CiCTrie - C Implementation of CTrie

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***Abstract*—We ported high-level memory managed data structure *CTrie* to an unmanaged language *C*, using *hazard pointers* mechanism, while keeping the basic operations of the data structure. We compared our implementation against Scala's standard library *TrieMap* (*CTrie*) using similar tests as in the original article.**

***Index Terms*—CTrie, Hazard Pointers.**

I. Introduction

CTrie [1] [2] (or concurrent hash-trie) is a concurrent *thread-safe*, *lock-free* implementation of a hash array mapped trie. This data structure is consists of *key-value* pairs and it supports the following operations:

- **insert**: add a new *(key, value)* pair.
- **remove**: remove a *(key, value)* pair if it exists.
- **lookup**: find the *value* (if any) for a specific *key*.

In addition the **CTrie** data structure has a *snapshot* operation which is used to implement consistent *iterators*. In fact **CTrie** is the first known concurrent data structure that supports *O(1)*, *atomic*, *lock-free* snapshots.
CTrie aspires to preserve the space-efficiency and the expected depth of hash tries by *compressing* after removals, disposing of unnecessary nodes and thus keeping the depth reasonable. The **CTrie** implementation is based on single-word *compare-and-swap* instructions.

II. Implementation

We wanted to give a simple interface for using *CiCTrie* which will be as close as possible to object oriented programming, therefore we used *Object Oriented C*; The user creates a *ctrie_t** struct using a "constructor" *create_ctrie* and use its functions passing itself as a "self object" (such as: `ctrie->insert(ctrie, key, value)`).
This way we could port easily the original *Scala* code from the original paper [1] and from the source code of the standard library itself [5].

A. Basic Operations

Some explanations about the general commands...

B. Memory Reclamation

Hazard pointers are a mechanism which aims to solve the ABA and safe memory reclamation problems [3] [4]. Each thread maintains a list of *hazard pointers* to resources it currently uses. This list usually has a fixed size and is kept small. A used resource may not be freed or modified.

In our implementation, each thread has 6 *hazard pointers* in total - 4 "trie" *hazard pointers* and 2 "list" *hazard pointers*. 6 *hazard pointers* are needed because in the worst case we reference 4 nodes (a parent *INode*, it's *CNode* child, a child *Inode* it's *MainNode*). Then, we must be able to iterate over a *LNode* linked list, which requires 2 *hazard pointers*. Before using

C. Snapshot

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III. Benchmarking

Fun, fun, fun, fun, fun...

References

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[4] Hazard pointers wikipedia reference - https://en.wikipedia.org/wiki/Hazard_pointer.
[5] **TrieMap Scala source code -** https://www.scala-lang.org/api/current/scala/collection/concurrent/TrieMap.html.