On the design space of Parallel Nesting

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Selling point of TM

Composability

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Composability

Parallel Nesting

Time complexity analysis may be deceiving in TMs

Outline

Compare three parallel nesting approaches

1. JVSTM
2. NesTM[1]
3. PNSTM[2]

[1] W. Baek, N. Bronson, C. Kozyrakis, and K. Olukotun. Implementing and evaluating nested parallel transactions in software transactional memory. In SPAA '10.

[2] J. Barreto, A. Dragojević, P. Ferreira, R. Guerraoui, and M. Kapalka. Leveraging parallel nesting in transactional memory. In PPoPP '10.

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Worst-case complexities - JVSTM

	JVSTM
read	$O(maxDepth)$
write	$O(1)$
commit	$O(r + children)$

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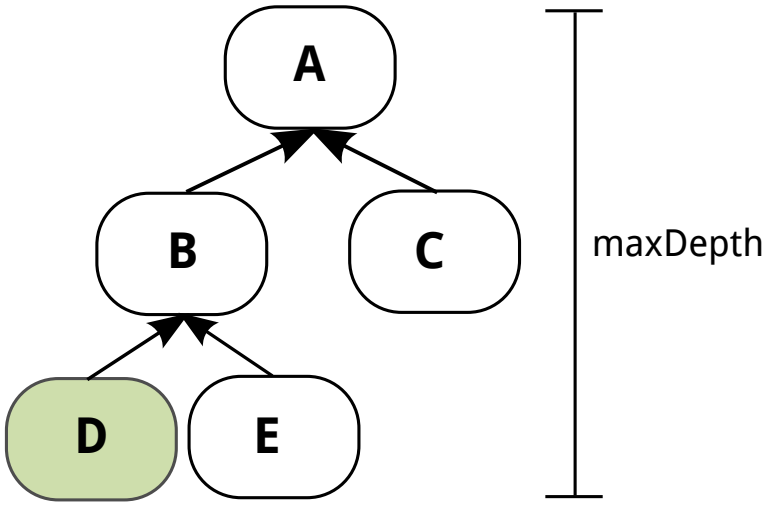
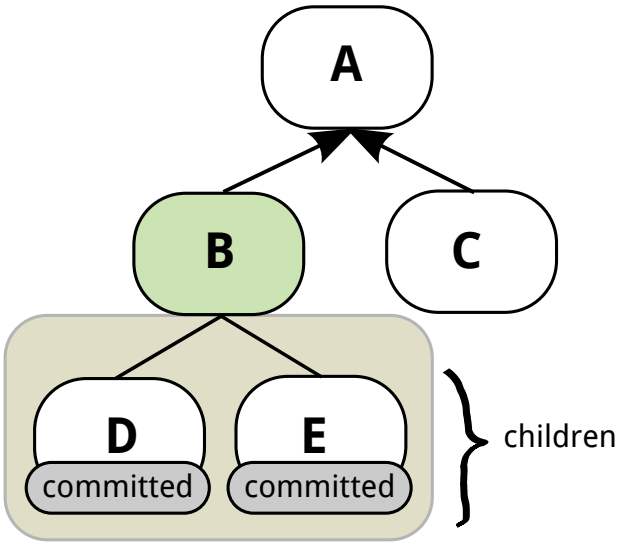


Worst-case complexities - JVSTM

	JVSTM
read	$O(maxDepth)$
write	$O(1)$
commit	**O(r+children)**

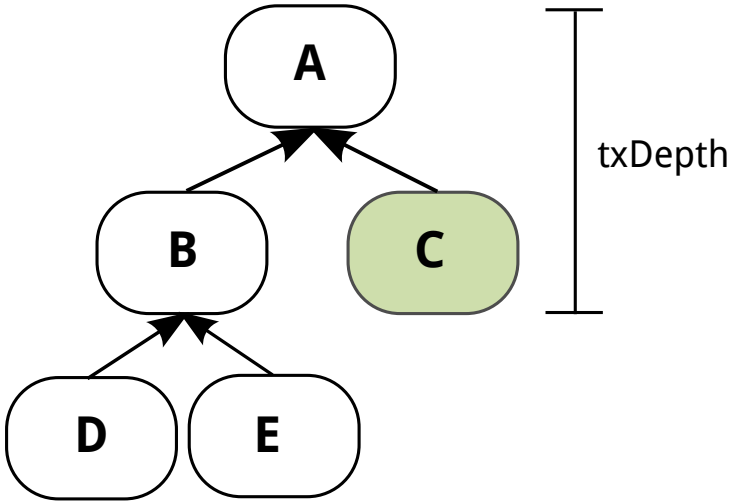


Worst-case complexities - NesTM

	JVSTM	NesTM
read	$O(maxDepth)$	$O(1)$
write	$O(1)$	$O(txDepth)$
commit	$O(r + children)$	$O(r + w)$

Worst-case complexities - NesTM

	JVSTM	NesTM
read	$O(maxDepth)$	$O(1)$
write	$O(1)$	**O(txDepth)**
commit	$O(r + children)$	$O(r + w)$



Worst-case complexities - PNSTM

	JVSTM	NesTM	PNSTM
read	$O(maxDepth)$	$O(1)$	$O(1)$
write	$O(1)$	$O(txDepth)$	$O(1)$
commit	$O(r + children)$	$O(r + w)$	$O(1)$

Worst-case complexities

	JVSTM	NesTM	PNSTM
read	$O(maxDepth)$	$O(1)$	**O(1)**
write	$O(1)$	$O(txDepth)$	**O(1)**
commit	$O(r + children)$	$O(r + w)$	**O(1)**

Best one?

Practical comparison

- STMBench7 - running given number of transactions

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- Implementation of STMs

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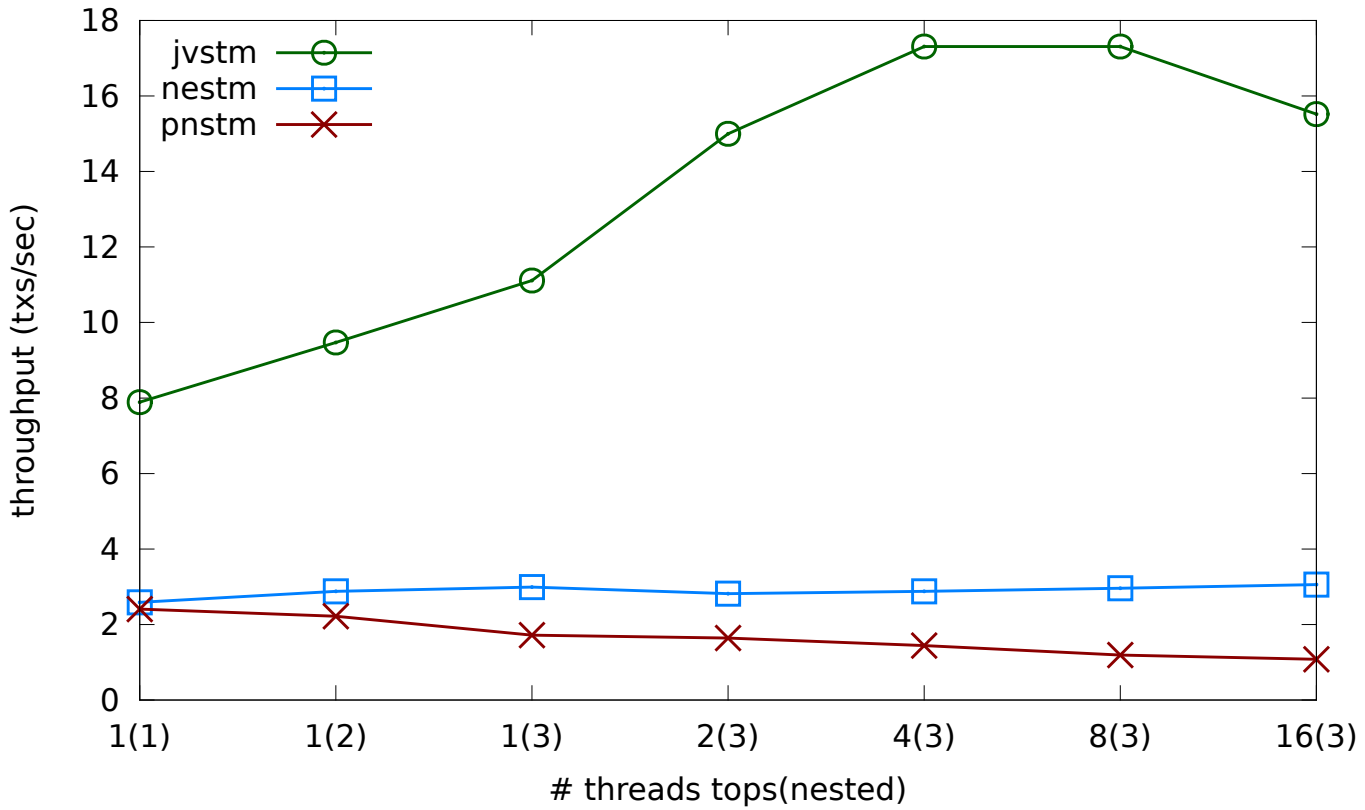
- Implementation of STMs
- Same API

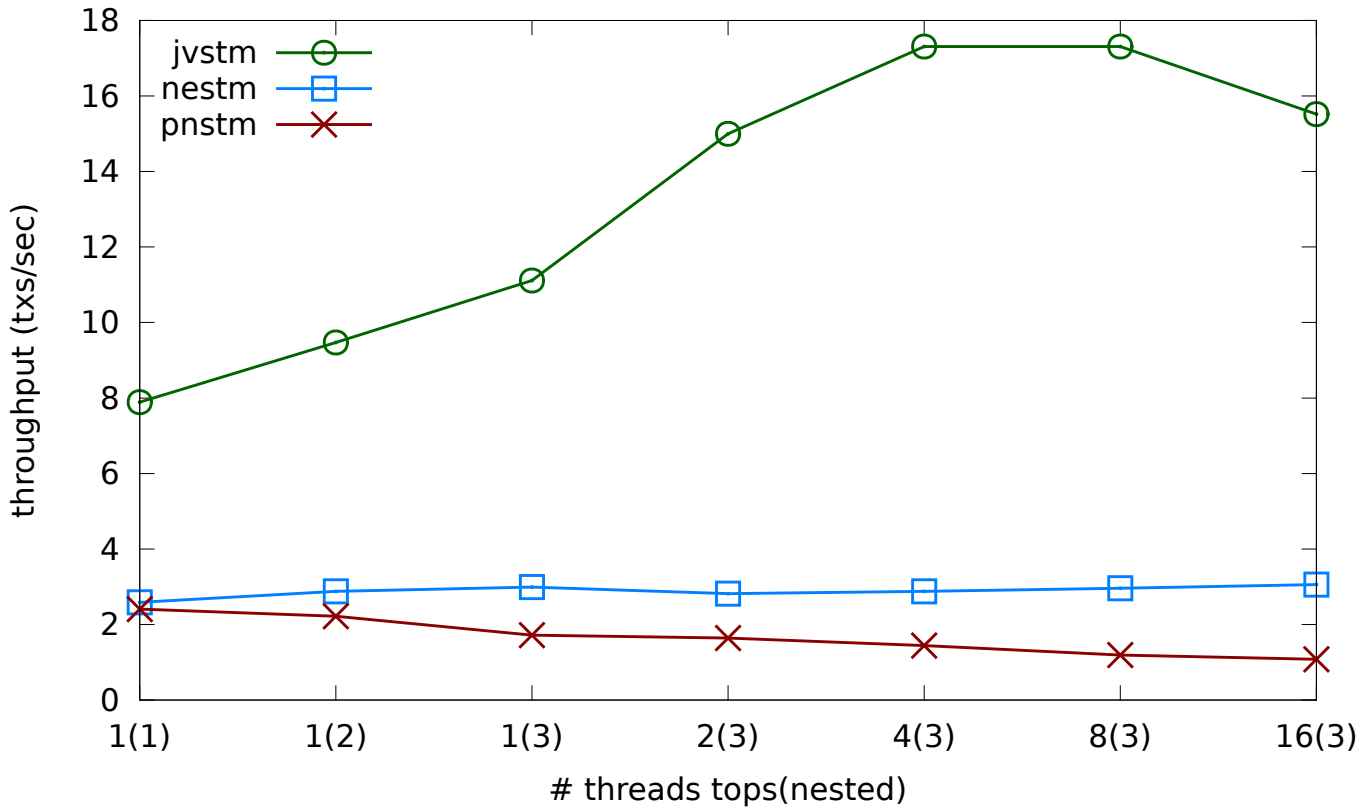
Practical comparison

- STMBench7 - running given number of transactions
- Implementation of STMs
- Same API
- 48 core machine

STMBench7

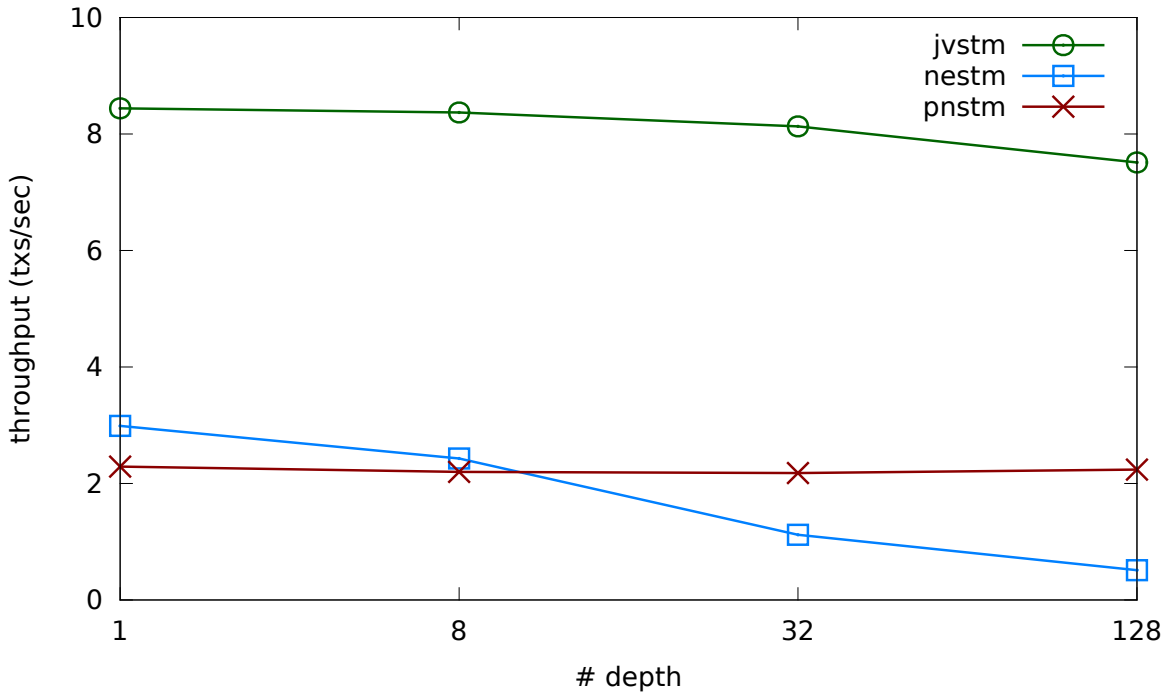

jvstm
nestm
pnstm
throughput (txs/sec)
0
2
4
6
8
10
12
14
16
18
1(1)
1(2)
1(3)
2(3)
4(3)
8(3)
16(3)
# threads tops(nested)

STMBench7



- 5 and 15 times with 48 threads/parallel nested

STMBench7 - Large depth count



Discussion

What is causing this?

Complexities of the fast-paths

	JVSTM	NesTM	PNSTM
read	**O(1)**	$O(1)$	$O(1)$
write	$O(1)$	**O(1)**	$O(1)$

Fast-paths occurrence

	Fast-path	Slow-path
JVSTM	0.99	0.01
NesTM	0.39	0.61
PNSTM	0.39	0.61

Fast-paths occurrence

	Fast-path	Slow-path	Time (μs)
JVSTM	0.99	0.01	1046
NesTM	0.39	0.61	5200
PNSTM	0.39	0.61	7357

Conflicts detected

	Conflicts
JVSTM	845
NesTM	1627
PNSTM	84496

Conflict detection

	JVSTM	NesTM	PNSTM
r-r	-	-	yes
r-w	yes	yes	yes
w-w	yes (if nested)	yes	yes

Conflict detection

	JVSTM	NesTM	PNSTM
r-r	-	-	yes
r-w	yes	yes	yes
w-w	yes (if nested)	yes	yes

Cheaper complexity bounds, more conflicts detected?

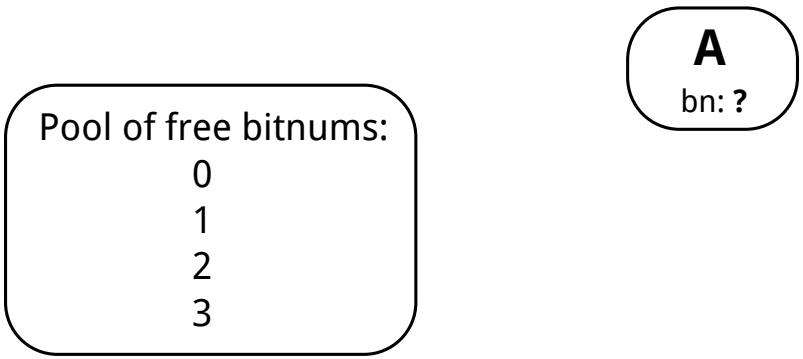
Summary

- Parallel nesting design is coupled with baseline TM
- Complexity analysis may be deceiving
- Average case and conflict detection

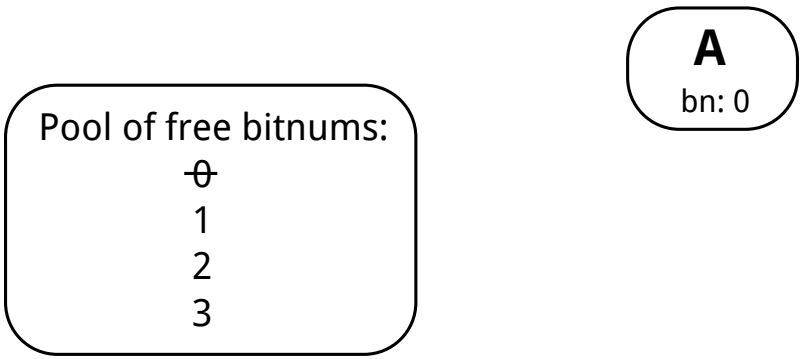
Thank you

Questions?

PNSTM



PNSTM

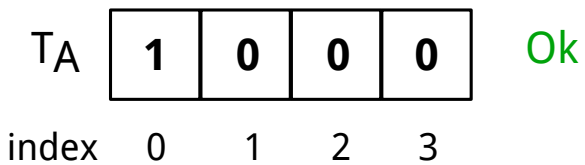


PNSTM

Pool of free bitnums:
~~0~~
1
2
3

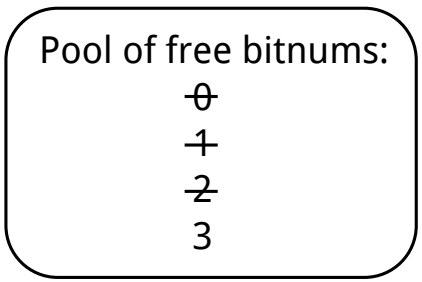
A
bn: 0

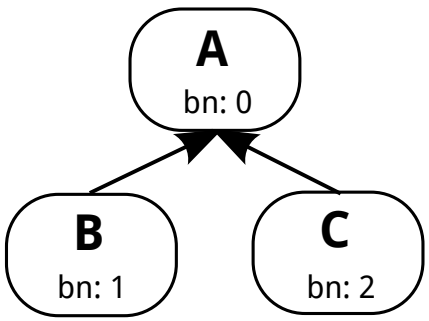
Access Stack of variable X



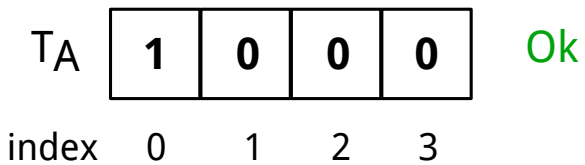
T_A reads X

PNSTM



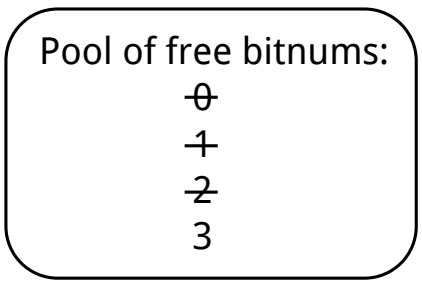


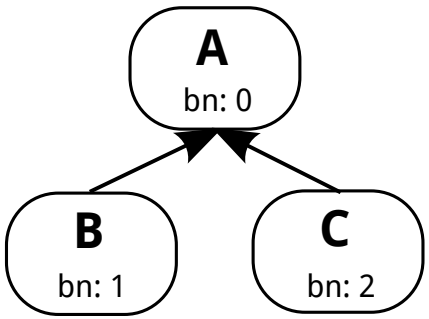
Access Stack of variable X



T_A spawns two children

PNSTM



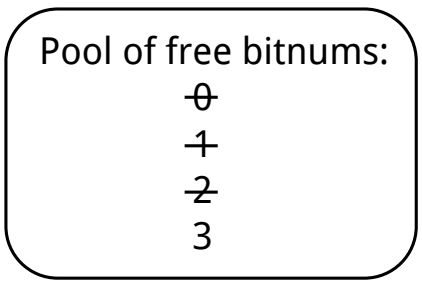


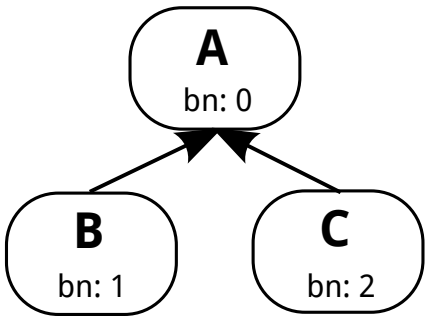
Access Stack of variable X

T_B	**1**	**1**	**0**	**0**	**?**
T_A	**1**	**0**	**0**	**0**	Ok
index	0	1	2	3	

T_B reads X

PNSTM



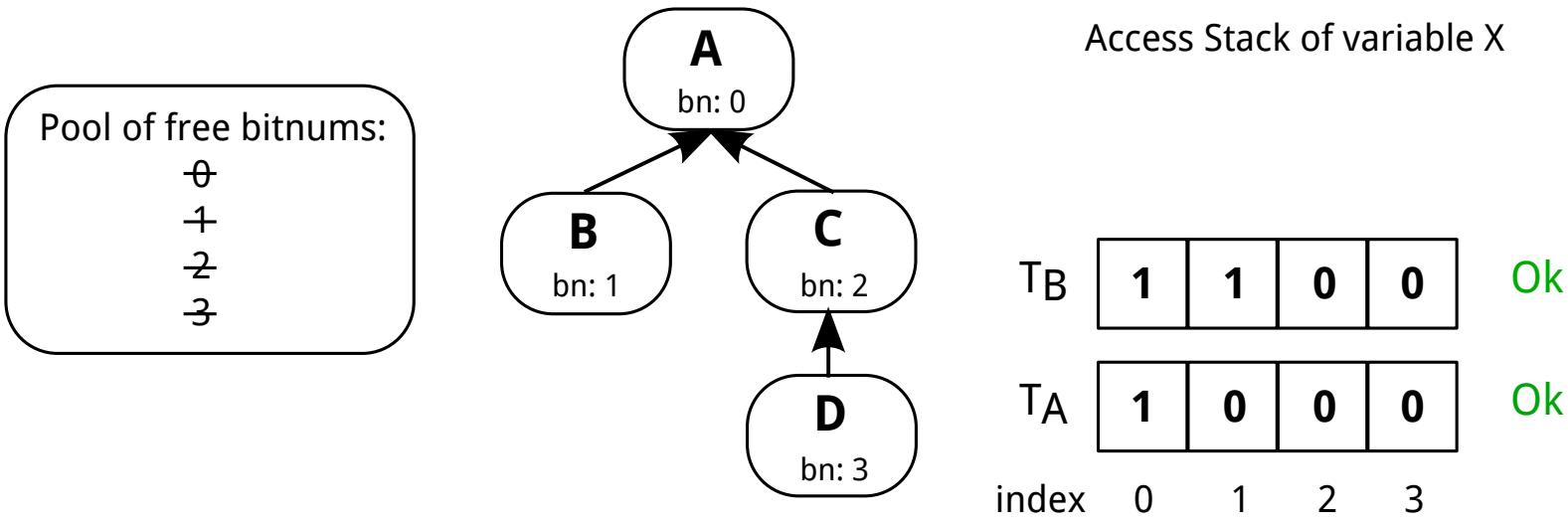


Access Stack of variable X

T_B	**1**	**1**	**0**	**0**	Ok
T_A	**1**	**0**	**0**	**0**	Ok
index	0	1	2	3	

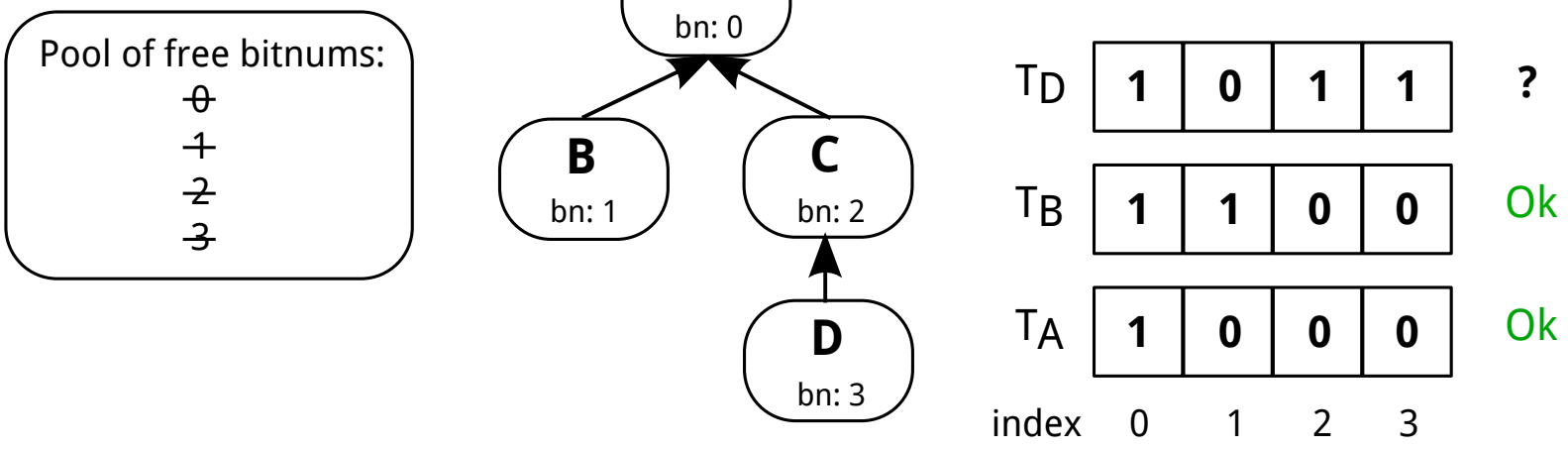
T_B reads X

PNSTM



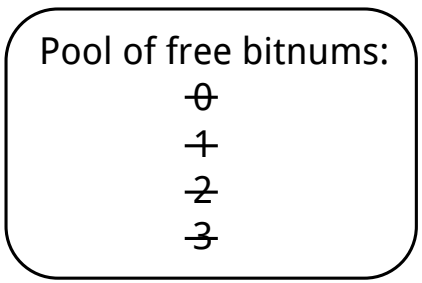
T_B spawns a child

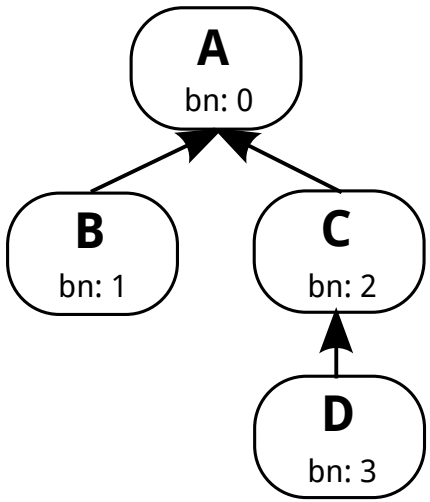
PNSTM

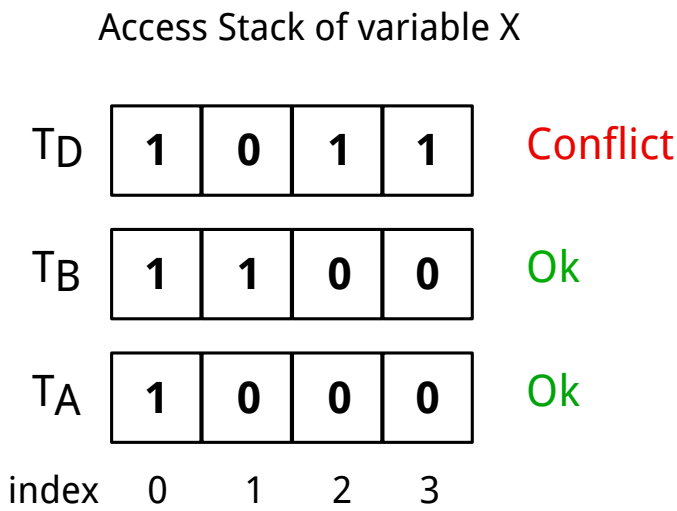


T_D reads X

PNSTM

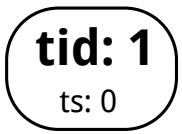






T_D reads X

NesTM

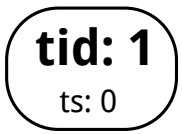


global clock: 0

	timestamp	tid
variable X:	0	0

T_1 starts

NesTM

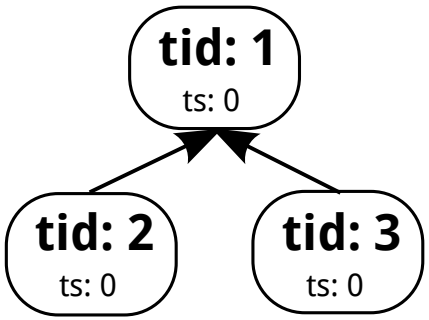


global clock: 0

	timestamp	tid	
variable X:	0	1	Ok

T_1 writes to X

NesTM

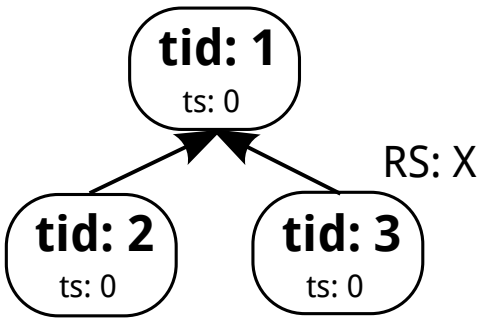


global clock: 0

	timestamp	tid
variable X:	0	1

T_1 spawns two children

NesTM - **read** operation

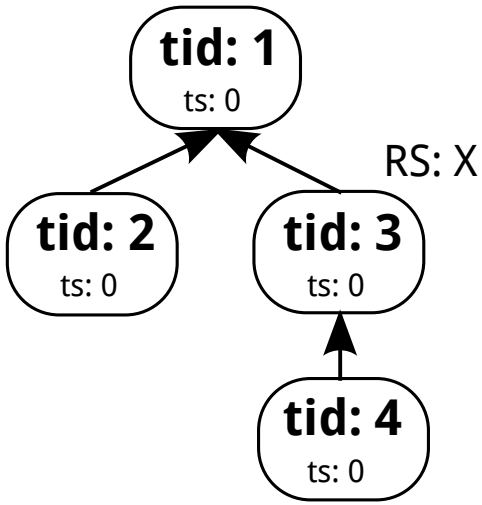


global clock: 0

	timestamp	tid
variable X:	0	1

T_3 reads X

NesTM - **write** operation

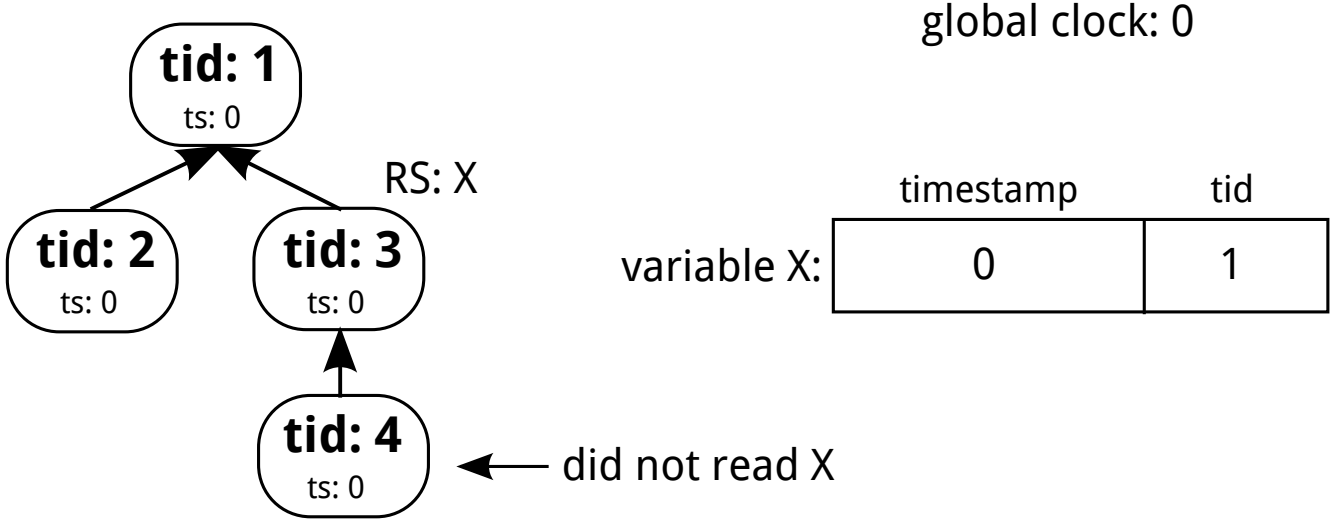


global clock: 0

	timestamp	tid
variable X:	0	1

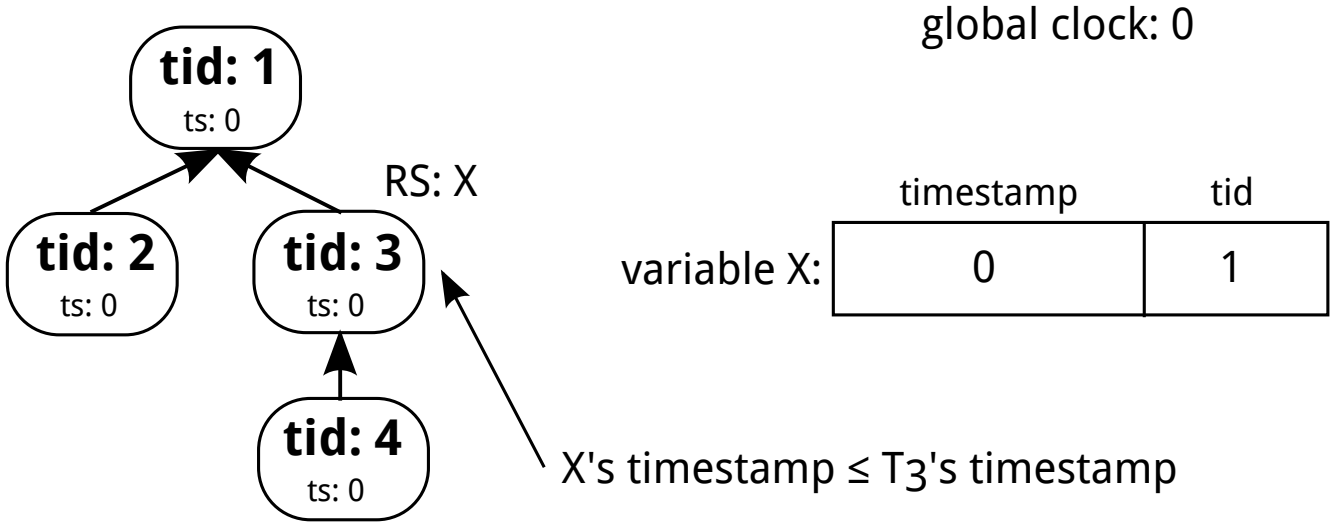
T_3 spawns a child

NesTM - **write** operation



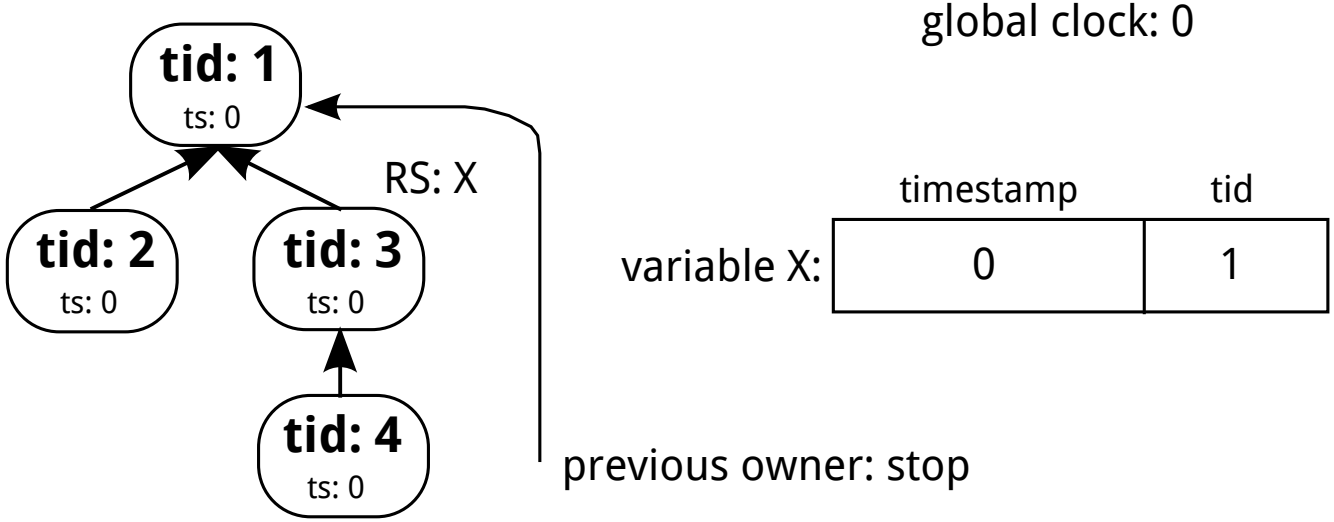
T_4 writes to X

NesTM - **write** operation



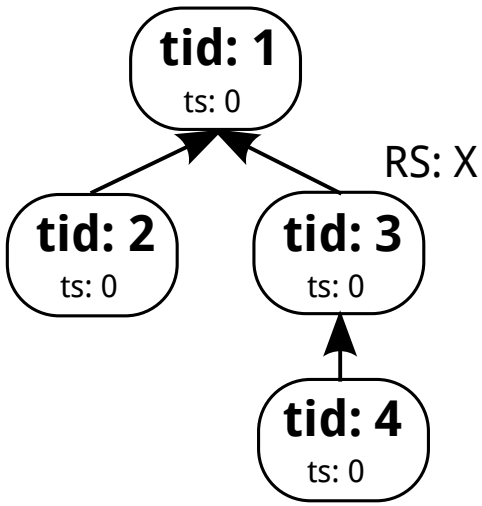
T_4 writes to X

NesTM - **write** operation



T_4 writes to X

NesTM - **write** operation

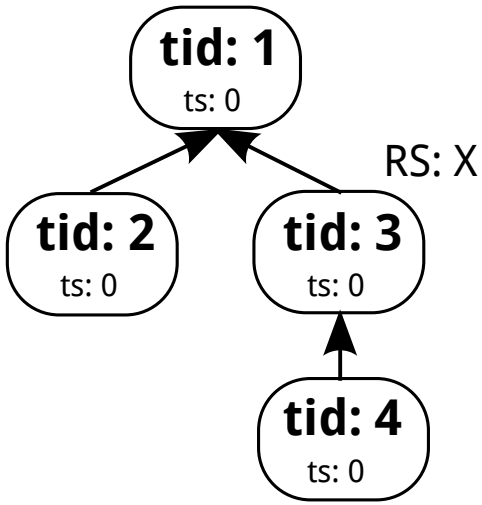


global clock: 0

	timestamp	tid	
variable X:	0	4	Ok

T_4 writes to X

NesTM - **commit** operation

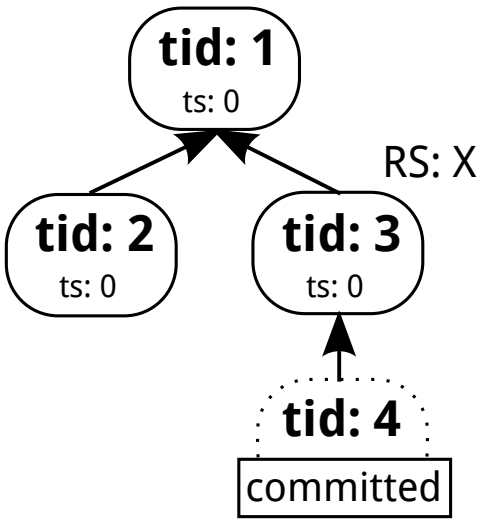


global clock: 0

	timestamp	tid
variable X:	0	4

T_4 prepares commits

NesTM - **commit** operation

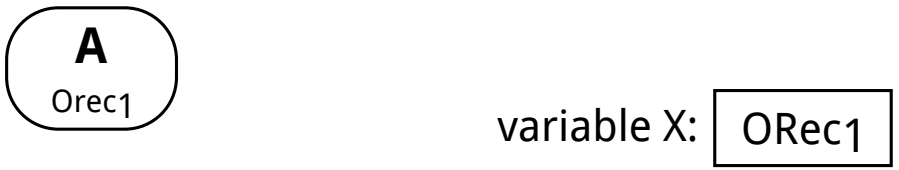


global clock: 1

	timestamp	tid
variable X:	1	3

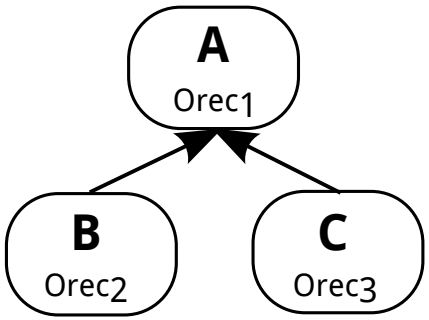
T_4 commits

JVSTM - **write** operation



T_A writes to X

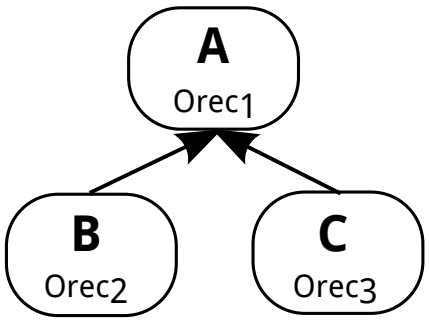
JVSTM - **write** operation

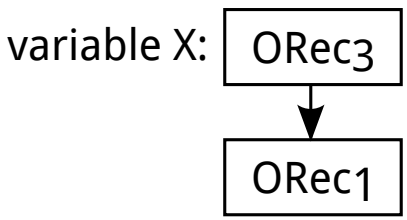


variable X: ORec1

T_A spawns two children

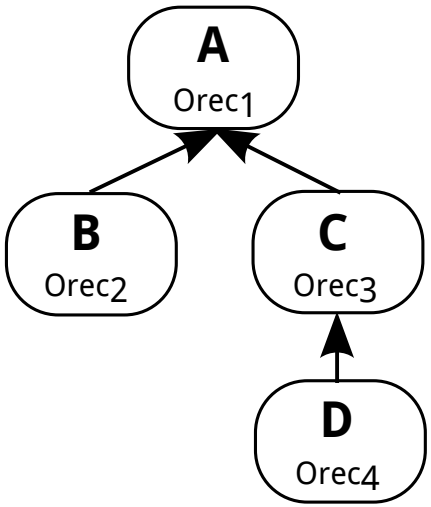
JVSTM - **write** operation

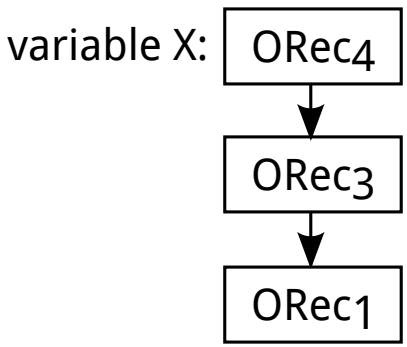




T_C writes to X

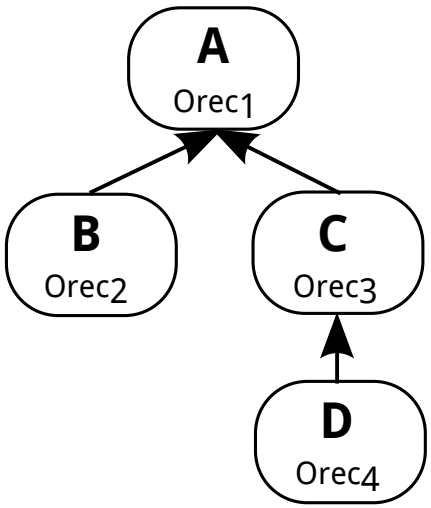
JVSTM - **write** operation

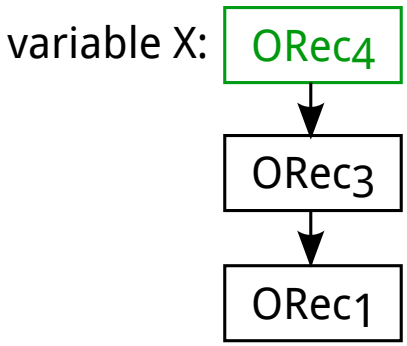




T_D is spawned and writes to X

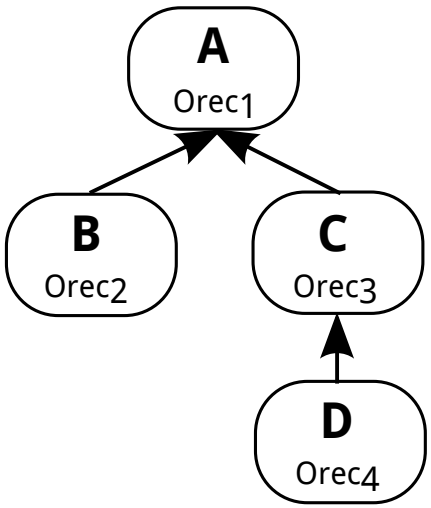
JVSTM - **read** operation

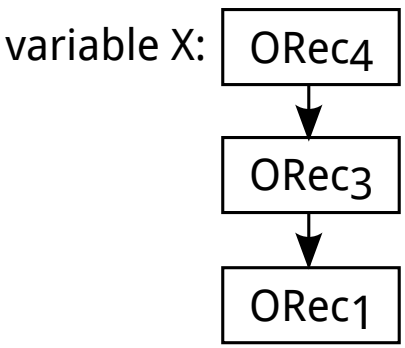




T_D reads X

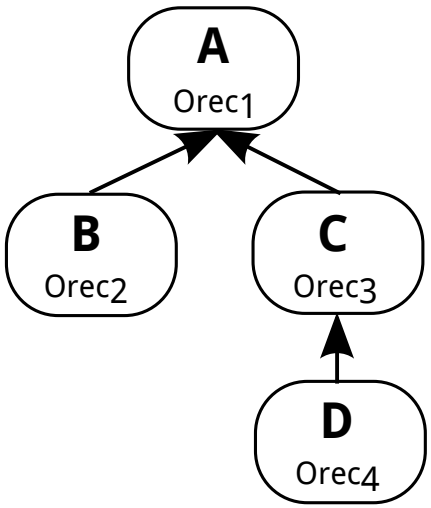
JVSTM - **read** operation

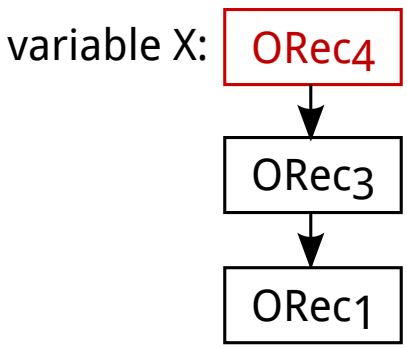




T_B reads X

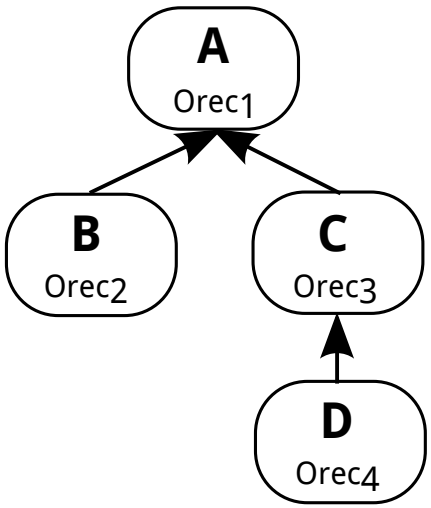
JVSTM - **read** operation

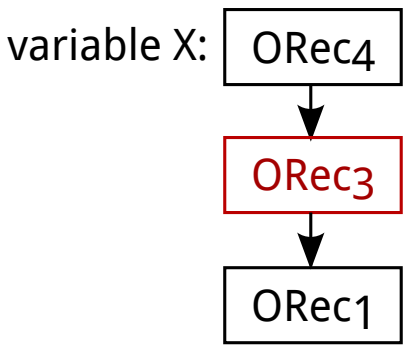




T_B reads X

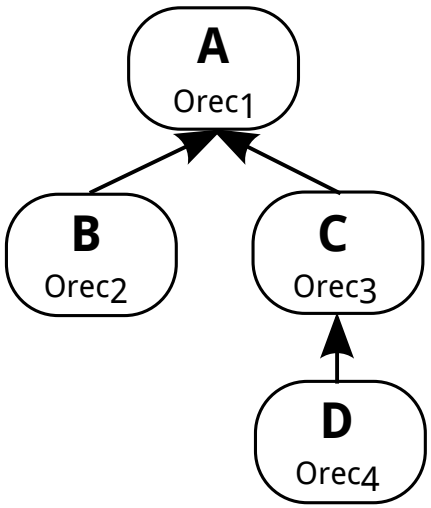
JVSTM - **read** operation

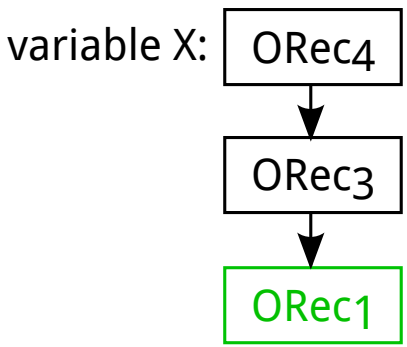




T_B reads X

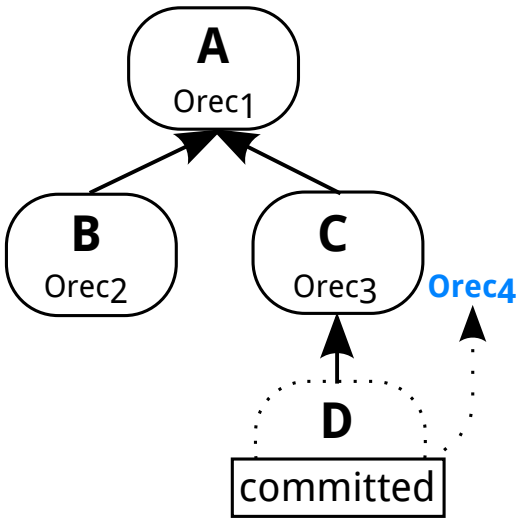
JVSTM - **read** operation

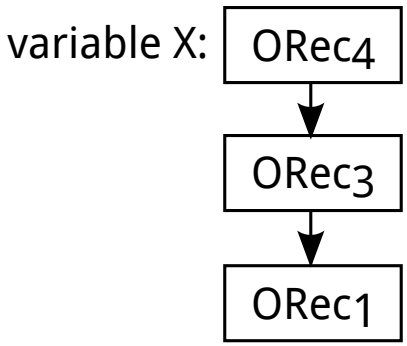




T_B reads X

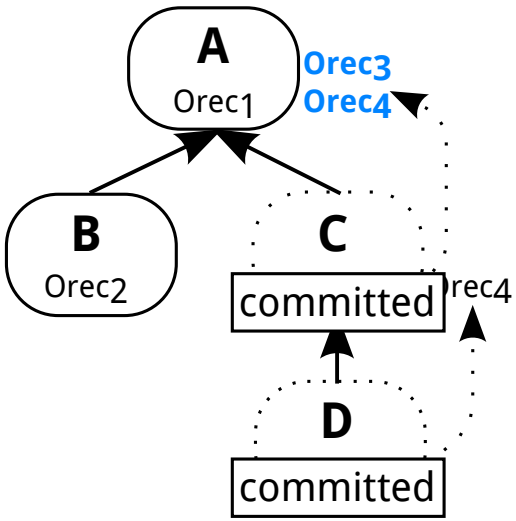
JVSTM - **commit** operation

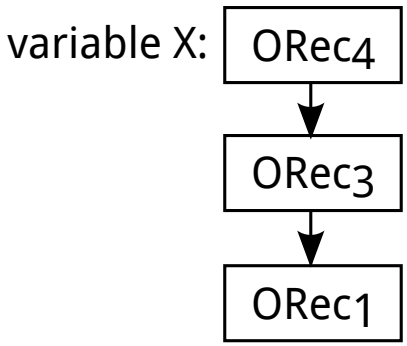




T_D commits

JVSTM - **commit** operation





T_C commits

Evaluation - Top-level txs only