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Concurrent Message Processing using Transactional Memory in the Actor Model

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The Actor Model

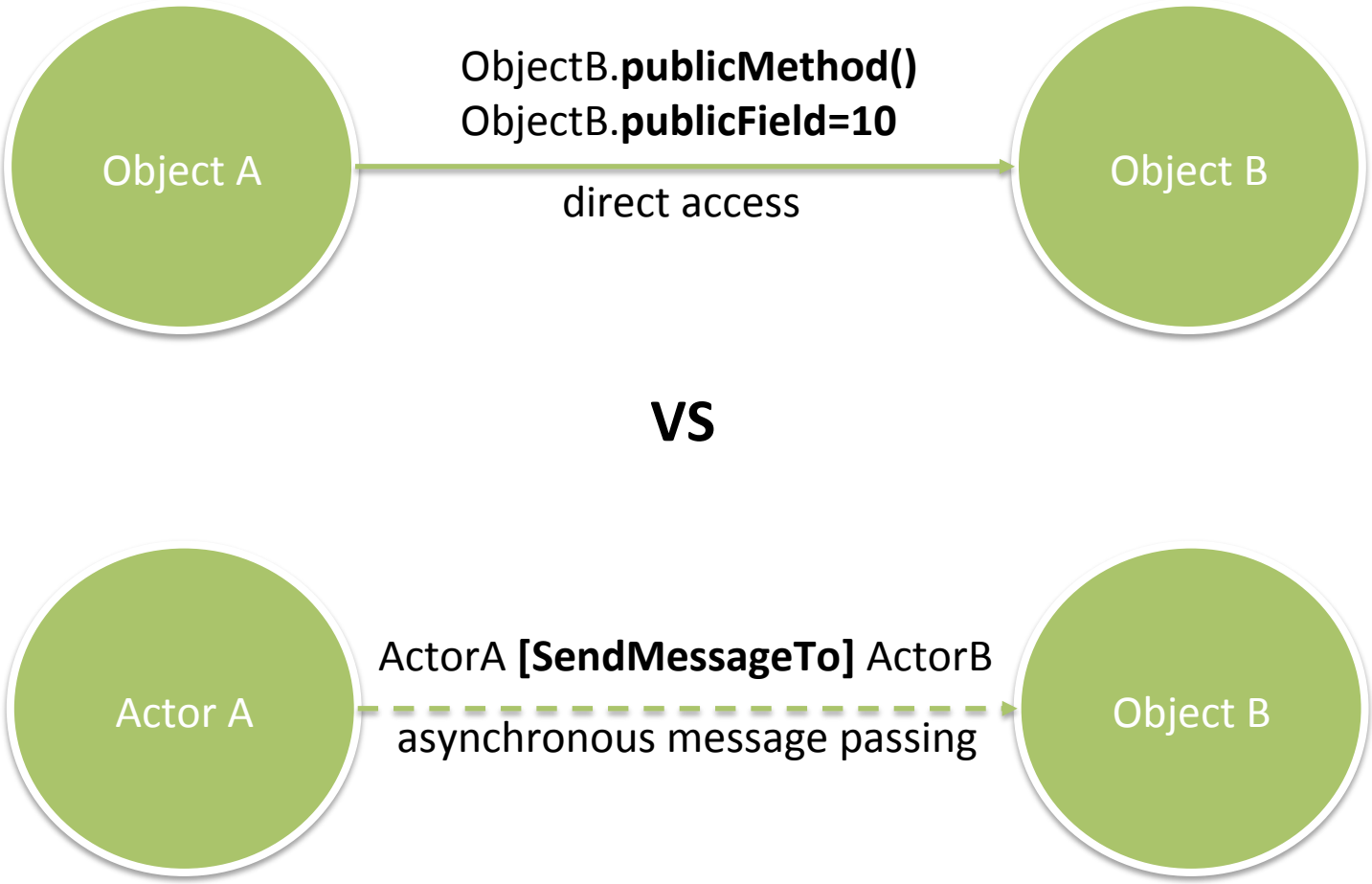
- **Hewitt & Baker** - „Laws for Communicating Parallel Processes“

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

The Actor Model – basic principles

- everything is an actor (VS an object)
- **asynchronous** message passing
- has access to its local state only
- strong encapsulation
- inherently concurrent

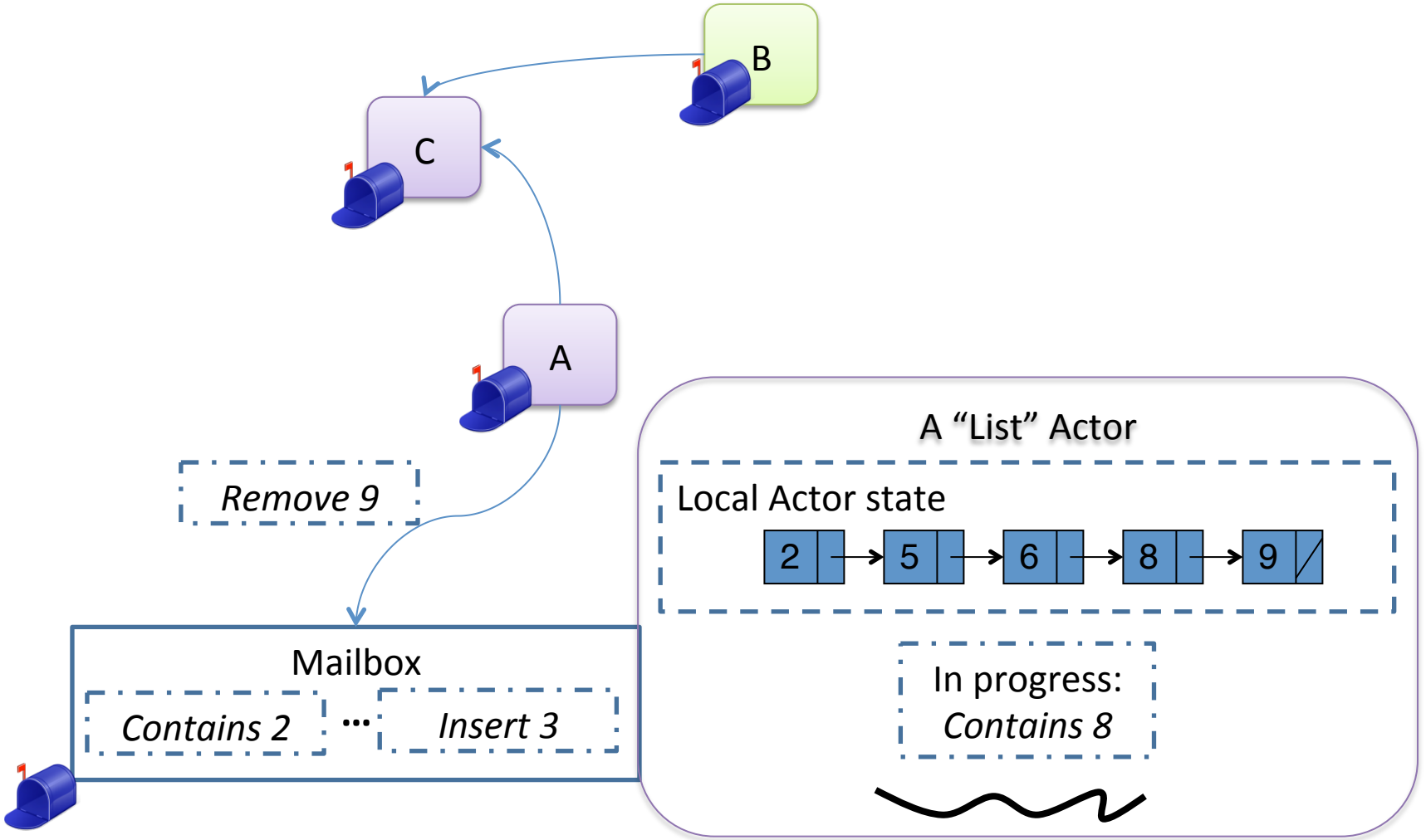
OOP and Actors: Communication



Essential Actor properties

- Processes **one** message at a time
  - Yey! No race conditions or other hazards
- No (access to) shared state
- Can send messages to other actors only
- Switch its behavior

Behind the (Actor) scenes



Main issues

1.

The processing of **one** message at a time

Notable Related Work

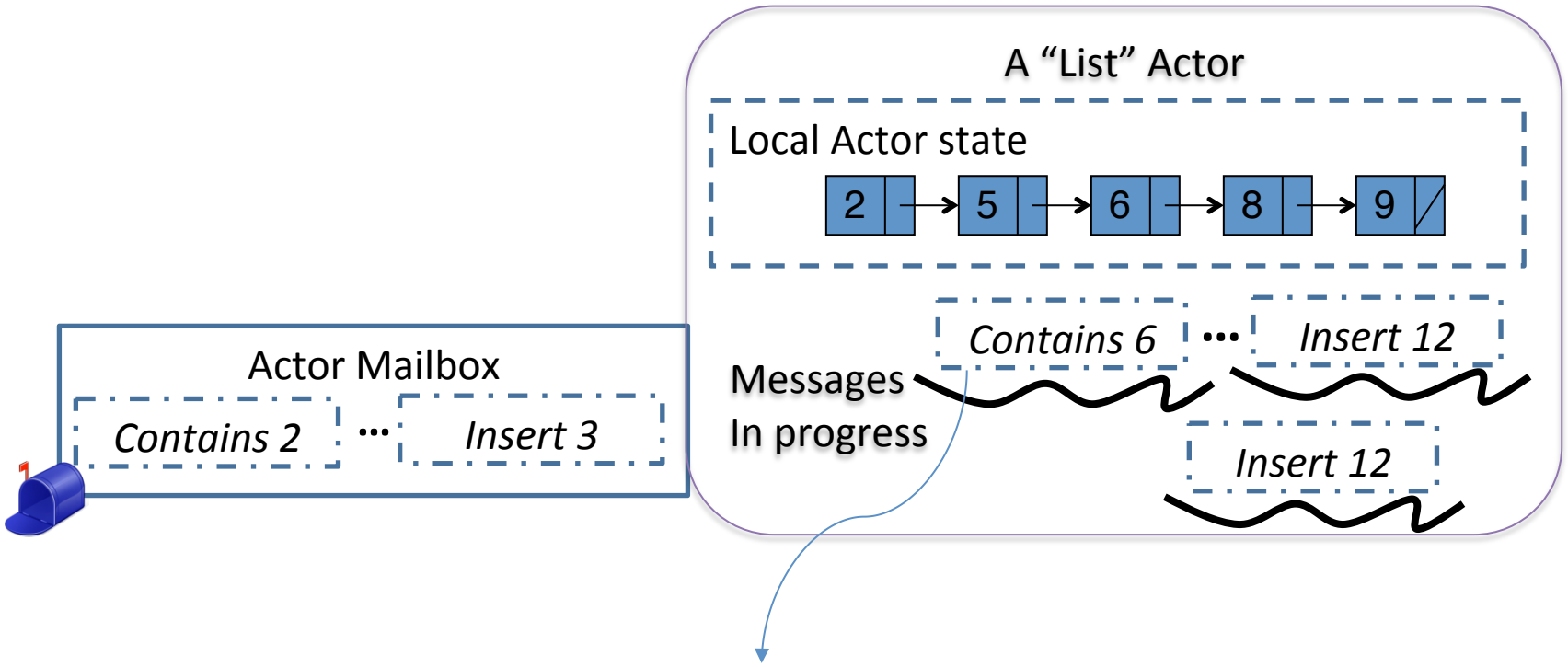
- Scholliers et al. – Parallel Actor Monitors
  - does not use STM for processing messages concurrently
- Shams et al. – Habanero Scala
  - async-finish programming model
  - processes parts of one message (and not many messages) concurrently

Idea:

Process multiple messages concurrently

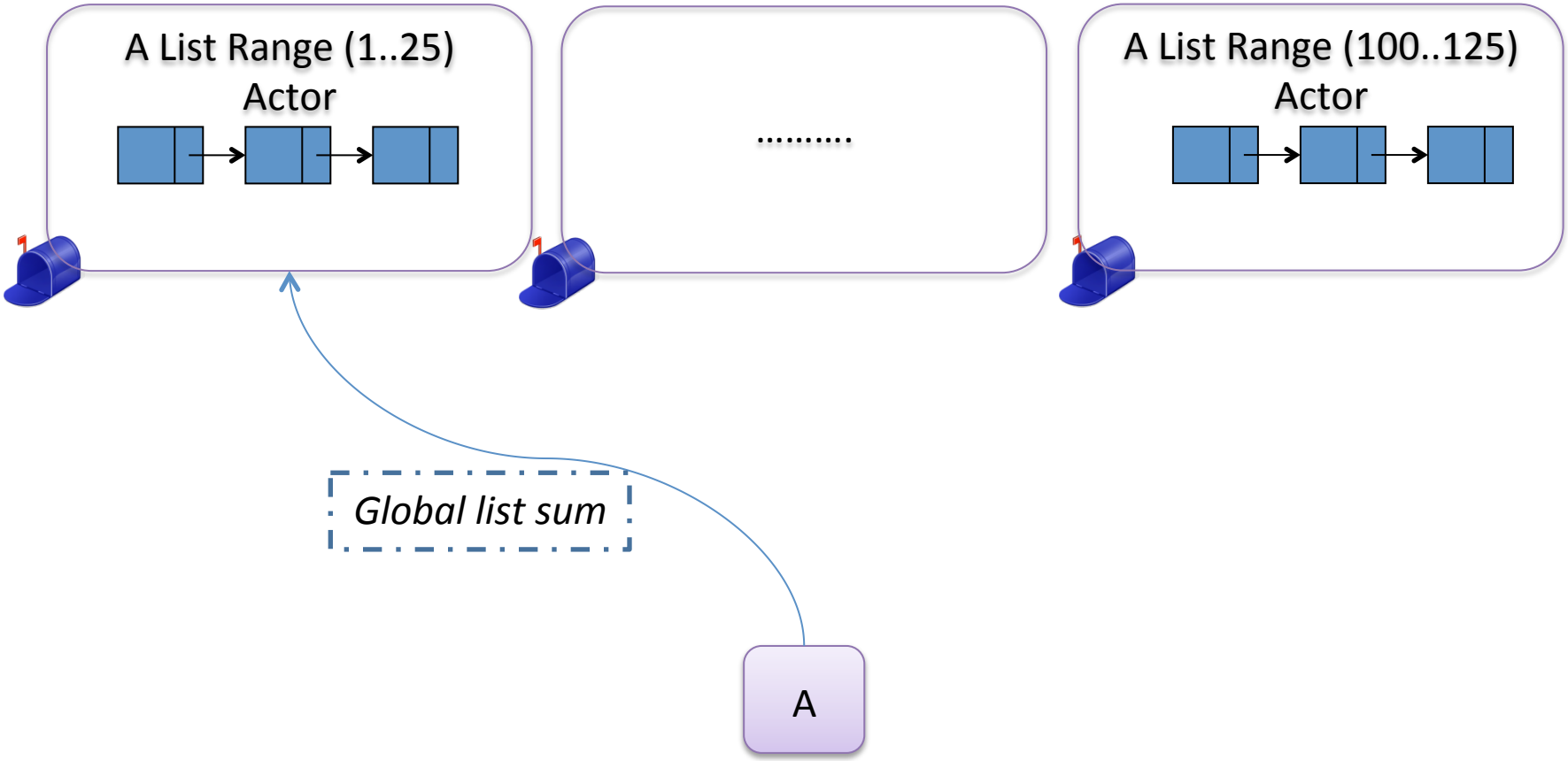
- Problem: the list can be easily corrupted
- Solution: Wrap each message processing in an STM transaction. When conflicts happen, (roll back and) repeat the message processing

Concurrent message processing

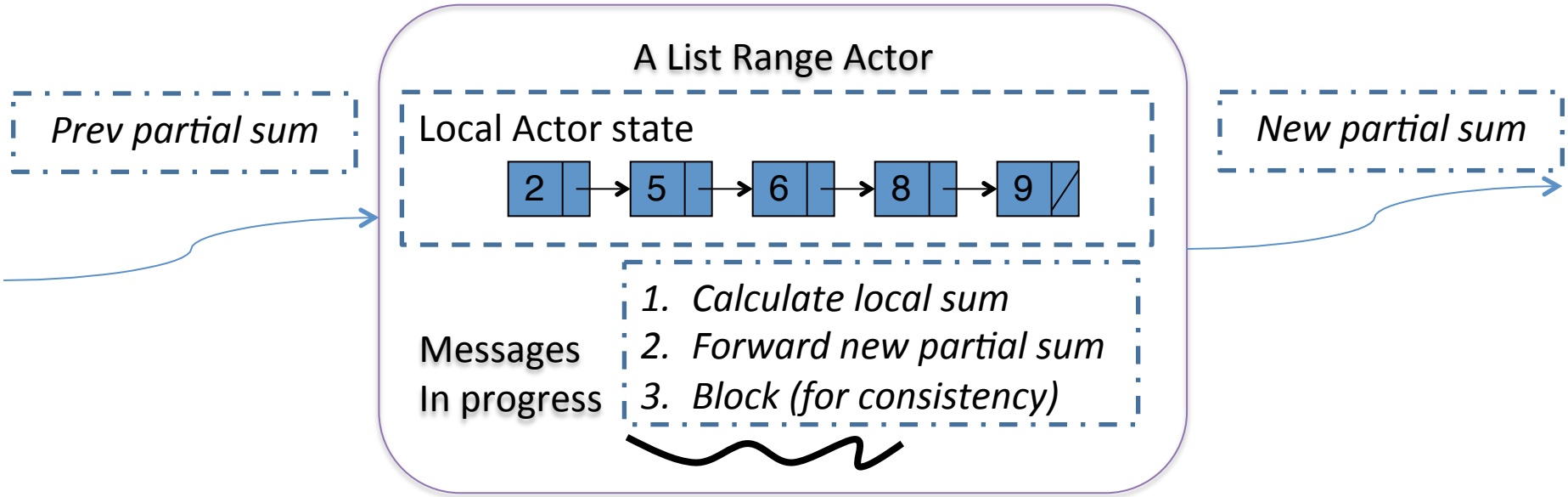


Each message is processed
in a transaction

Coordinated Transactions



Local Actor Sum: Zoom-in



Main issues

2.

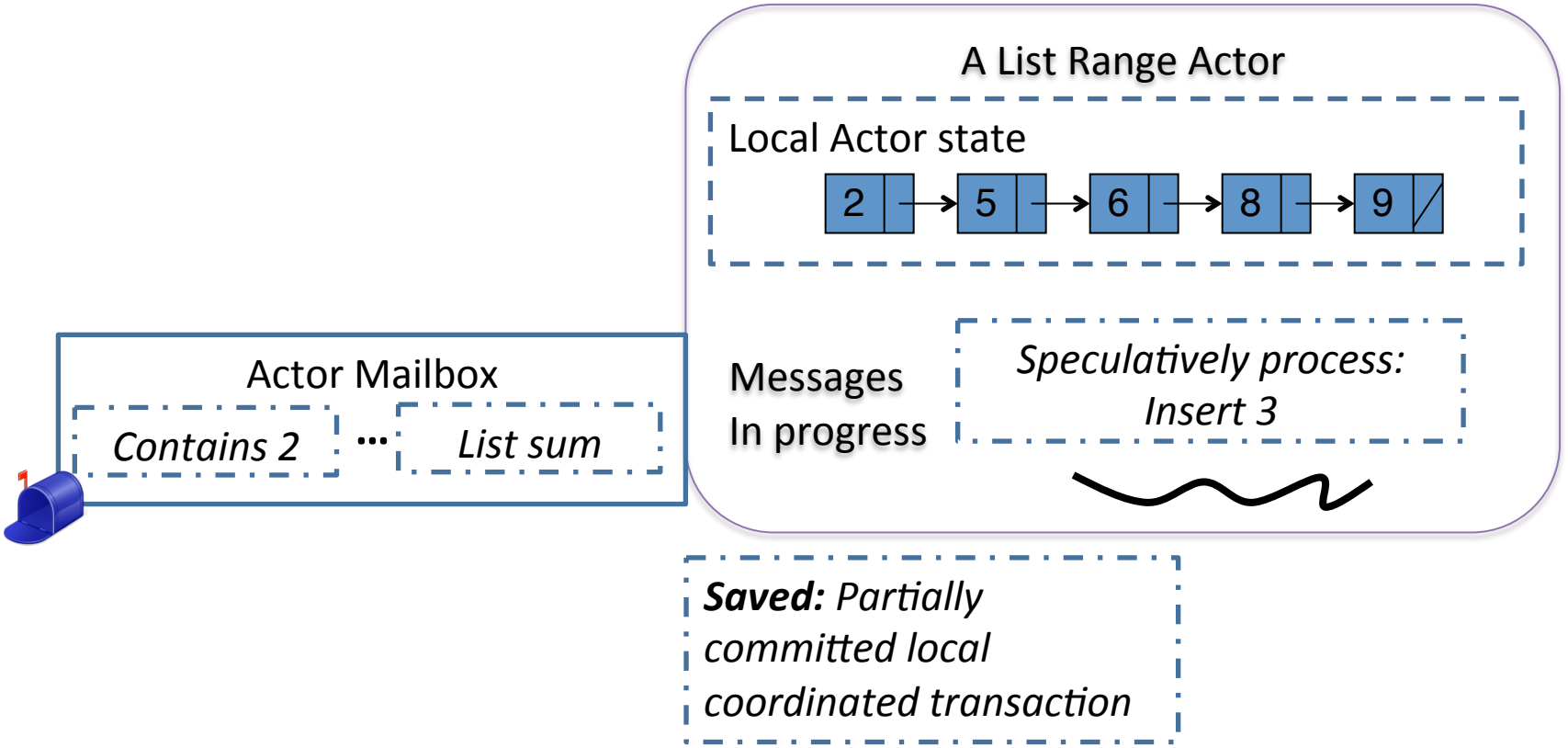
Extensive blocking of actors involved in a coordinated transaction

Idea:

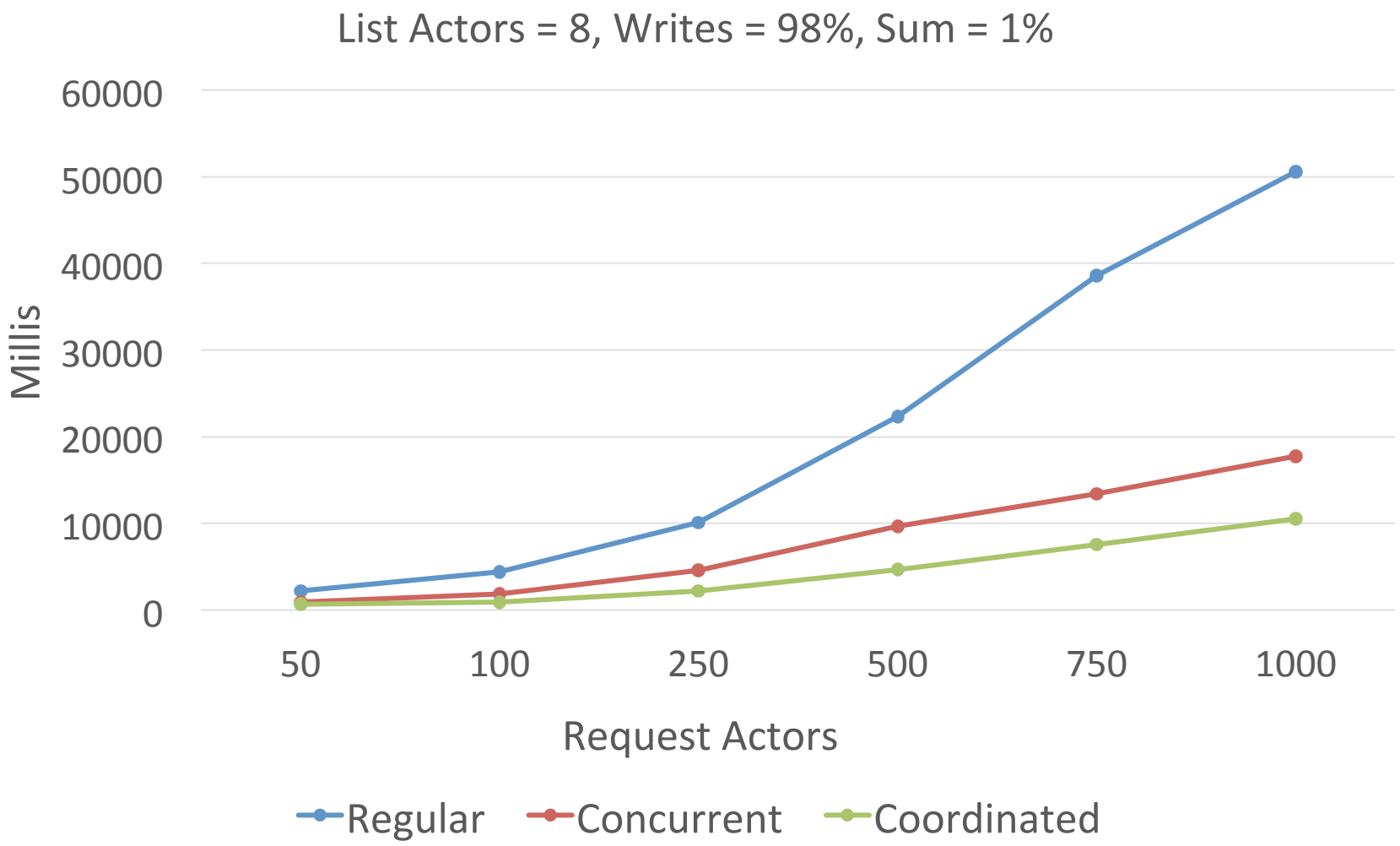
Remove blocking; process other messages speculatively

- Pre-commit the local coordinated transaction
- Process other messages in a transaction speculatively

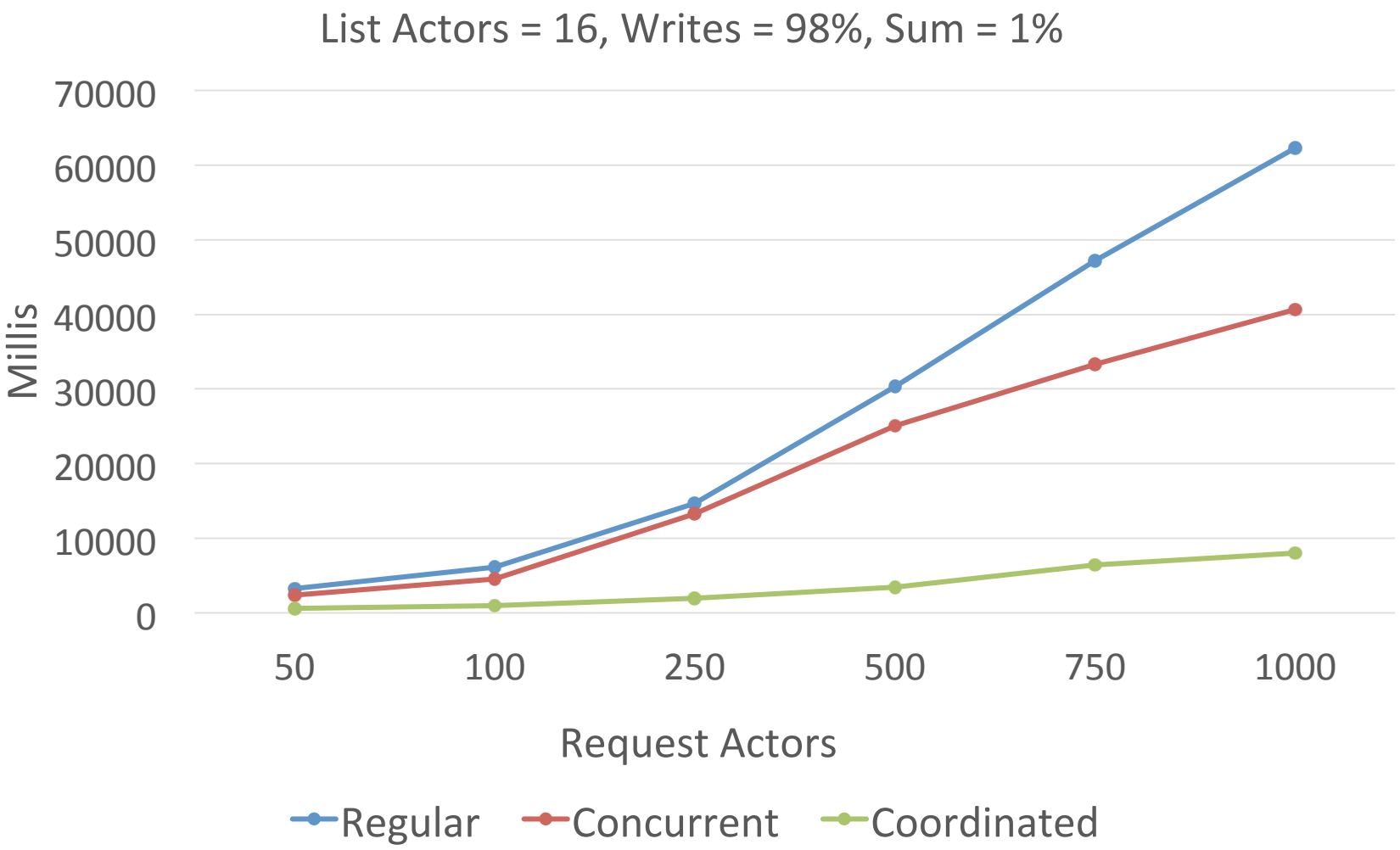
Non-blocking coordinated transactions



Evaluation


List Actors = 8, Writes = 98%, Sum = 1%
60000
50000
40000
30000
20000
10000
0
Millis
50
100
250
500
750
1000
Request Actors
Regular
Concurrent
Coordinated

Evaluation


List Actors = 16, Writes = 98%, Sum = 1%
70000
60000
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30000
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Millis
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100
250
500
750
1000
Request Actors
Regular
Concurrent
Coordinated

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

Thank you
Questions?