Non-preemptive scheduling of real-time STM

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Outline

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MOTIVATION
Motivation

• Multicore architectures for embedded systems:
  – less computing power on each core, but
  – more computing power from parallel concurrent programming.

• Synchronisation mechanisms that are able to cope with parallel programming.
BACKGROUND
Real-time embedded systems

• Computer system.
  – Application functionality is divided into tasks.
  – Tasks are instantiated recurrently throughout time: jobs.
  – A job must provide a correct result within a time window.
  – It does not have to be fast: it has to be predictable!
Synchronisation mechanisms for real-time systems

• Traditionally lock-based, but...
  – Coarse-grained locks impair parallelism.
  – Fine-grained locks impair composability.
SERIALISING TRANSACTIONS
How to serialise transactions in real-time systems?

- Polite, aggressive, karma, exponential back-off
  - Not predictable!
- Priority, deadline
  - Possibly starves transactions with lower priority.
- Slack
  - Possibly starves transactions with more slack.
How to serialise transactions in real-time systems?

• Time of arrival (FIFO)
  – Priority inversion, but...
    • All transactions have a fair chance to commit.
    • Blocking must by limited!
  – Cascading aborts:
    • T1 (earliest) writes objects A and B
    • T2 (in between) writes objects B and C
    • T3 (latest) writes objects C and D
    • T3 may abort because of T2, that is aborting due to T1!
FIFO approach

If already a zombie, repeat.
Get ownership of read set.
For each object in write set...
  Get ownership of object.
  If there is a earlier transaction active conflicting release all objects and repeat.
If still active...
  Release read set.
  Set contenders as zombies and release write set.
NON-PREEMPTIVE SCHEDULING OF TRANSACTIONS
Preemptions can modify the contention management behaviour

- Contention in the same core.
Preemptions can modify the contention management behaviour

- Contention in different cores.
Non-preemptive approaches

• Non-preemptive until commit (NPUC)
  – Job is not preemptible until transaction successfully commits.
  – At most one transaction started on each core.
    • Response time of transaction is totally predictable.
  – Blocking can be long.
Non-preemptive approaches

• Non-preemptive during attempt (NPDA)
  – Job is not preemptible during transaction, but has preemption points between attempts.
  – Allows *more than one* transaction started on each core.
    • Response time analysis of transaction is too pessimistic.
  – Blocking is limited to the duration of the longest transaction attempt.
Non-preemptive approaches

- NPUC
- NPDA
Conclusions

• FIFO serialisation may provide a predictable serialisation method.

• Preemptions can undermine the expected behaviour of a contention manager.

• Two non-preemptive approaches:
  – NPUC, more predictable, less responsiveness.
  – NPDA, more responsiveness, but very hard to analyse.
THANK YOU! QUESTIONS?

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