Non-preemptive scheduling of real-time STM

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Outline

- Motivation
- Background
- Serialising transactions
- Non-preemptive scheduling of transactions
- Conclusion

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 programing.

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.

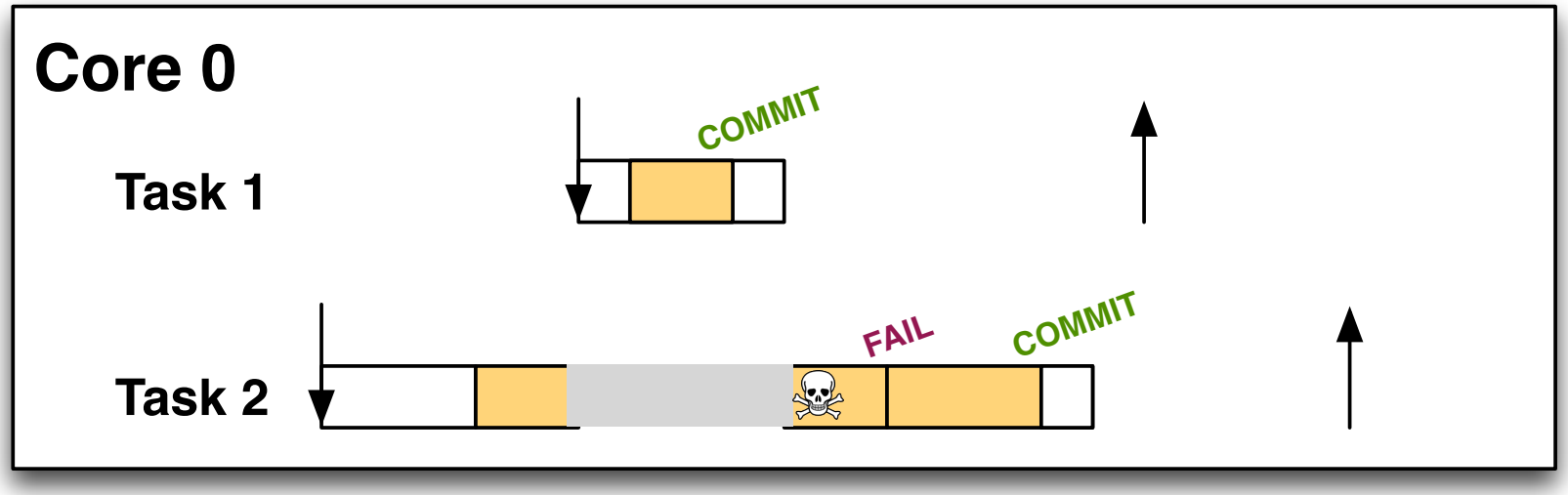
If still active…

- Release read set.
- Set contenders as zombies and release write set.

NON-PREEMPTIVE SCHEDULING OF TRANSACTIONS

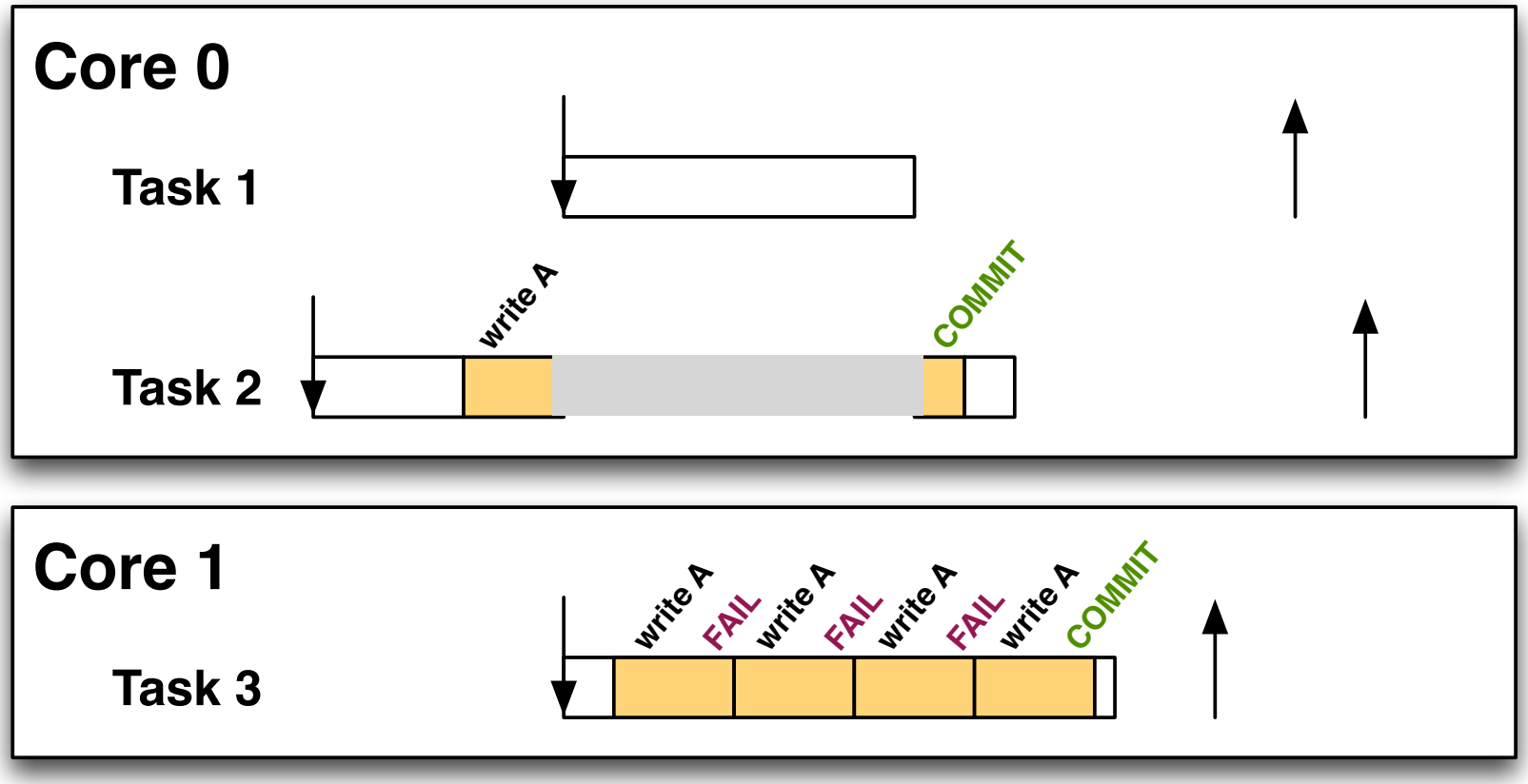
Preemptions can modify the contention management behaviour

- Contention in the same core.



Preemptions can modify the contention management behaviour

- Contention in different cores.



Non-preemptive approaches

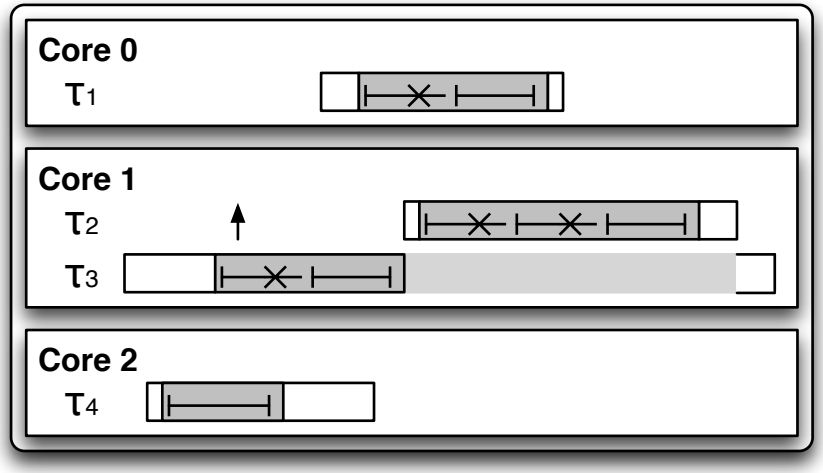
- Non-preemptive until commit (NPUC)
  - Job is not preemptible until transaction successfully commits.
  - At most *one* transaction started on each core.
    - Response time of transaction is totally predictable.
  - Blocking can be long.

Non-preemptive approaches

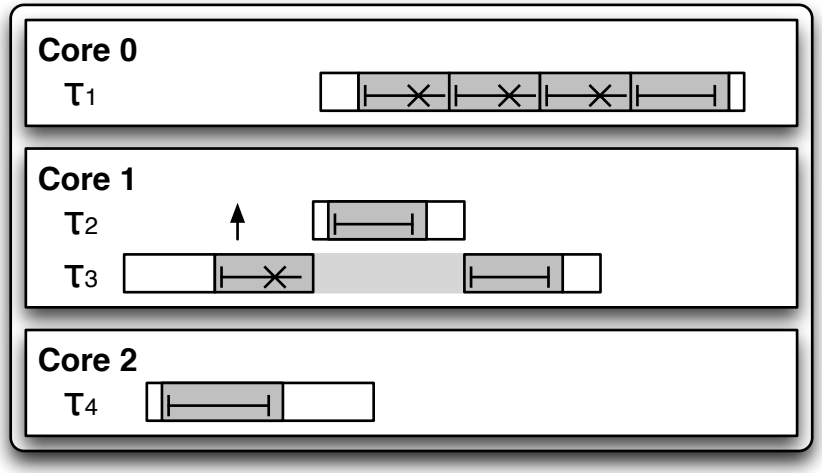
- Non-preemptive during attempt (NPDA)
  - Job is not preemptible during transaction, but has preemption points between attempts.
  - Allows *more than one* transaction started on each core.
    - Response time analysis of transaction is too pessimistic.
  - Blocking is limited to the duration of the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

Non-preemptive approaches

- NPUC



- NPDA



CONCLUSIONS

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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