

DETERMINISTIC MULTIPROCESSORS

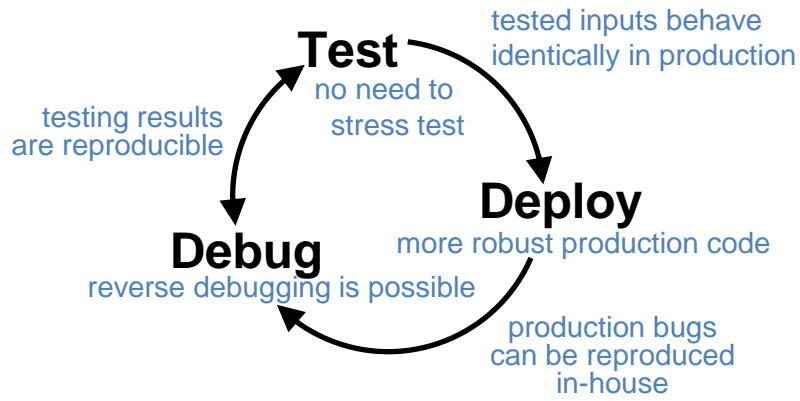
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MARK OSKIN



ONE INPUT => MULTIPLE OUTPUTS

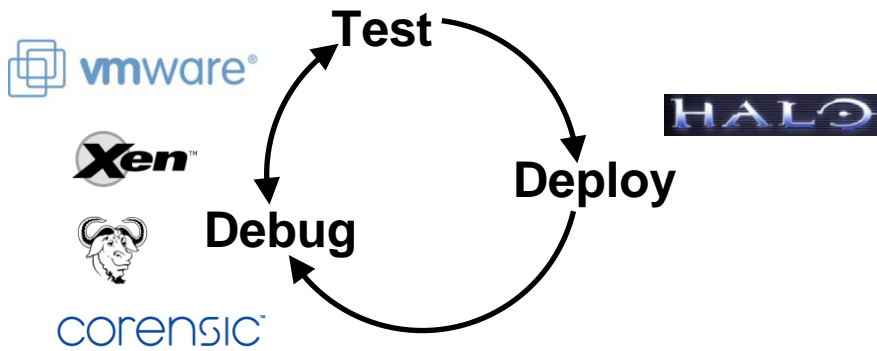
NONDETERMINISM IS REALLY ANNOYING

DETERMINISM IMPROVES SOFTWARE DEVELOPMENT



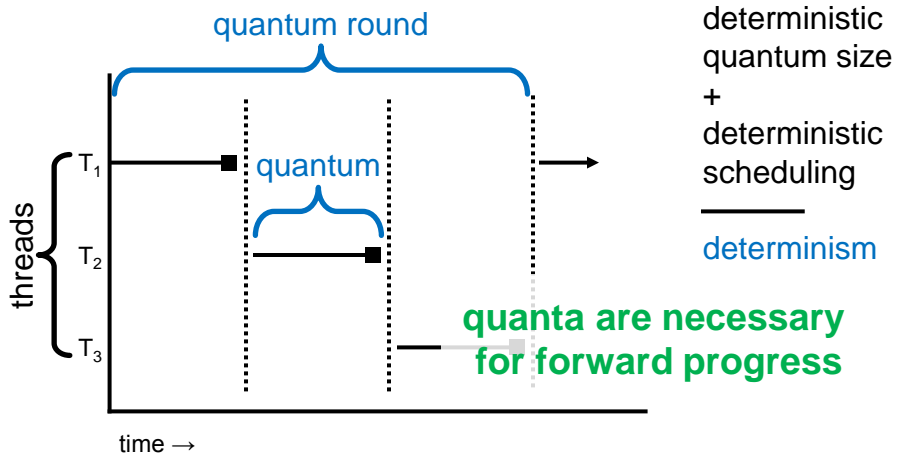
3

DETERMINISM IMPROVES SOFTWARE DEVELOPMENT



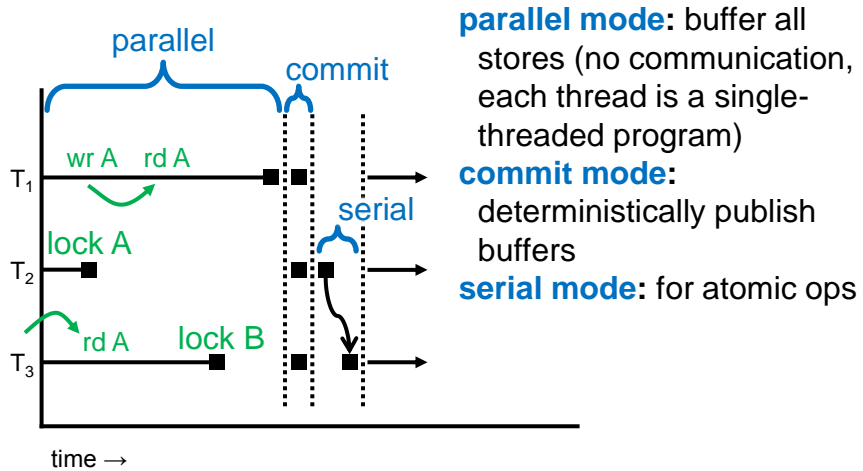
4

STARTING SIMPLE: SERIALIZATION



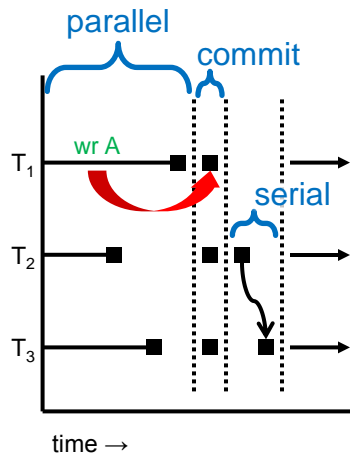
5

RECOVERING PARALLELISM WITH DMP-TSO



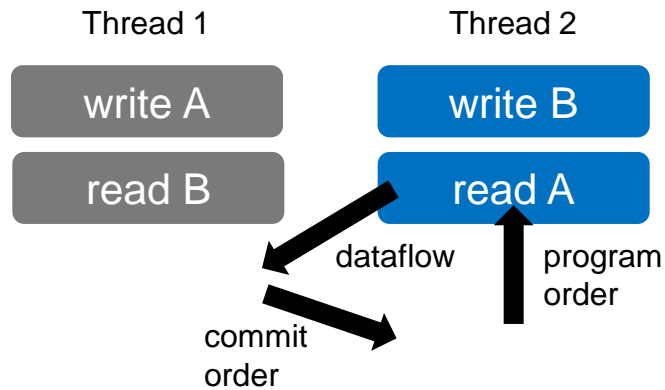
6

STORE BUFFERS BREAK SC (1/2)



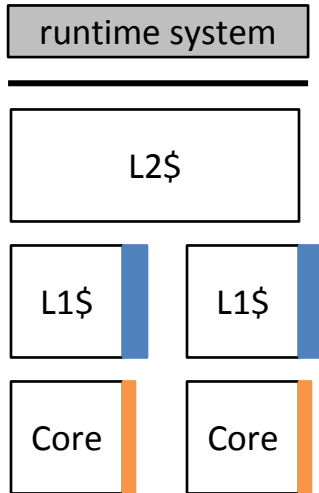
stores are reordered
from parallel mode
into commit mode

STORE BUFFERS BREAK SC (2/2)



causal cycle → no sequential consistency

ARCHITECTURE MODIFICATIONS



Store Buffers in Private \$
 application/OS can choose nondeterminism
 align context switches with quantum boundaries

StoreToSB
 CommitSB
 SaveSB
 RestoreSB

Precise Insn Counting

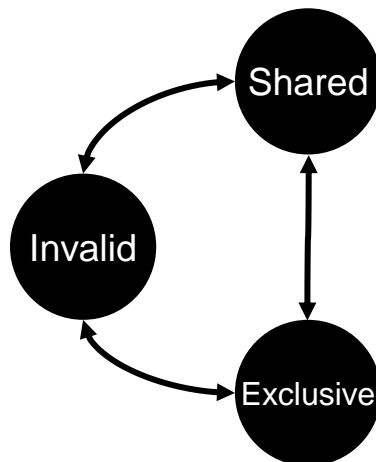
StartInsnCount
 StopInsnCount
 ReadInsnCount

Traps

SBFull
 QuantumReached

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COHERENCE PROTOCOL MODIFICATIONS



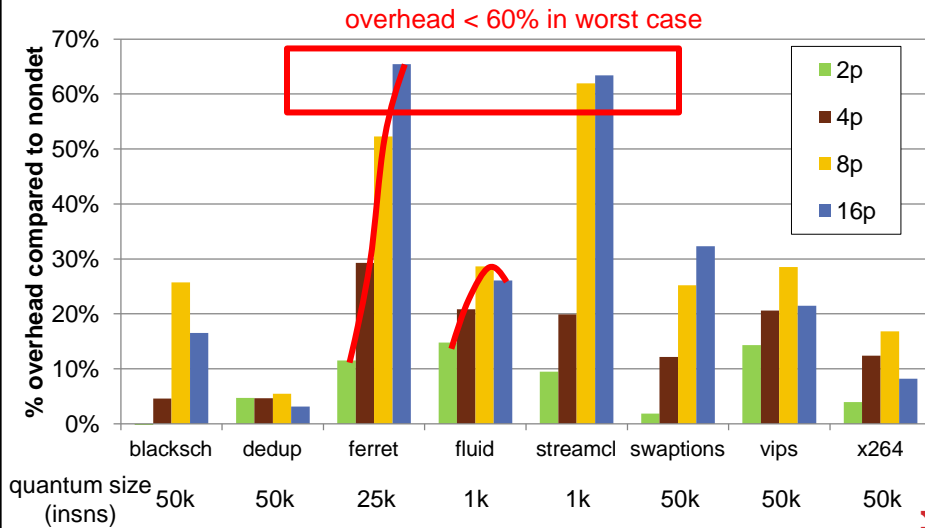
no Exclusive state

merge conflicts
 deterministically

no false sharing!

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SIMULATION RESULTS



THANKS!

- **Recent work:**
 - deterministic compilers, operating systems, distributed systems, programming languages
- **Learn more:**
 - sampa.cs.washington.edu
 - devietti@cs
 - luisceze@cs