

Enhancing Permissiveness of Transactional Memory via Time-Warp

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Transactional Memory

Simple API + guarantee of correctness criterion
Easy to use and reason

Introduction

To guarantee a given correctness level, a TM aborts transactions.

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A ● —

B ● — $r(z)$

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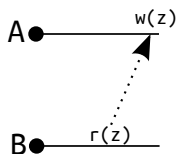
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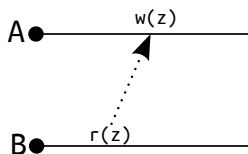
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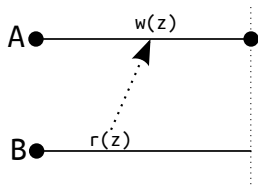
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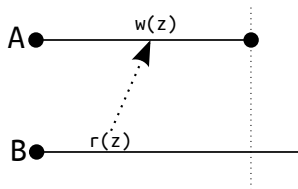
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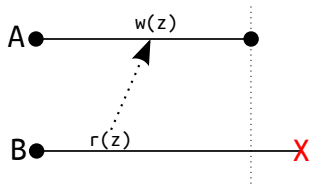
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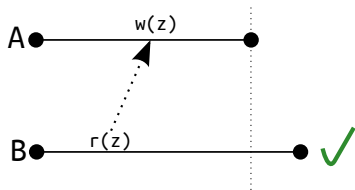


Problem at hands

But why are we aborting the transaction in the example?

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Instead, we could do the following:



Serialization order: B, A

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Condition:

Abort T if its reads are not up-to-date when it attempts to commit.

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- But **not** sufficient

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Condition:

Abort T if its reads are not up-to-date when it attempts to commit.

Serializability:

- Necessary condition
- But **not** sufficient
- Deemed to be practical

Permissiveness

Notion of avoiding unnecessary abortions

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Notion of avoiding unnecessary aborts:

- If it only aborts a transaction when the resulting history (without the abort) does not respect some target correctness criterion

Permissiveness

State of the art TMs far from being permissive.

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State of the art TMs far from being permissive.

- Cost is **not** negligible.

What do we have to counter that?

- One way is to track the graph of dependencies — DATM
 - ▶ inconsistent reads and zombie transactions
- Maintain interval of possible serialization points — AVSTM
 - ▶ Moderate bookkeeping
 - ▶ Aborts read-only transactions

Goal

Enhance permissiveness without such costs

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Enhance permissiveness without such costs:

- More restrictive abort condition
- Always read consistently
- Wait-free read-only transactions (mv-permissiveness)

Time-warping

Allow transactions to commit in the past

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Allow transactions to commit in the past:

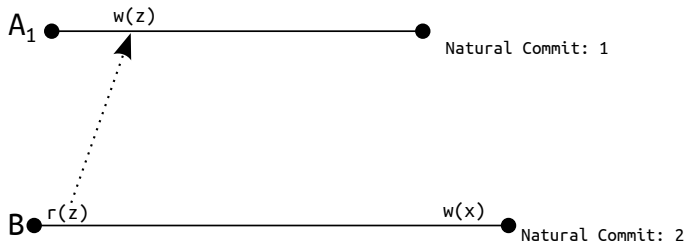
- Pick the condition defined previously
 - ▶ Abort T if its reads are not up-to-date when it attempts to commit.

Time-warping

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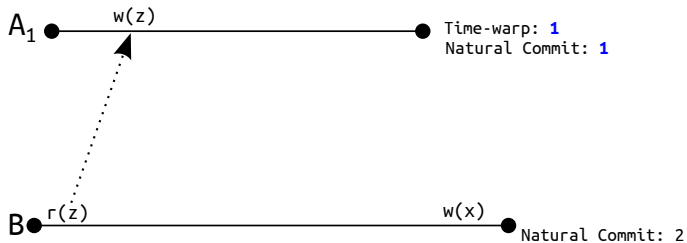
- Pick the condition defined previously
 - ▶ Abort T if its reads are not up-to-date when it attempts to commit.
- Commit T and serialize it before the writes it missed
 - ▶ Time-warp commit

Time-warp



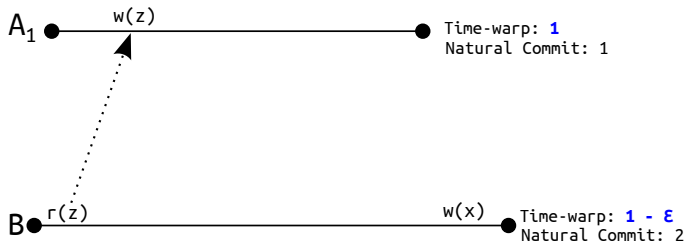
Same history as before

Time-warp



Time-warp order

Time-warp



B time-warp commits

Time-warp

When can we not apply this idea?

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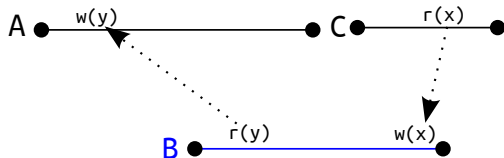
Time-warp

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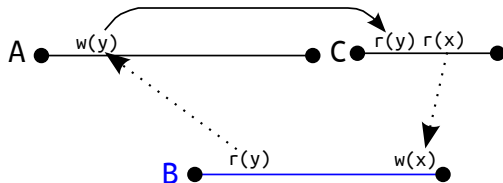
- Three transactions connected — a triad
- The link between all three — the pivot
- Abort T if:
 - ▶ Completes a triad
 - ▶ Whose pivot time-warp committed

Abort rule



C aborts here

Abort rule



(rather strict) necessary condition for a cycle

Theoretical and Practical results

- Virtual World Consistency

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 - ▶ Serializability for committed transactions
 - ▶ Prevent a range of phenomena for running transactions

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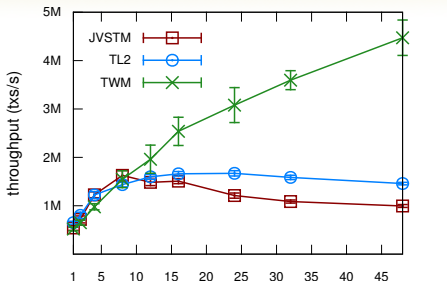
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- Lock-free prototype in Java: TWM

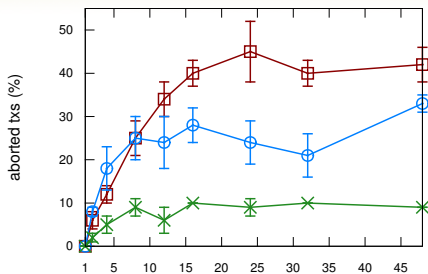
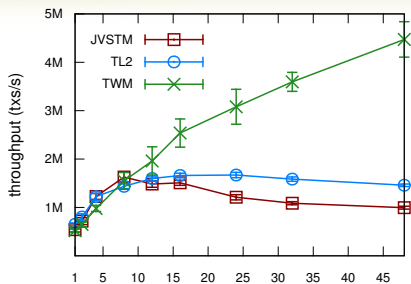
Theoretical and Practical results

- Virtual World Consistency
 - ▶ Serializability for committed transactions
 - ▶ Prevent a range of phenomena for running transactions
- Lock-free prototype in Java: TWM
- 48 core machine
- Comparison with TL2 and JVSTM

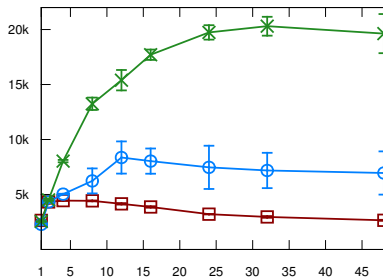
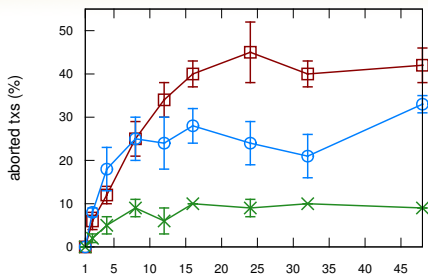
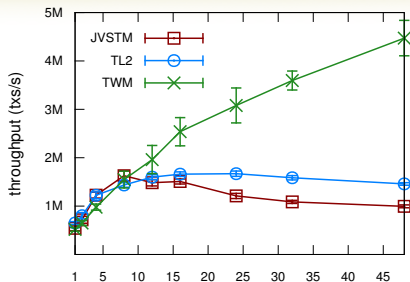
SkipList and Vacation from STAMP



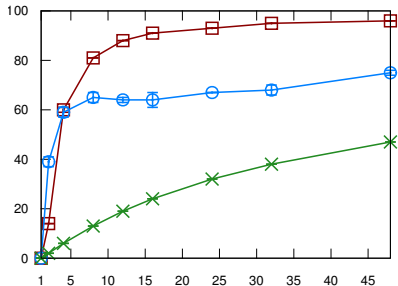
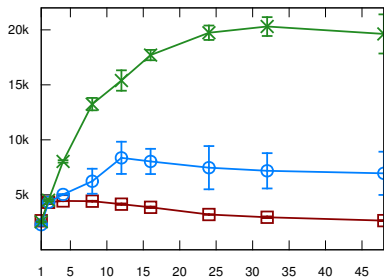
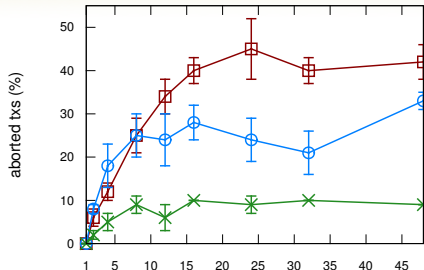
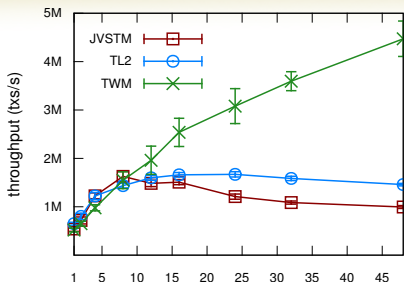
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Ongoing work

Distributed Data Platforms:

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- Flurry of strong consistency

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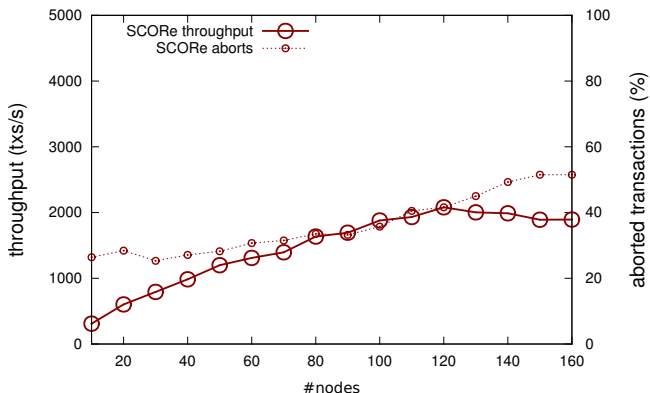
- Flurry of strong consistency
- Scalable performance in read-dominant or uncontended scenarios

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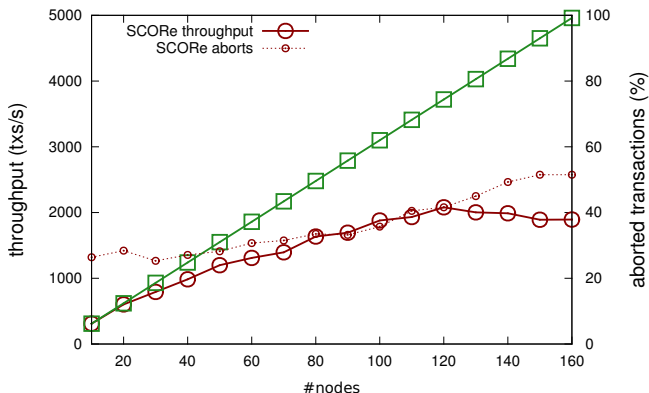
- Flurry of strong consistency
- Scalable performance in read-dominant or uncontended scenarios
- **Bumper**: tackle conflict-prone scenarios

Ongoing work



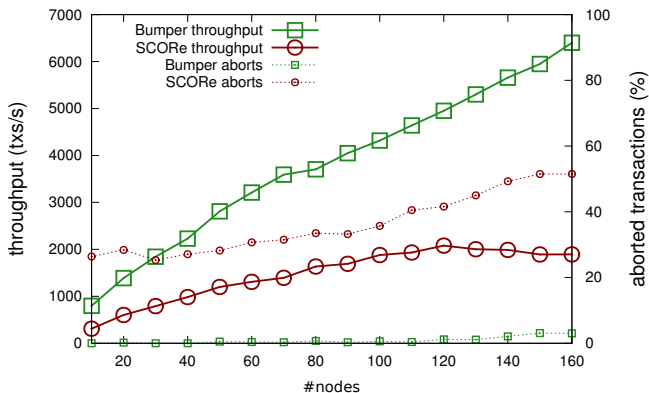
Limited scalability when faced with contention in TPC-C

Ongoing work



Limited scalability when faced with contention in TPC-C

Ongoing work



Same TPC-C workload

Relevant publications

- *Enhancing Permissiveness in Transactional Memory via Time-Warping.*
Nuno Diegues and Paolo Romano.
Technical Report INESC-ID 2013.
- *Bumper: Sheltering Transactions from Conflicts.*
Nuno Diegues and Paolo Romano.
Technical Report INESC-ID 2013.

Thank you