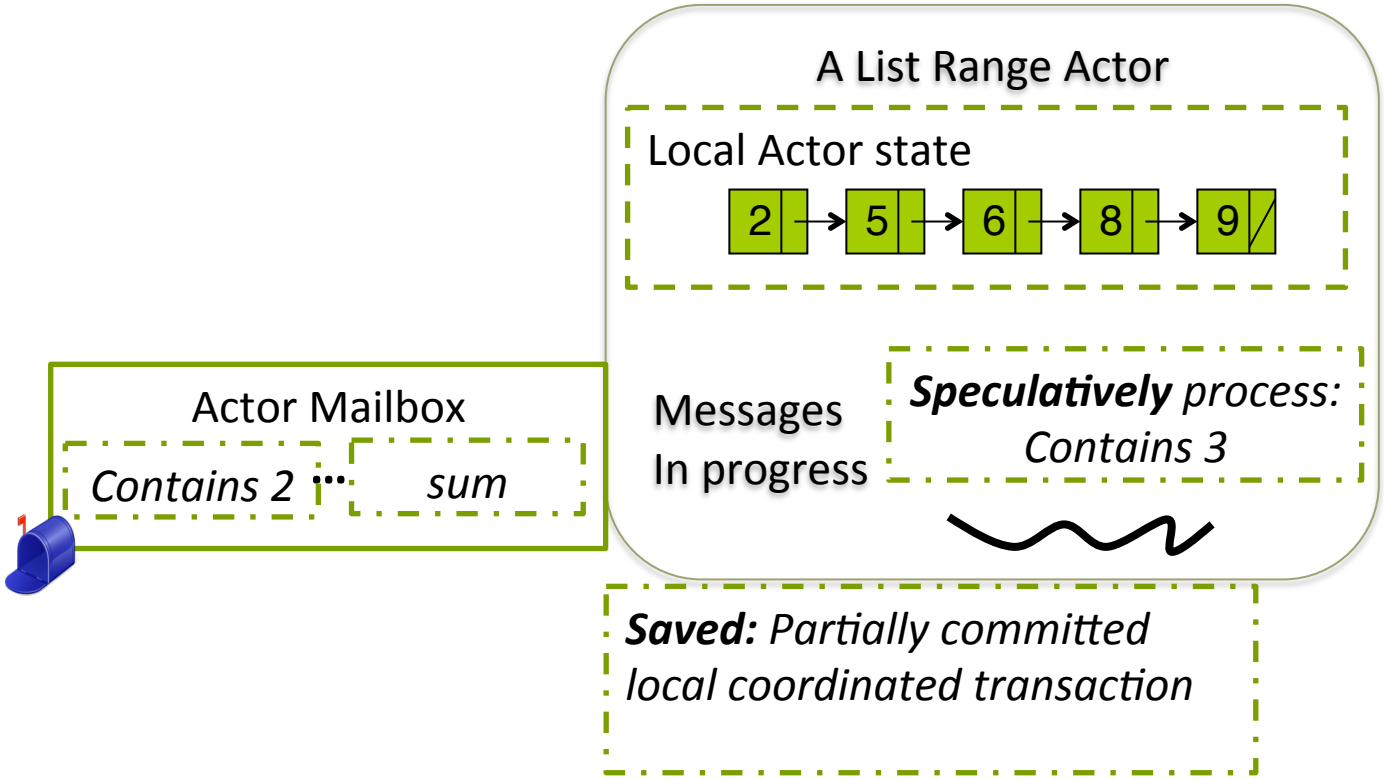


Bottlenecks?

Case 2: Our solution

- Remove blocking; process other messages speculatively
  - ⇒pre-commit the local coordinated transaction
  - ⇒process other messages in a transaction speculatively

Our solution illustrated

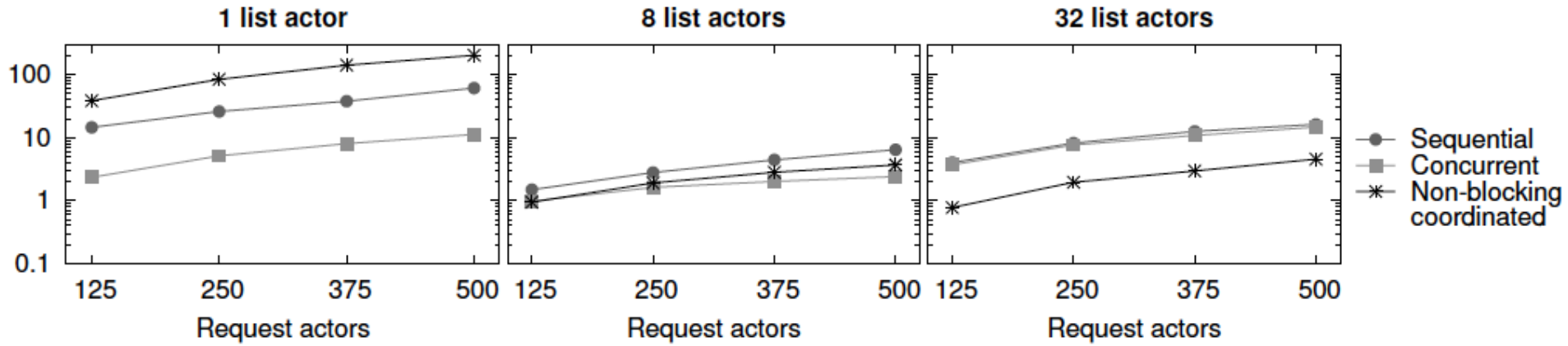


Experimental settings

- Software: a modified Akka 2.10 distribution & Scala 2.10
- Hardware: 48-core AMD Opteron 6172 CPUs running at 2.1GHz
- Application: Stateful distributed sorted integer linked-list

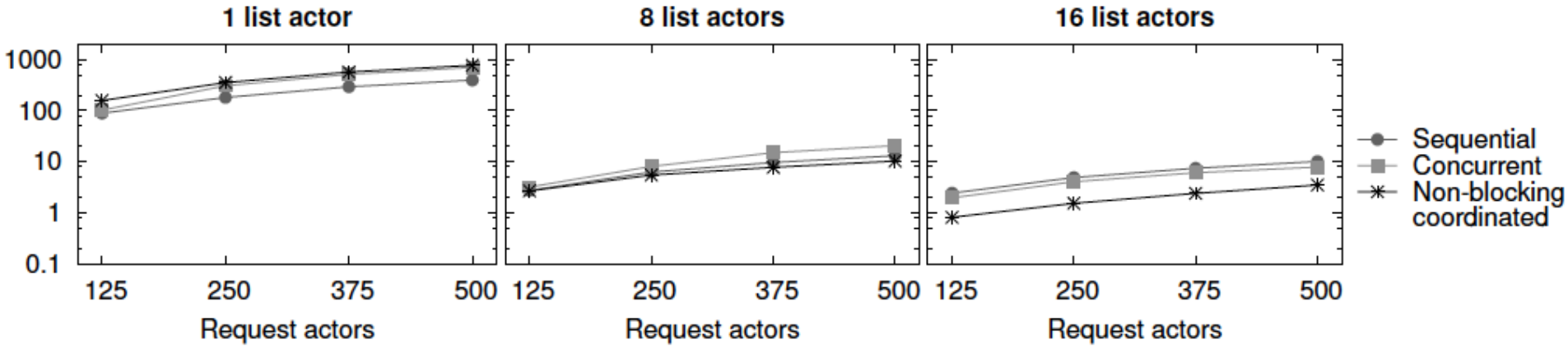
Results

Execution time for sequential, concurrent, and non-blocking: **write-dominated** workload



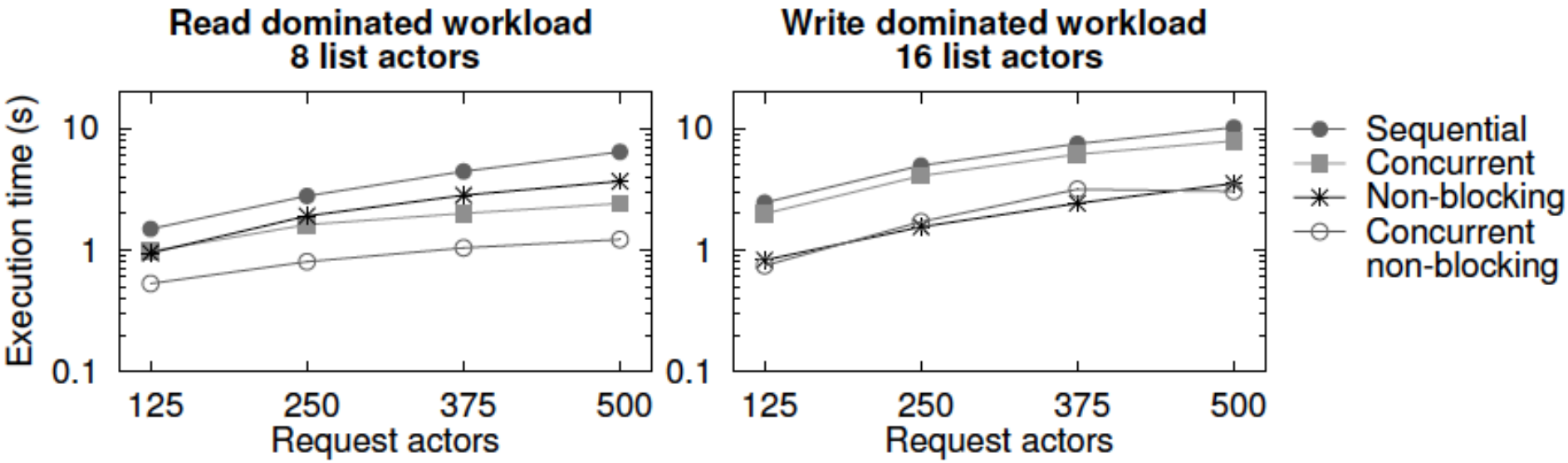
Results

Execution time for sequential, concurrent, and non-blocking: **read-dominated** workload



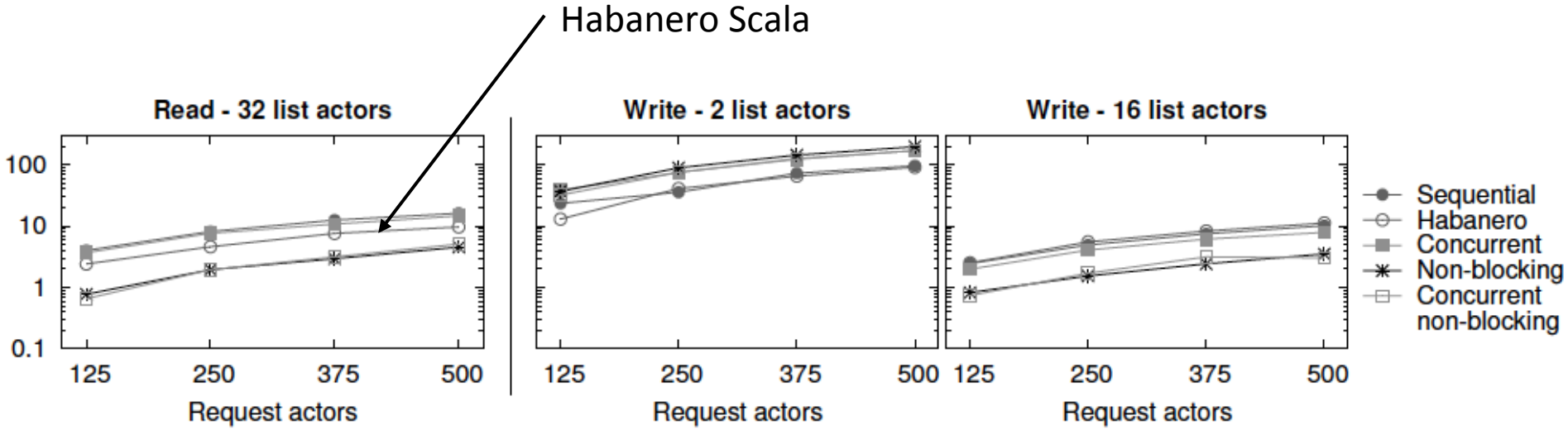
Results

Combined concurrent & non-blocking execution



Results

Comparing with Habanero Scala



Summary

- By using speculation, we can achieve a higher message throughput in the Actor Model
- By using STM we guarantee that the Actor's state is never corrupted

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Questions?