# Octet: Capturing and Controlling Cross-Thread Dependences Efficiently


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# Parallel programming is mainstream

Shared memory with locks

Challenge:
performance & correctness

Need practical runtime support

- Help express parallelism better
- Eliminate concurrency errors
- Diagnose production bugs
- Deal with nondeterminism

Need practical runtime support

- Atomicity checking
- Data race detection
- Record & replay
- Transactional memory
- DRF/SC enforcement
- Deterministic execution

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Track dependences

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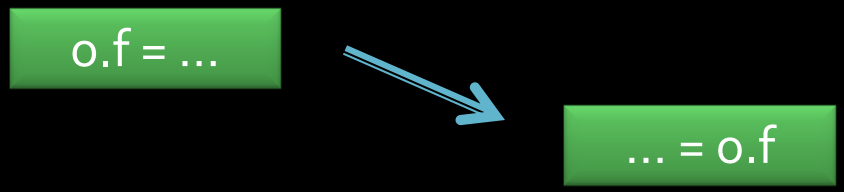
Control dependences



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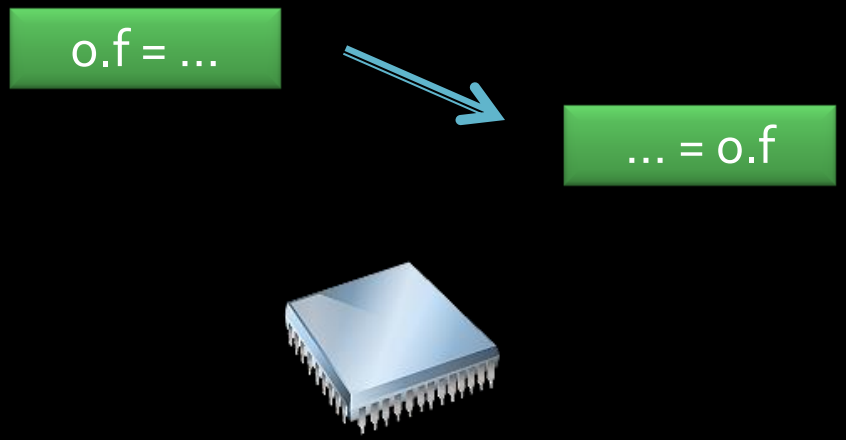

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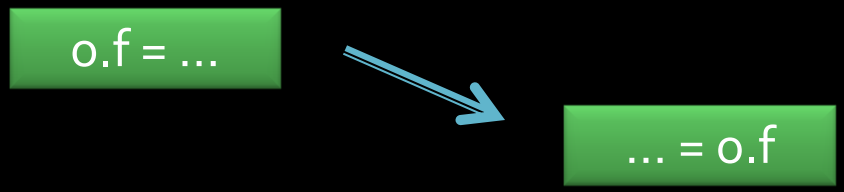


Commodity (software-only) approaches
slow programs by several times

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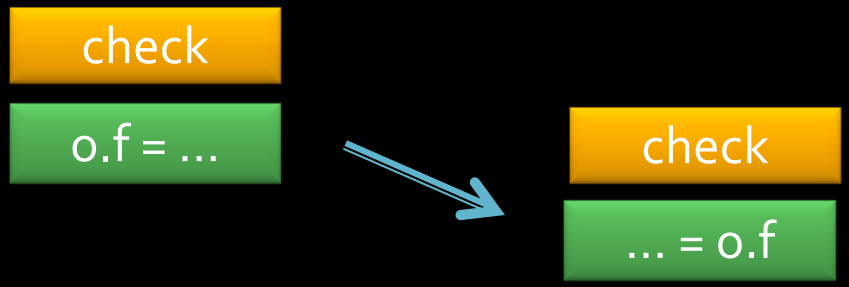


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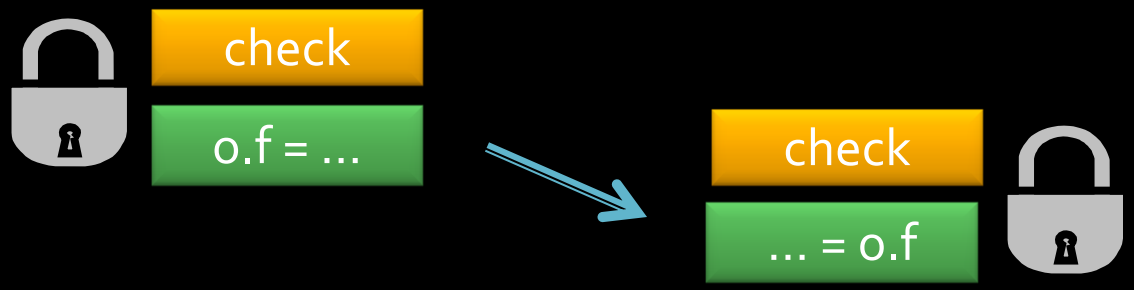


Any access could race →
add synchronization at every access

# Octet

Framework for runtime support

HB edges → all dependences

Atomicity of analysis & access

Concurrency control mechanism

Synchronization ⇔ cross-thread dependence

→ Qualitative performance improvement

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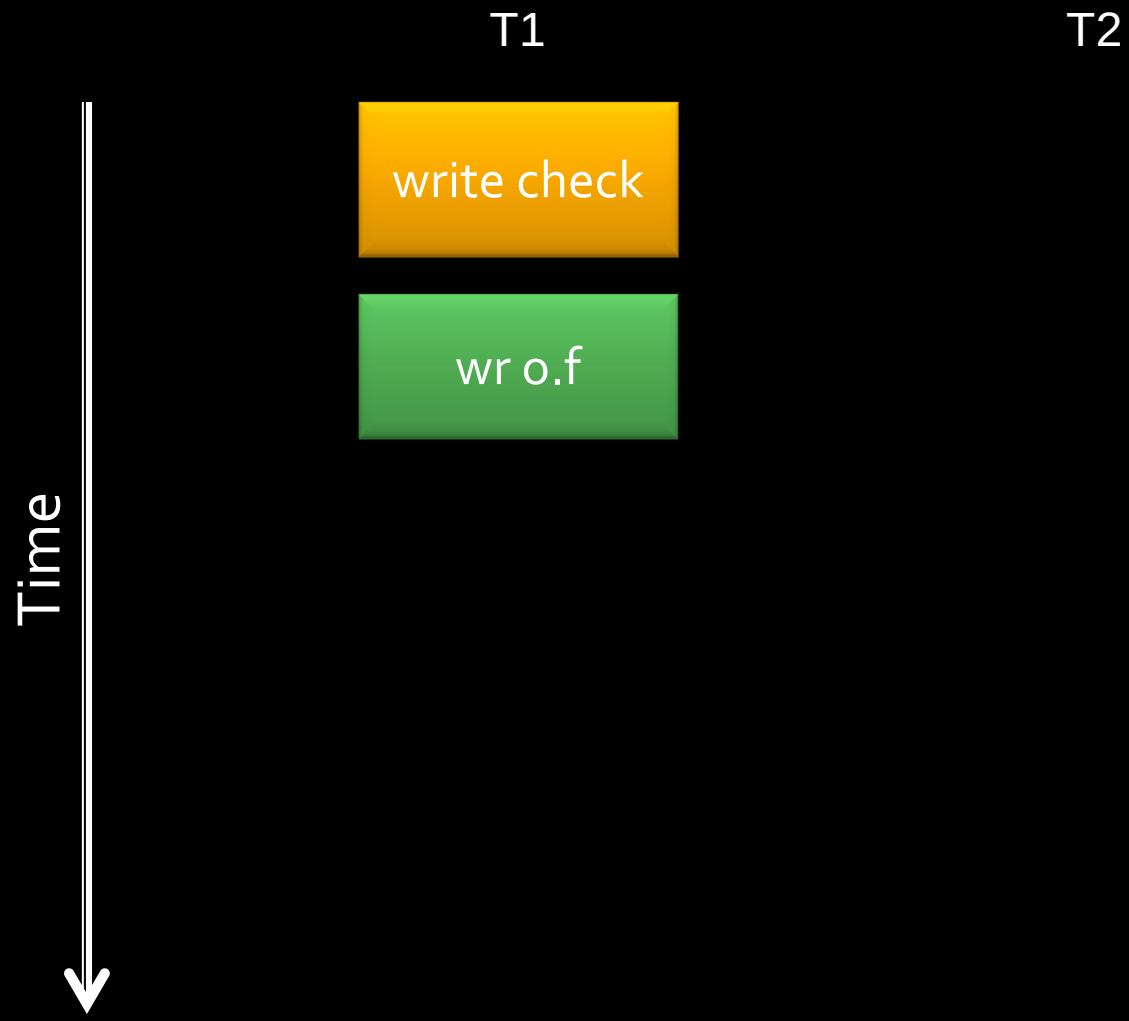
# Octet tracks ownership

Each object's **state** $\in \{ \mathrm{WrEx}_T, \mathrm{RdEx}_T, \mathrm{RdSh}_c \}$

o's state = $WrEx_{T1}$



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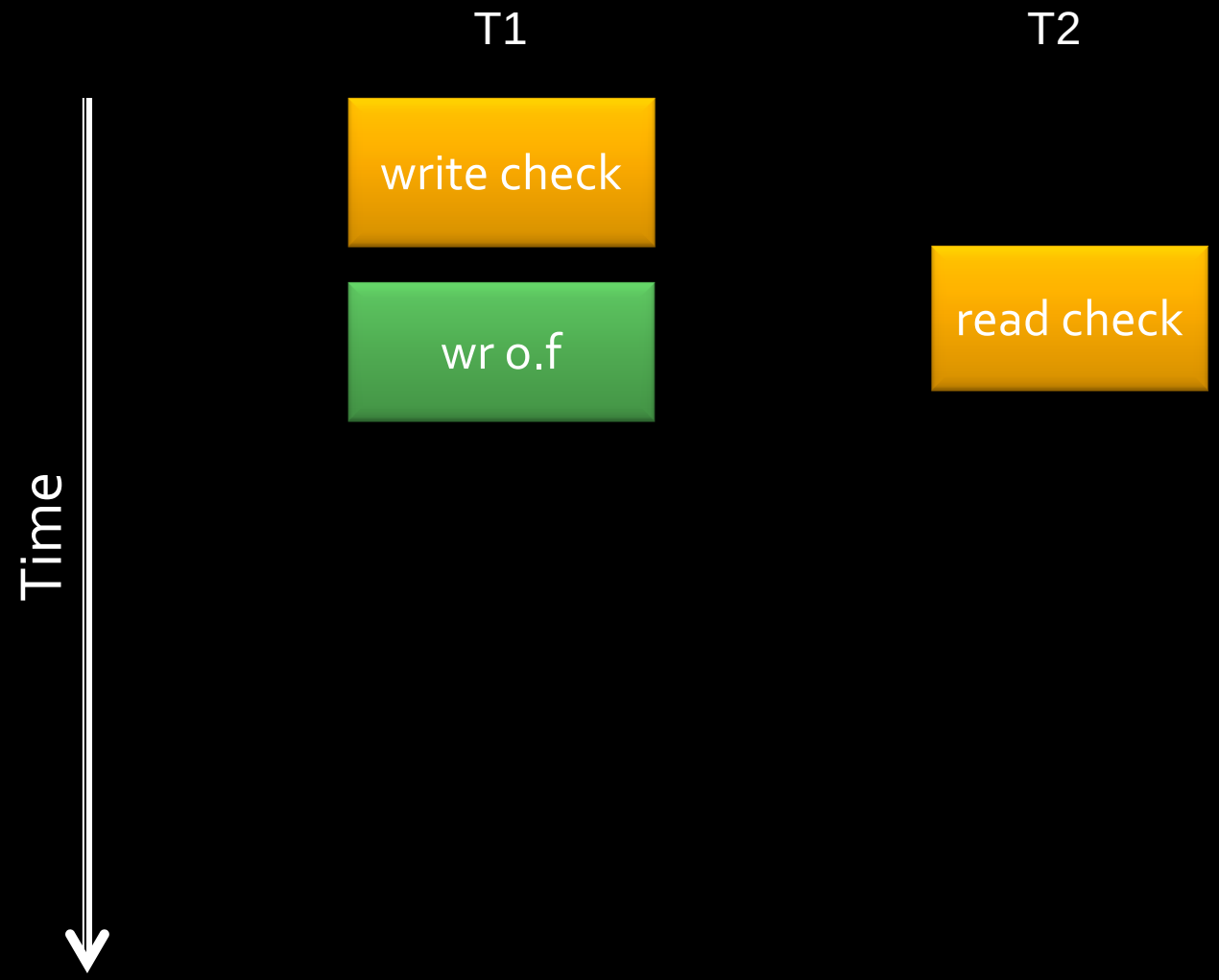

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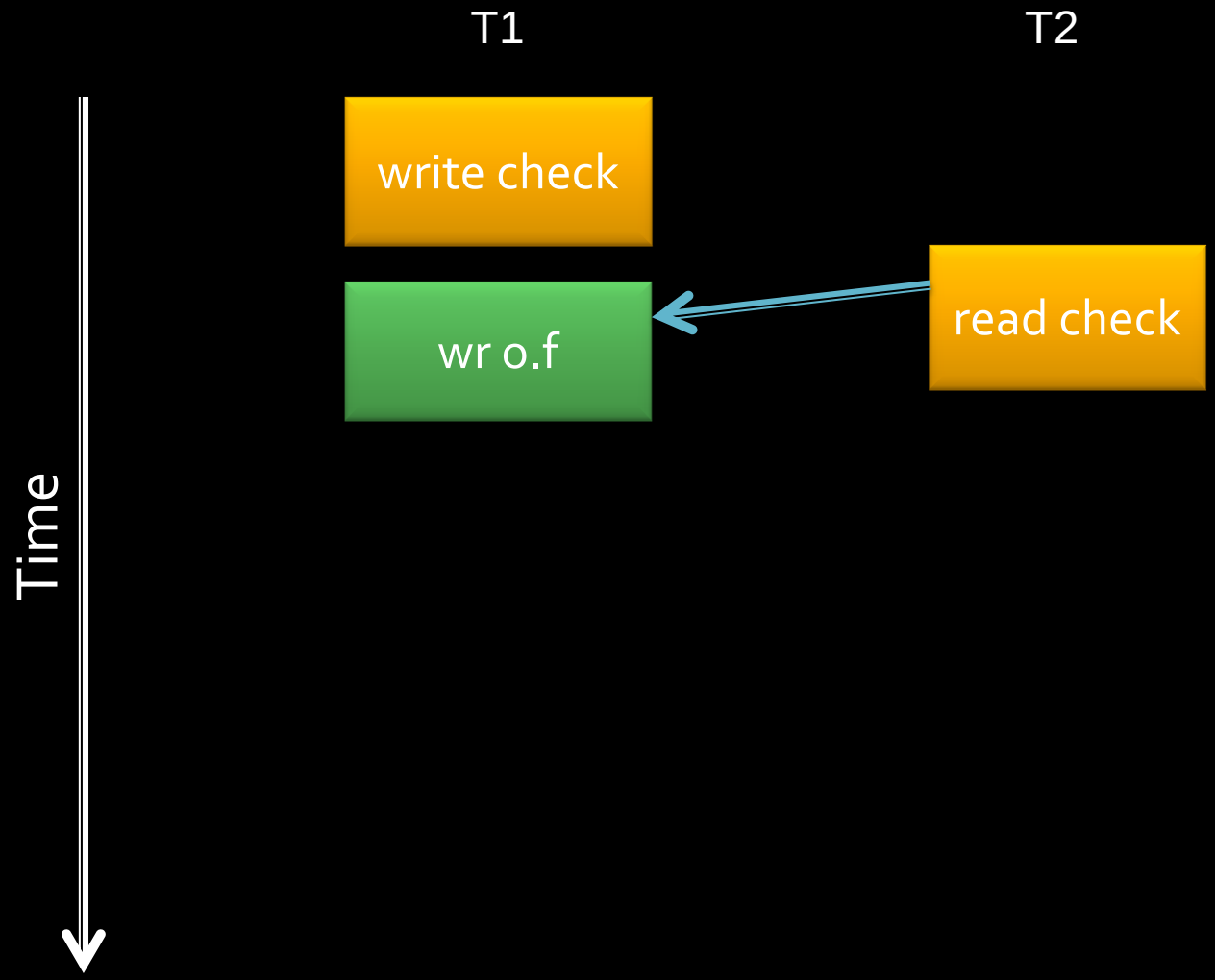

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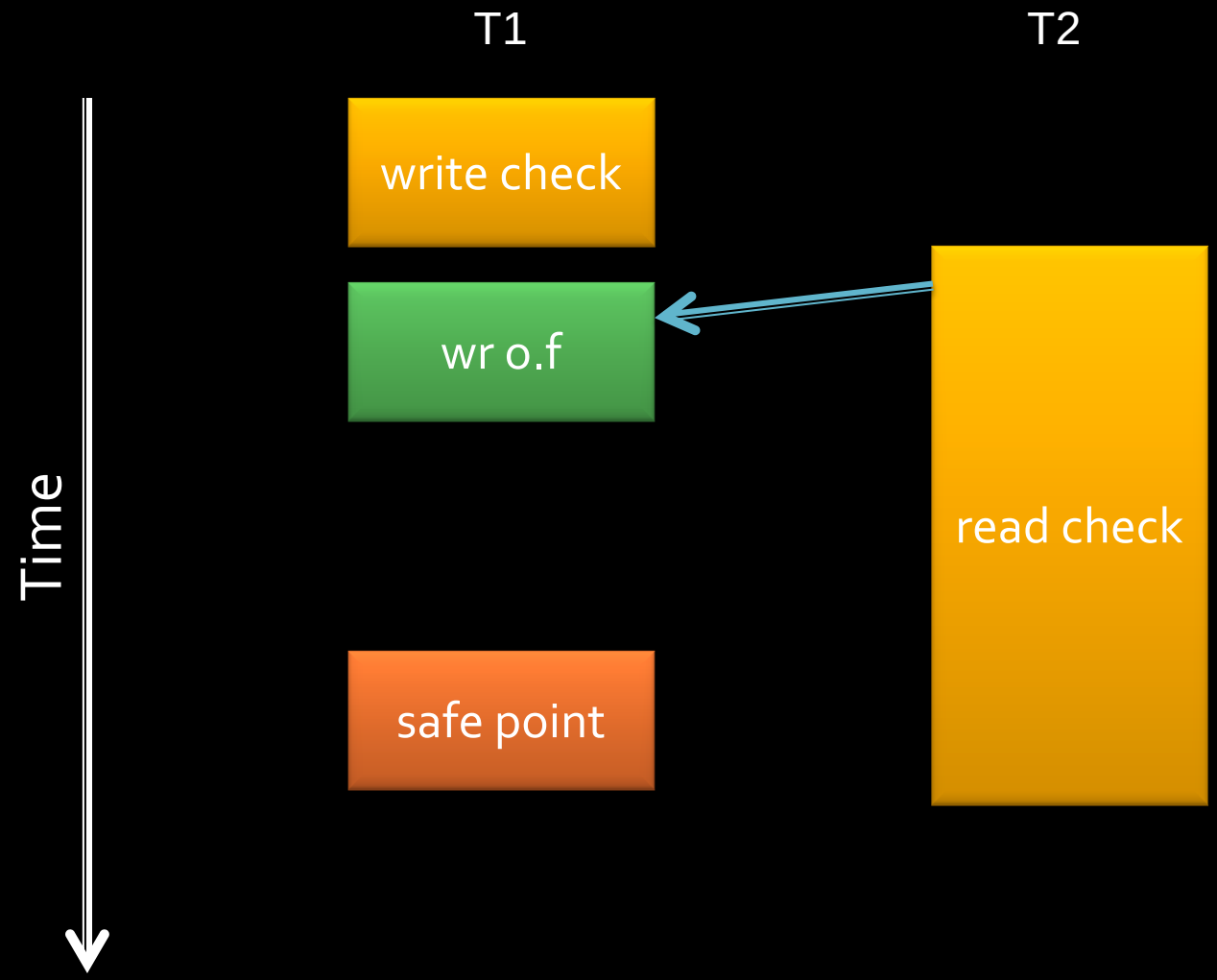

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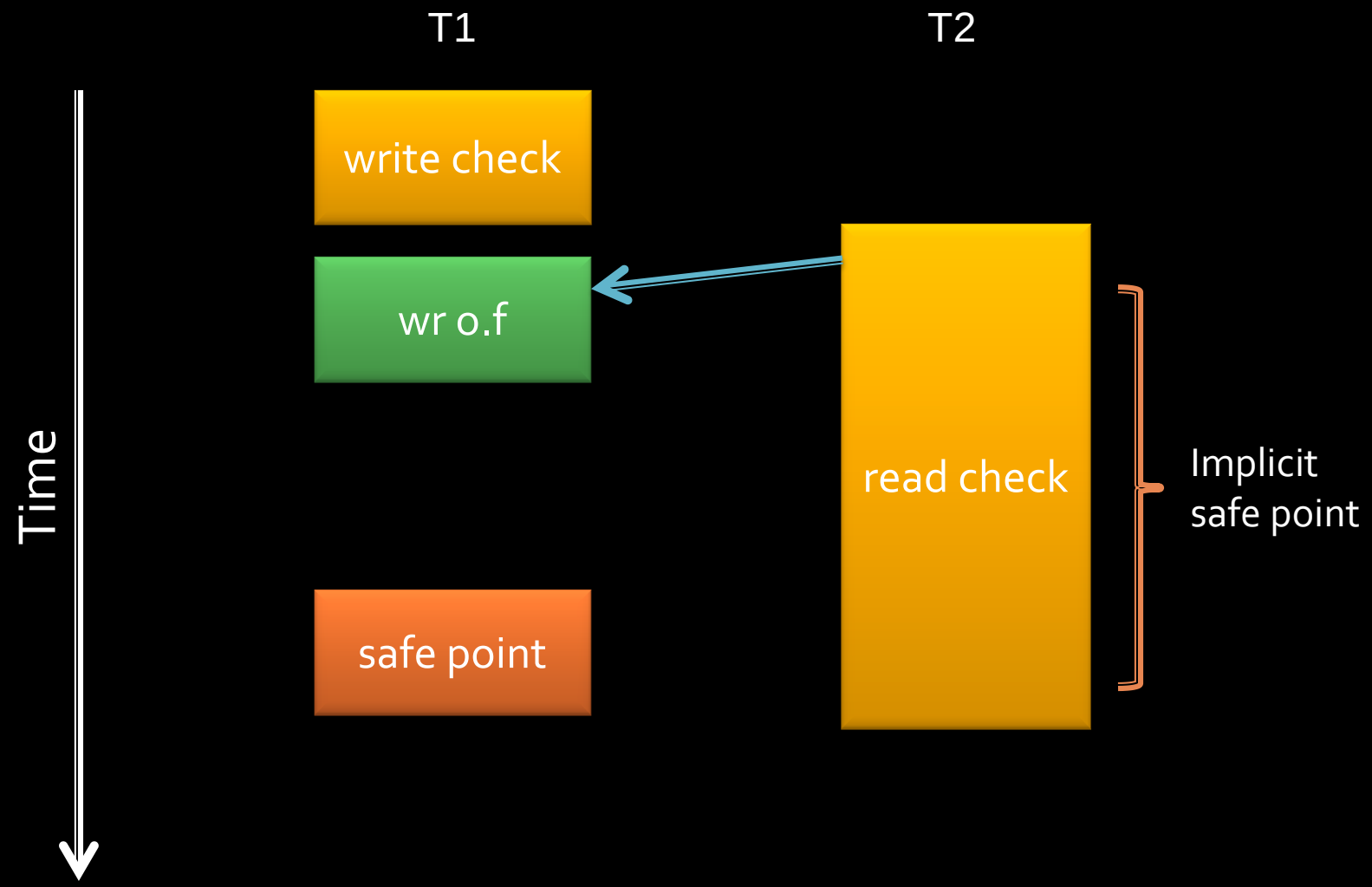

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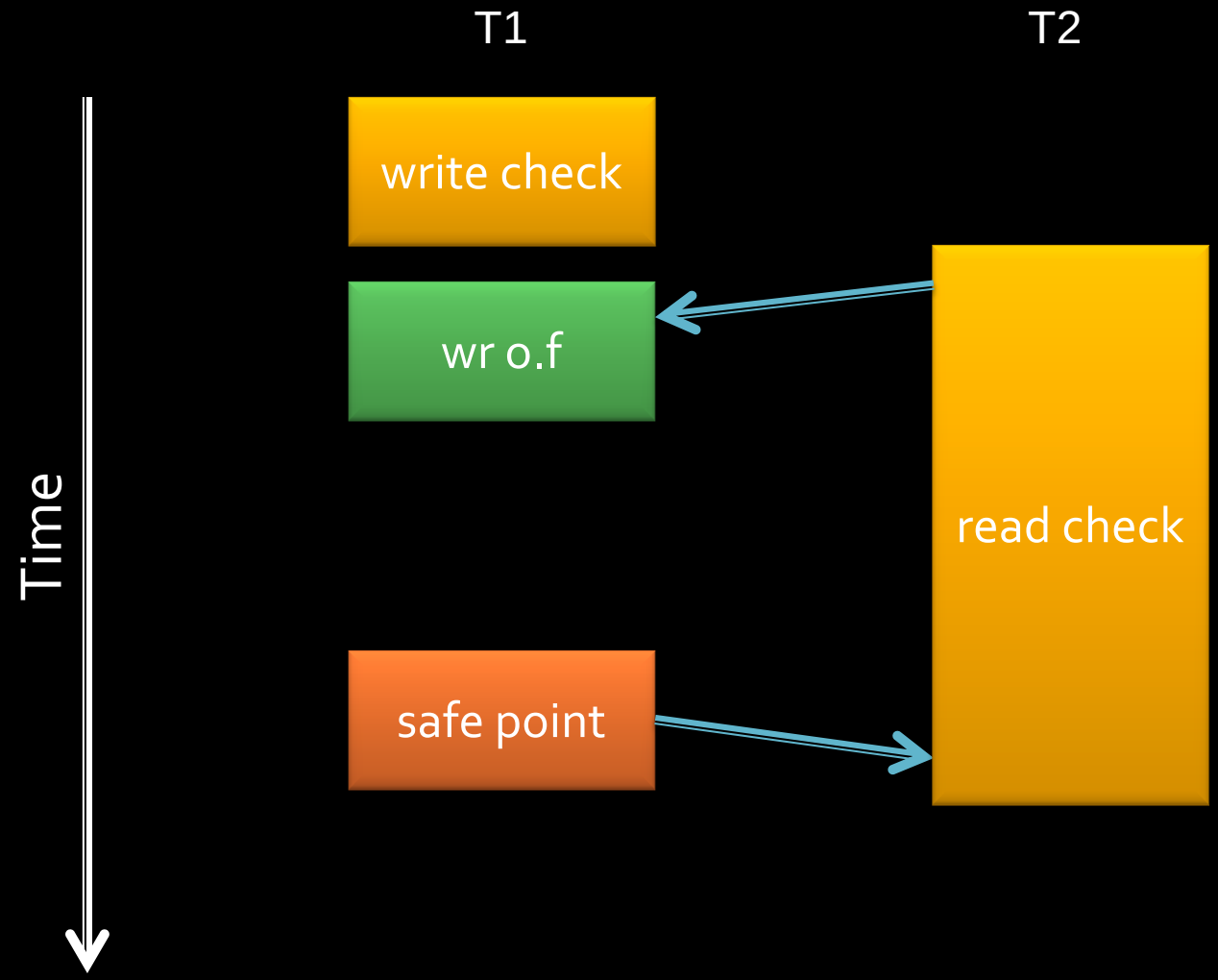
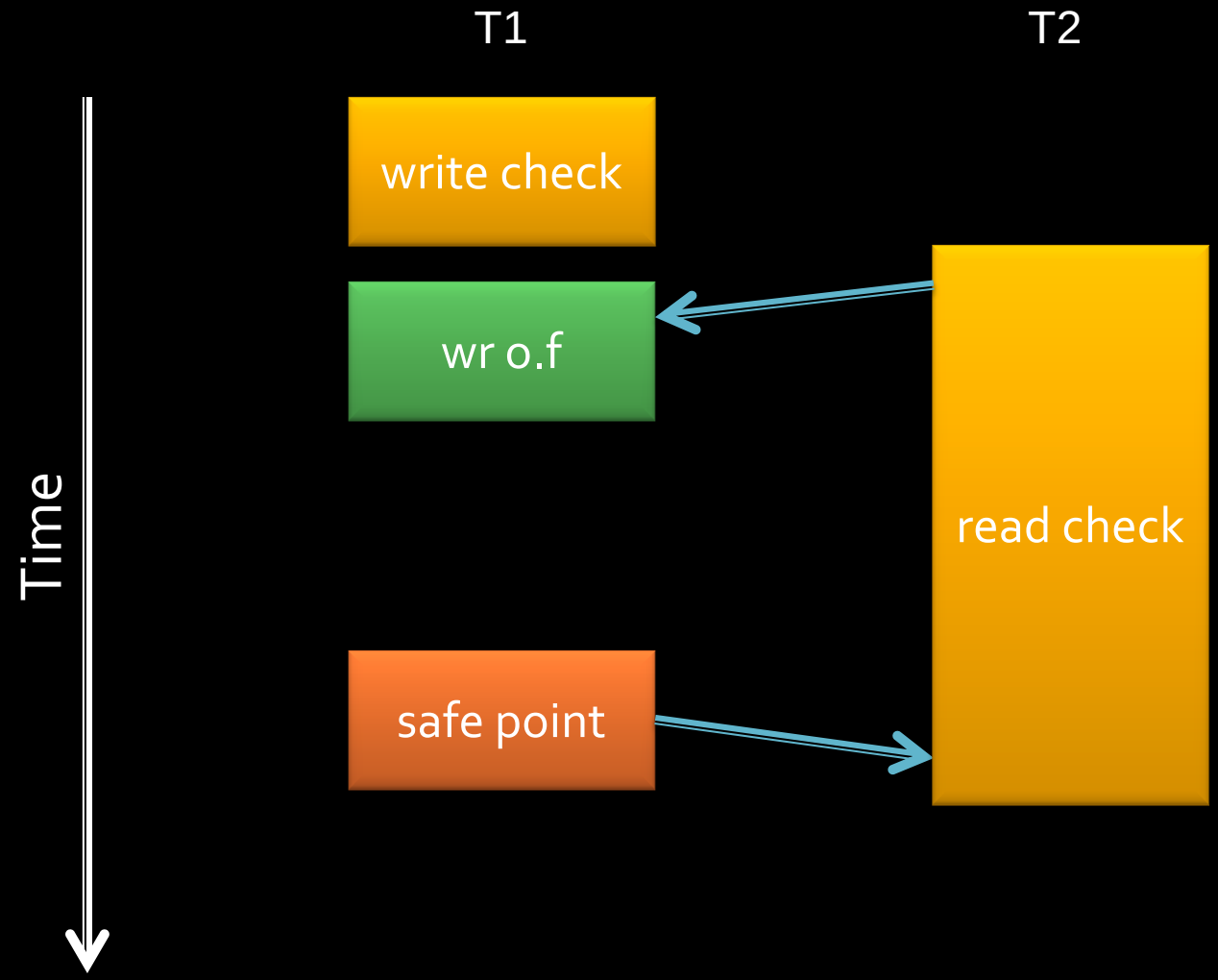


o's state = $RdEx_{T2}$



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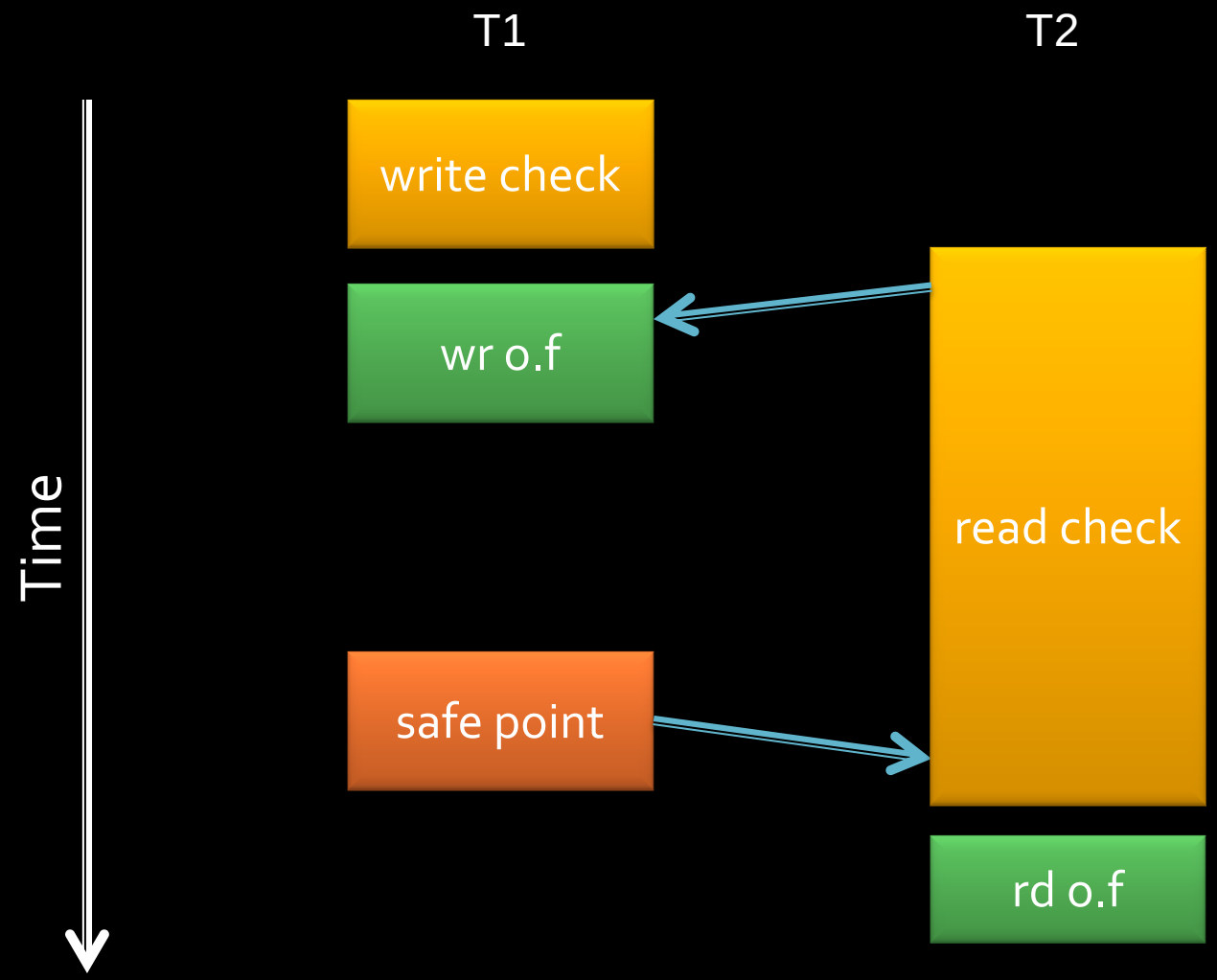

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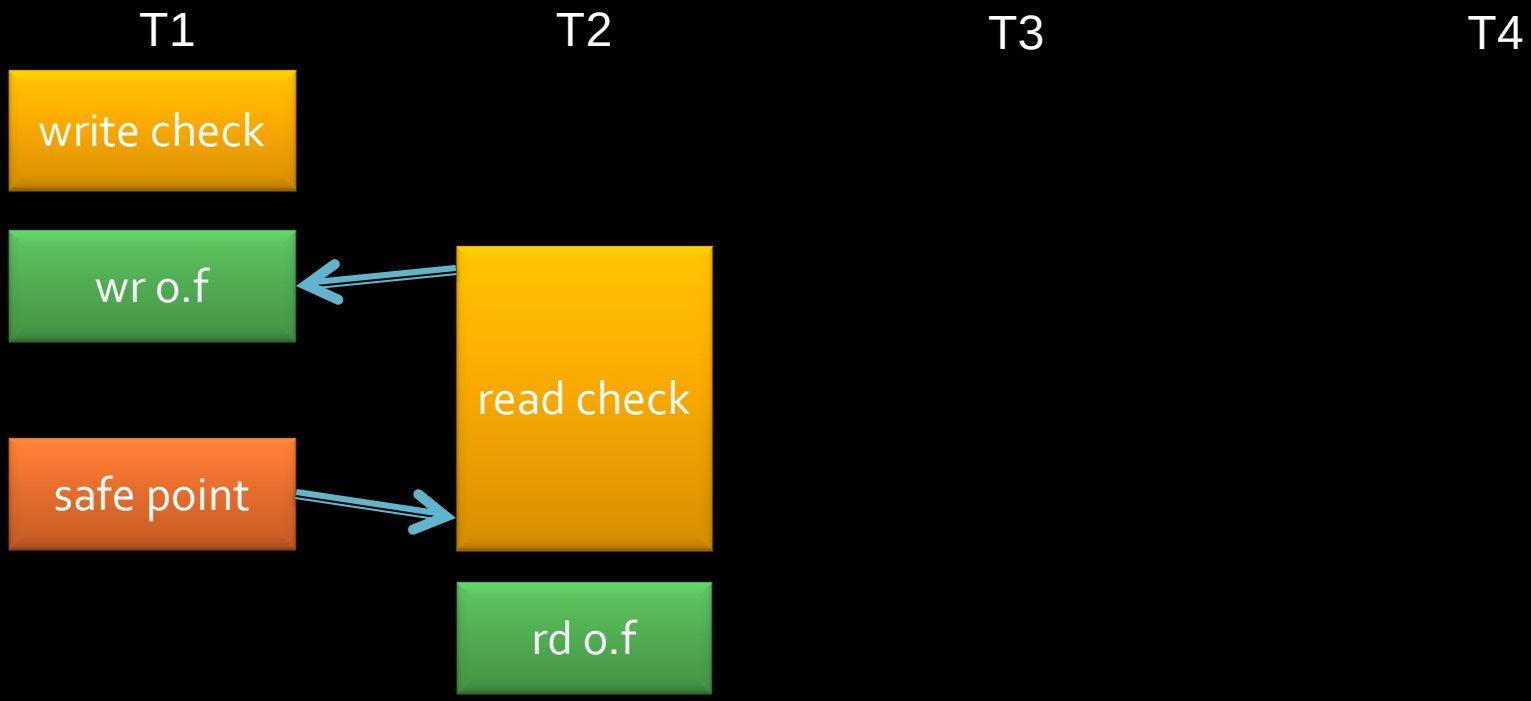

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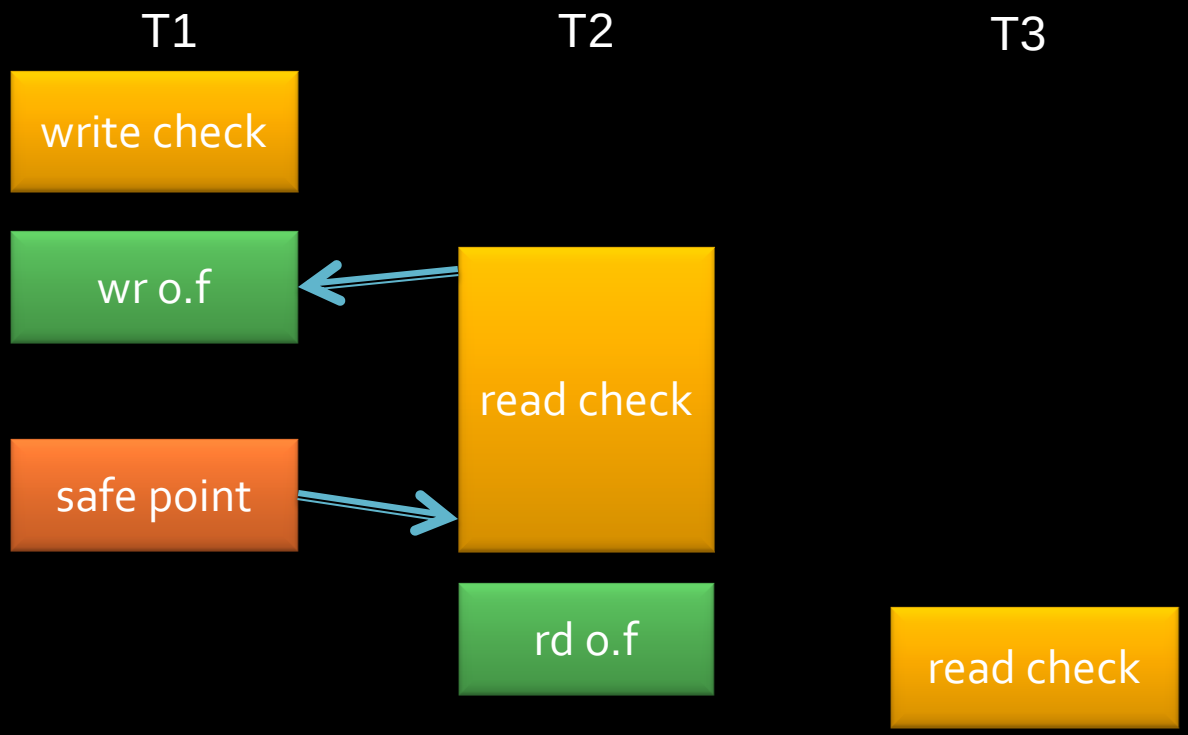
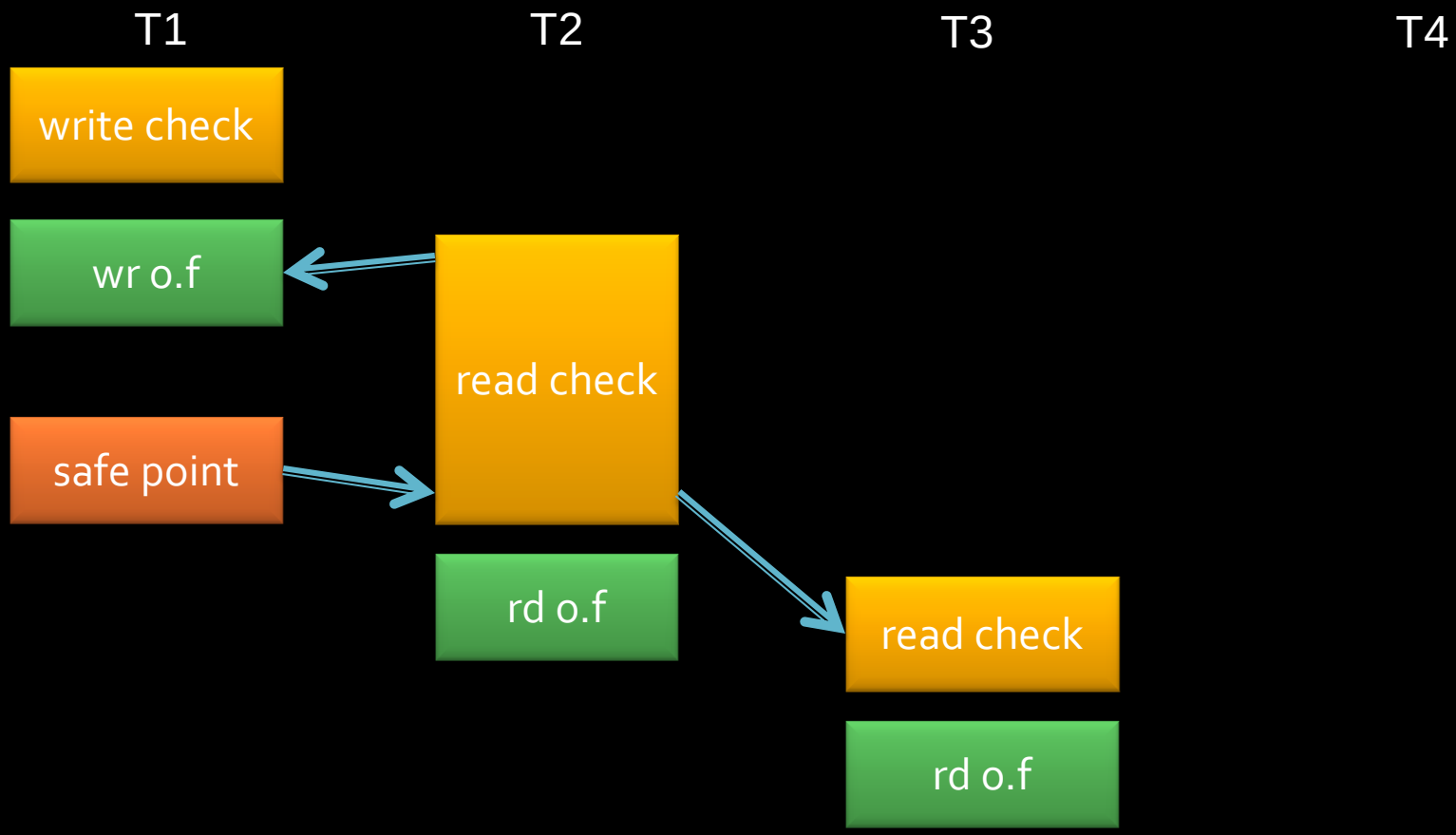


# o's state = $RdSh_c$



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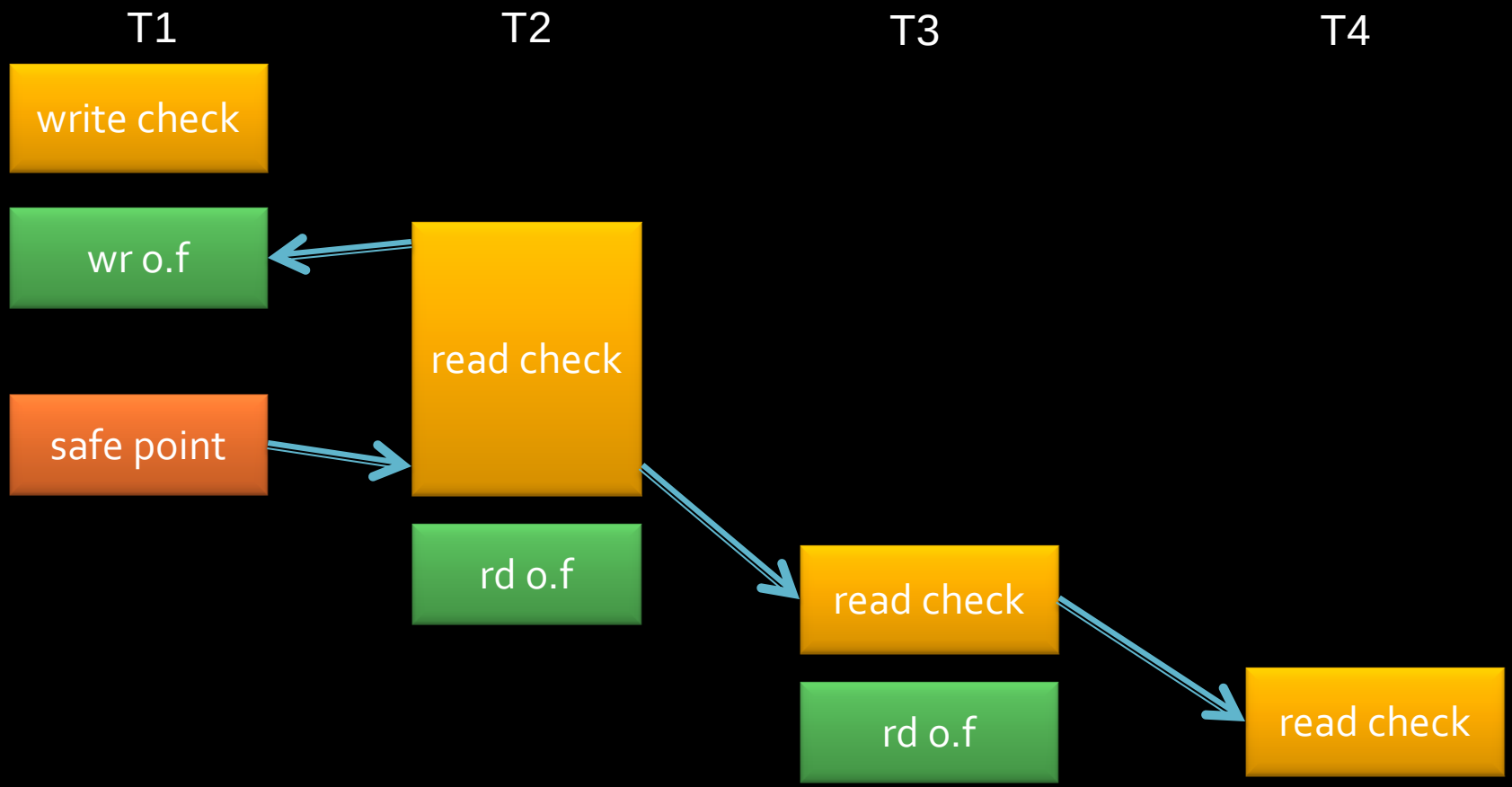

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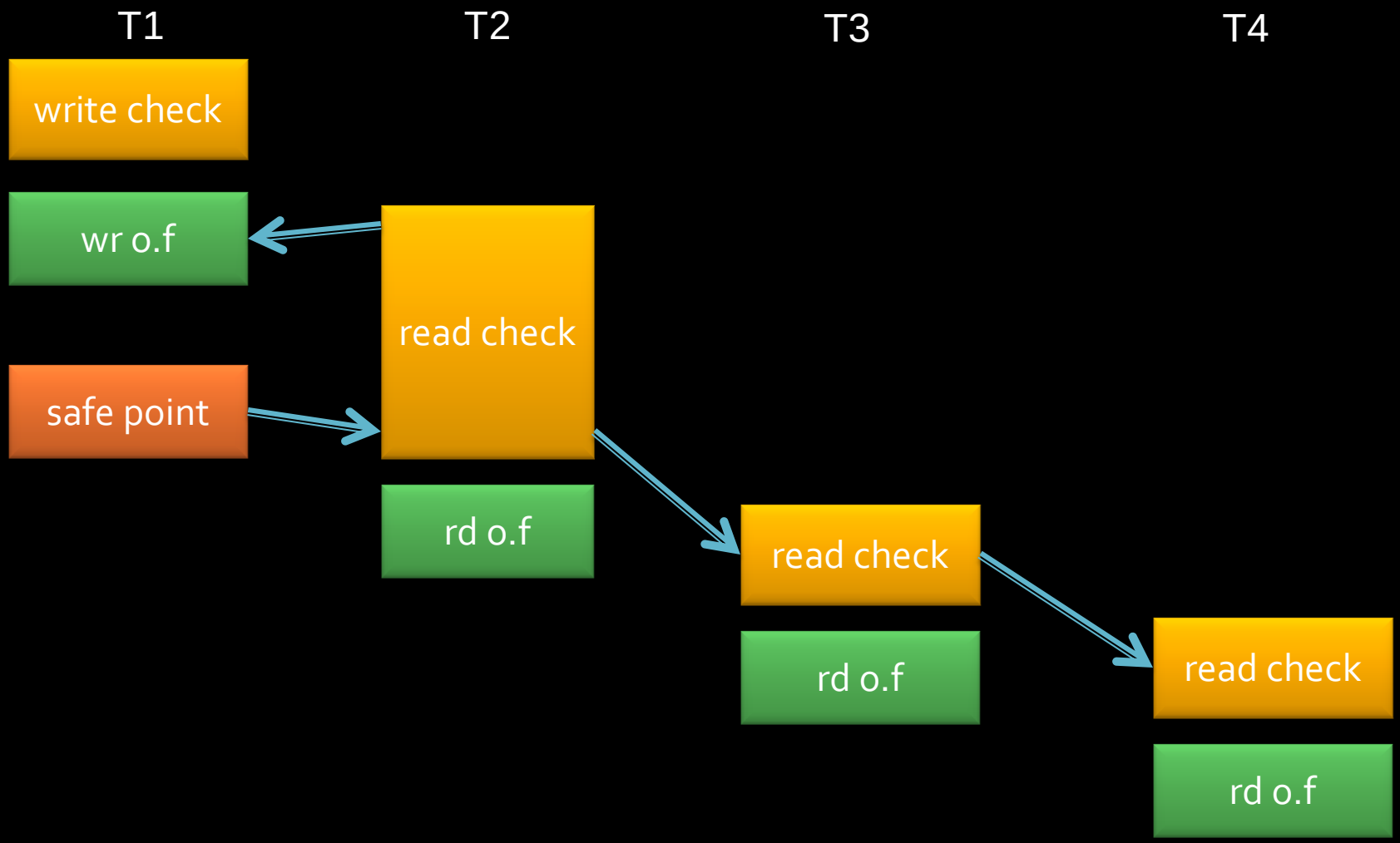

o's state = $RdSh_c$

T1 T2 T3 T4

write check

wr o.f

safe point

read check

read check

rd o.f

## Sharing detection

[von Praun & Gross '01]

*Comparison in our paper*

## Distributed shared memory

Shasta [Scales et al. '96]

## Biased locking

[Kawachiya et al. '02]

[Russell & Detlefs '06]

[Hindman & Grossman '06]

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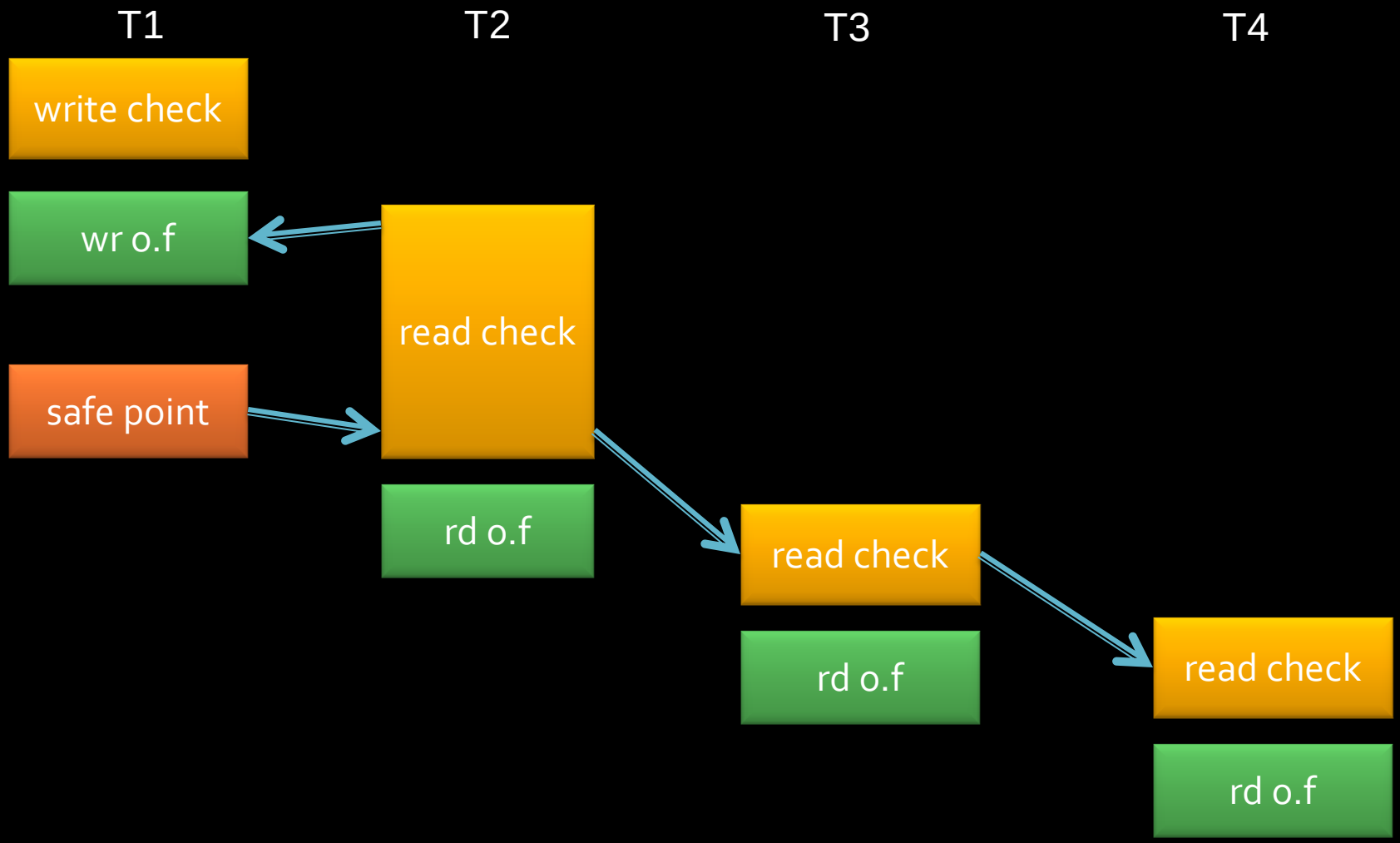
Framework for runtime support
Concurrency control mechanism

# Dependence recorder records happens-before edges



## Implementation in Jikes RVM

Publicly available

http://jikesrvm.org/Research+Archive

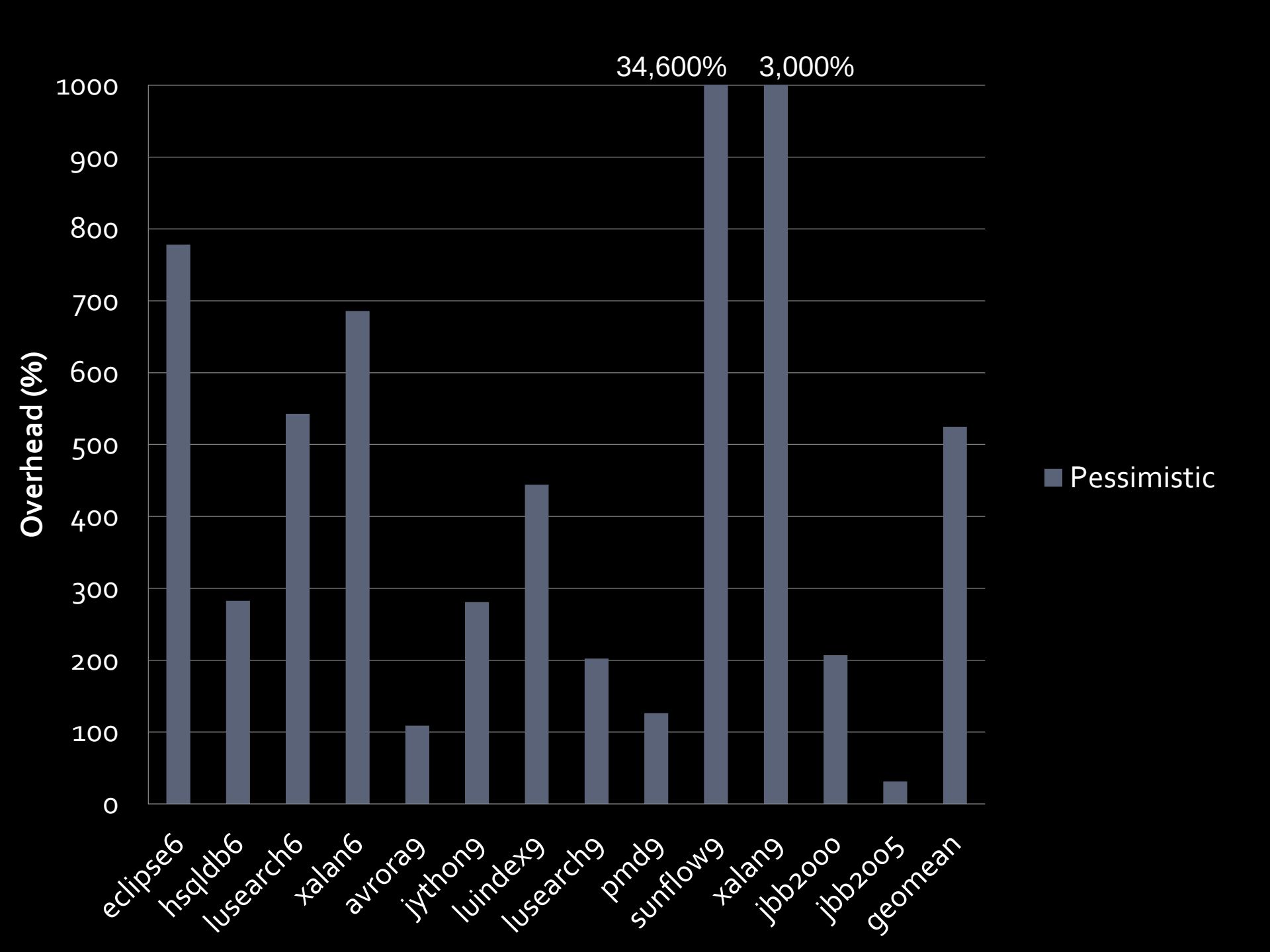
## Parallel programs

DaCapo Benchmarks 2006 & 2009

SPEC JBB 2000 & 2005

## Parallel platform

32 cores (AMD Opteron 6272)


34,600%
3,000%
1000
900
800
700
600
500
400
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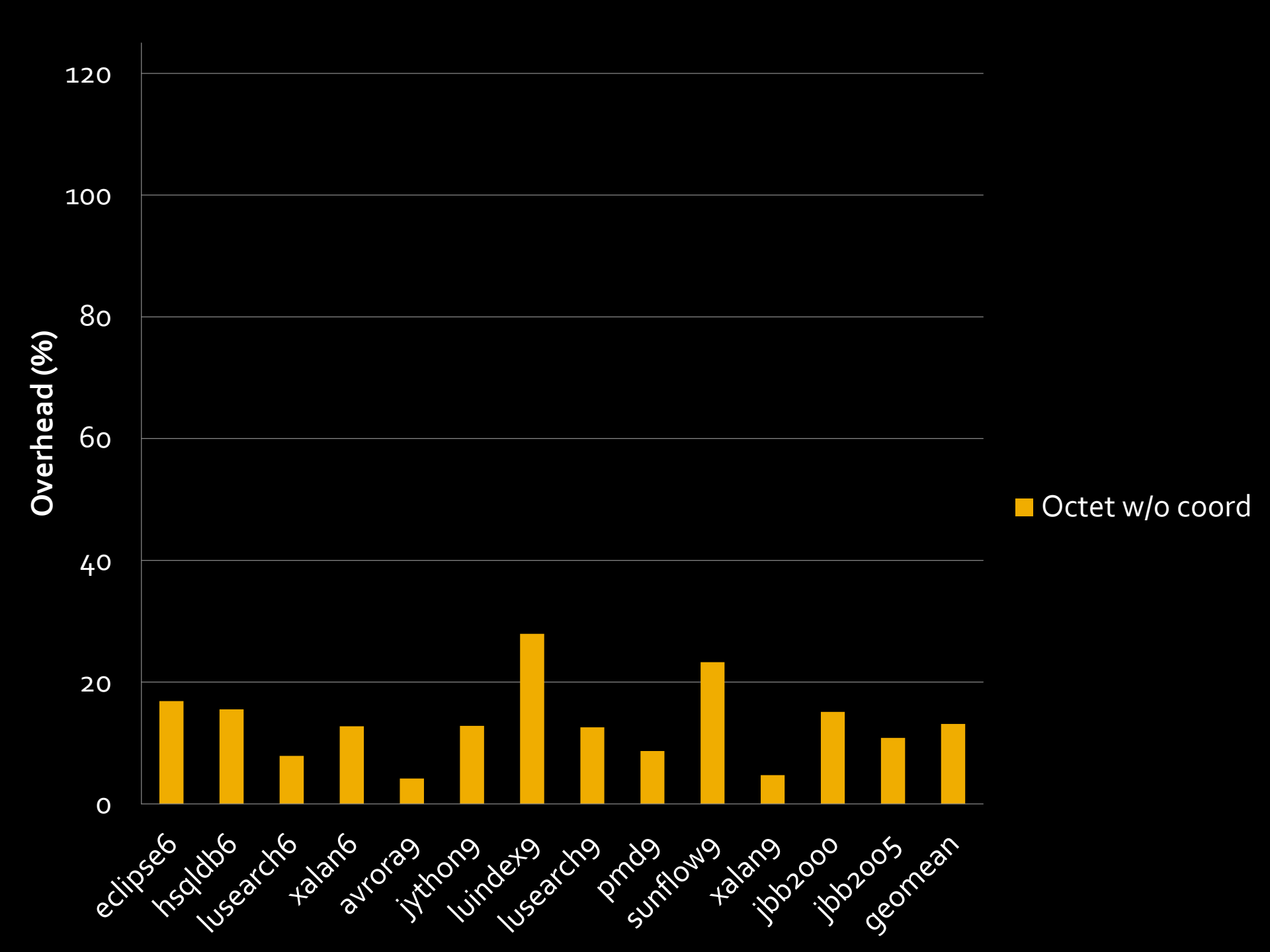
100
0
Overhead (%)
Pessimistic
eclipse6
hsqldb6
lusearch6
xalan6
avrora9
jython9
luindex9
lusearch9
pmd9
sunflow9
xalan9
jbb2000
jbb2005
geomean


Overhead (%)
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Octet w/o coord
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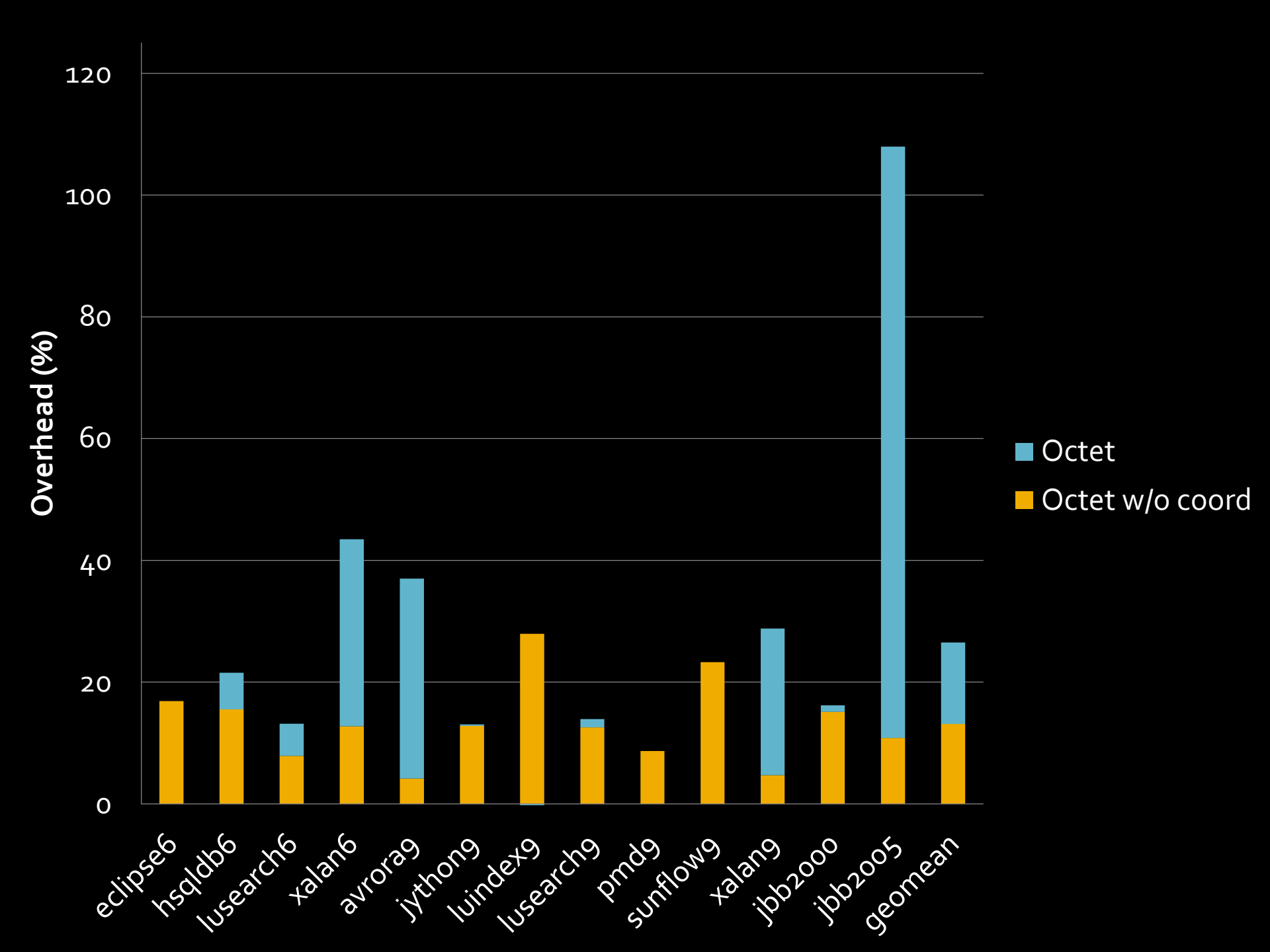
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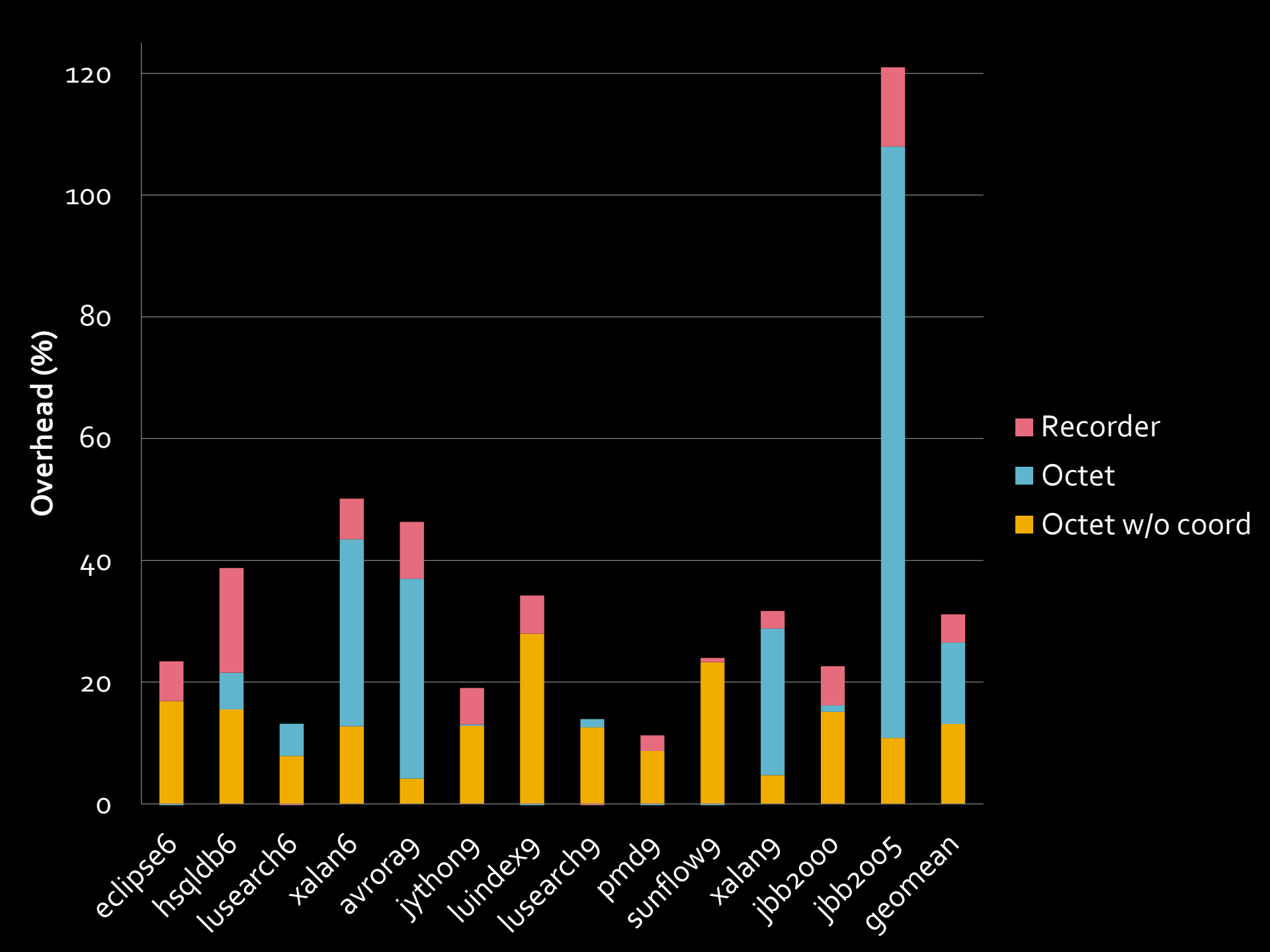
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Octet helps enable practical runtime support for reliable, scalable concurrency

Framework for runtime support

HB edges → all dependences

Atomicity of analysis & access

Concurrency control mechanism

Synchronization ⇔ cross-thread dependence

→ Qualitative performance improvement