Transactifying Apache's Cache Module

H. Eran O. Lutzky Z. Guz I. Keidar

Department of Electrical Engineering
Technion – Israel Institute of Technology

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Outline

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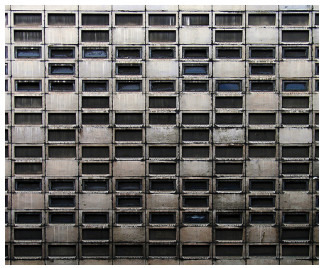
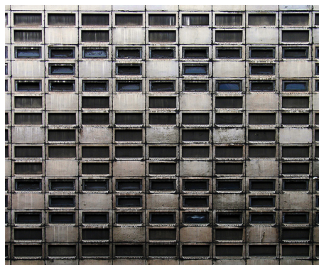


The shift to multicore machines challenges software developers to exploit parallelism. Transactional Memory is one approach to make this easier.

Our Goals:

- Transactifying a large-scale legacy application.
- Creating a benchmark for STM systems.

Transactifying Apache's Cache Module



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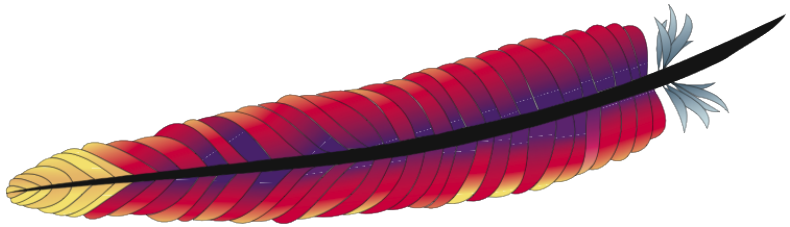
- Popular
- Already parallel



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- Well encapsulated.
- Currently implemented using one big lock.

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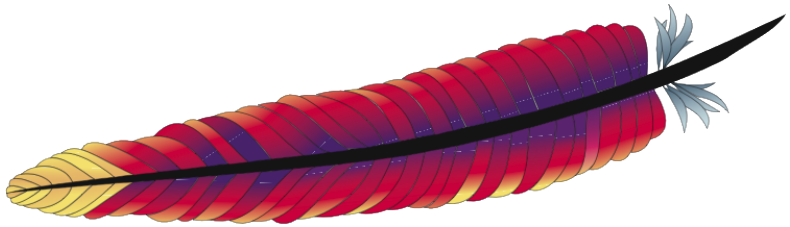

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Previous work

- Concurrent data structures
  (e.g. red-black trees and skip lists.)
- STMBench7 – Measures operations on a more complex yet still artificial object graph.
- STAMP – Standford Transactional Applications for Multi-Processing:
  A collection of transactified scientific algorithms.

Transactifying C Programs

Library-based STM or compiler-based

Originally: Library-based

- Transactions delimited by special function calls.
- Access to shared memory through function calls.
- Manual handling of function calls inside transactions.

Too cumbersome for legacy code.

Recently: Compiler-based

- Syntactic support for transactions. (e.g. `__tm_atomic` blocks).
- Compiler automatic wrapping of access to shared memory.
- Nested function calls are either handled automatically, or by special attributes on declaration.

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Which STM to use?

- TANGER
  - Open source
  - LLVM compiler extension
  - Supports tinySTM and other STM systems.
  - The version we used had problems with transactifying only a small part of the code base.
- Intel STM Compiler
  - Experimental version of Intel's ICC
  - Proprietary STM system.
  - Has published interface for other STM systems.

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2. ...
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4. ...
5. End transaction

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1. Begin transaction
2. --obj→ refcount;
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Defining Atomic Blocks

An interesting example

Step 1: Convert mutex critical sections into transactions.

Get an object from the cache

1. Mutex lock
2. `obj` ← find key in cache
3. if `obj` found
   1. increment reference count on `obj`
   2. register `obj` for reference count decrementation later.
4. Mutex unlock

Defining Atomic Blocks

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Might not be optimal:

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Defining Atomic Blocks

An interesting example

Provided registration is local to the current thread:

Get an object from the cache

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2. `obj` ← find key in cache
3. if `obj` found
   1. increment reference count on `obj`
4. End transaction
5. if `obj` found
   1. register `obj` for reference count decrementation later.

Commit Handlers

- Pieces of code a transaction requests to be run on commit.
- Can be used in our scenario to clean up the code.

Commit Handlers
Example

`register_dec(obj)`

register `obj` for reference count decrementation later.

Get an object from the cache

1. Begin transaction
2. `obj` ← find key in cache
3. if `obj` found
   1. increment reference count on `obj`
   2. Register commit handler `(&register_dec, obj)`
4. End transaction

Handler Closures

- In languages that support closures (e.g. ML, Smalltalk, Java's inner classes), the use of commit handlers for our purpose would be much cleaner.

Get an object from the cache

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Evaluation

Client The *Siege* HTTP load testing tool.

Workload The set of unix man-pages, served using the *man2html* CGI program. The program uncompressed the man-pages and rendered them to HTML.

Distribution Request files by Zipf distribution, whose s parameter determines the level of localilty in the requests.

Setup Two 32-core machines (8-processors $\times$ quad core), connected by Gigabit ethernet, with 2.3GHz AMD Opteron processors and 126GB of RAM each.

Experiments no-cache, no-transactions, transactified

Expectations

STM Disadvantage:

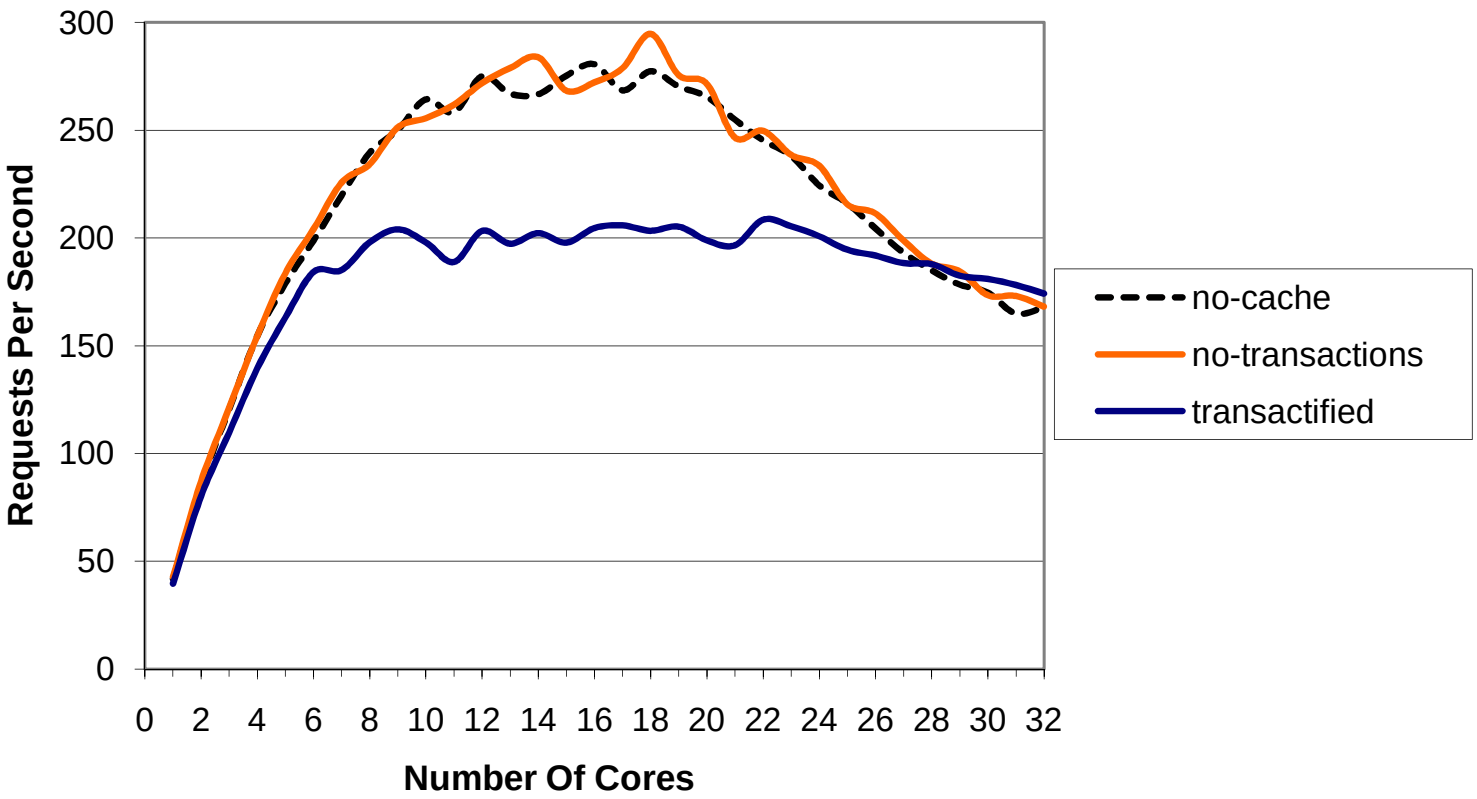
- Incurs an overhead for each read/write inside a transaction.

STM Advantage:

- Conflict only when same memory is accessed, not due to the coarse-grained lock.

Results – Requests per Second

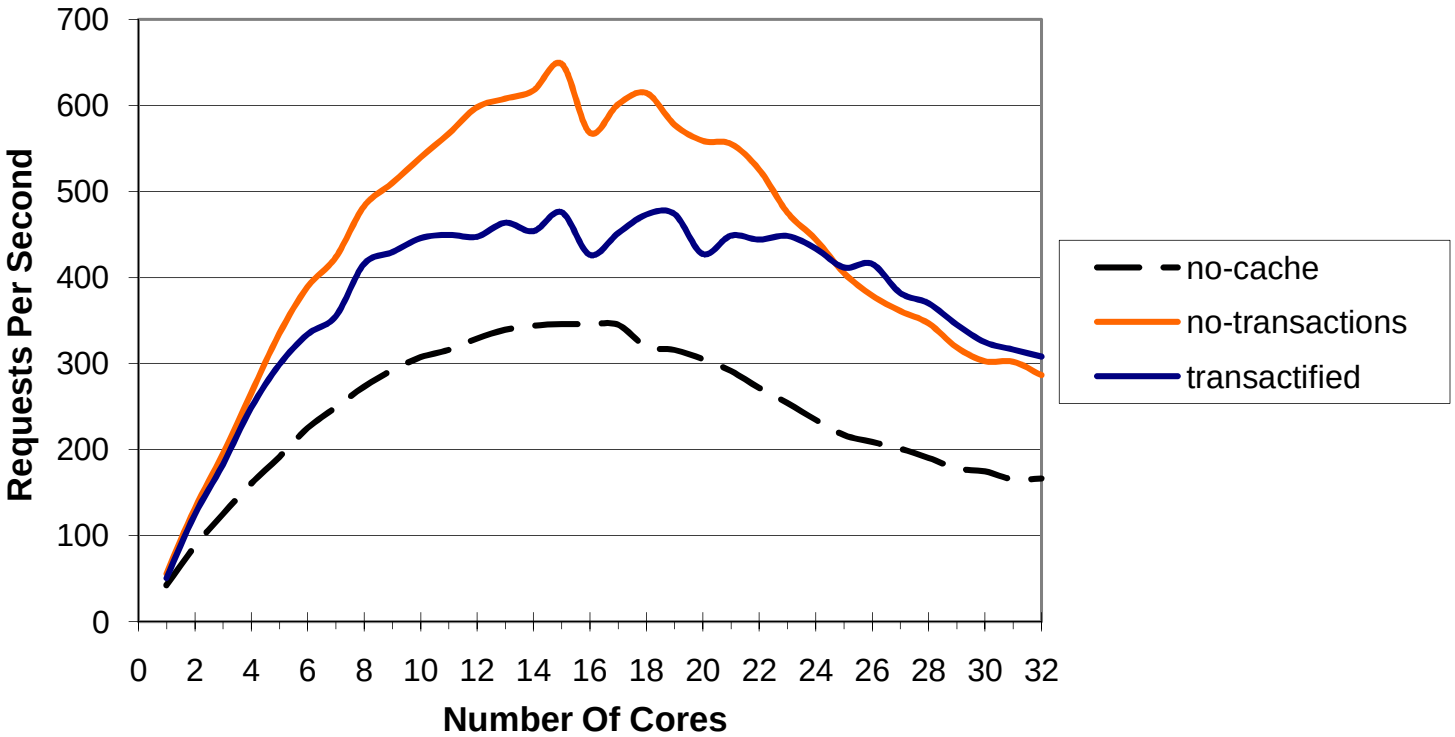
$s = 0.1$



Very low locality. Cache not effective. STM penalty high.

Results – Requests per Second

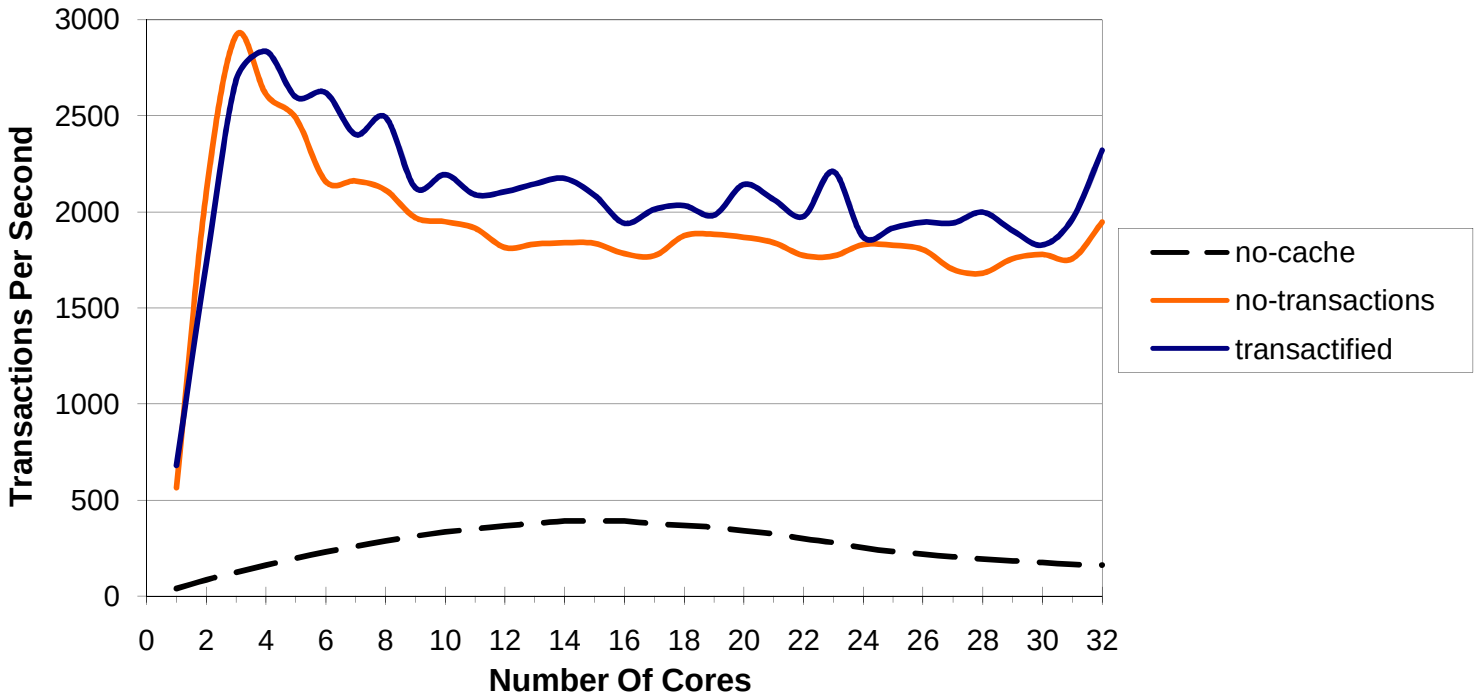
$s = 1$



Medium locality. Cache is an improvement. STM incurs penalty.

Results – Requests per Second

$s = 2$



High locality. Cache is vital. STM version works best.

Conclusion

We started with looking how is it to transactify a large legacy application.
Our lessons:

- Choose Compiler-based STMs.
- Encapsulation support is important.
- Commit handlers can simplify code changes.
- Real-world applications are challenging and important to work on.

Questions?