18-344 Recitation 10

Lab 5 - Synchronization: Overview

Logistical Notes

- HW 9 due Nov 21
- Lab 4 due Nov 28
- Thanksgiving Break next week

Review of the week

- Recap: sparse problems
- Cache coherence
- MSI, MESI, snoopy
- Data races
- Mutex, SpinLocks, Transactional Memory
- Memory Consistency
- Reordering: write buffers, write combining, etc

Intel Transactional Memory

General Psuedo-code

```
for(i = 0..MAX_TRIES){
    if(xbegin()){

        …; xend();
        goto done;
    }
}

    //Fallback code here
    Lock()
    … // do work
    Unlock()

Done:
    //continue
```

Reasons a transaction might abort

- Too many blocks with their TM bits set leaves no room for more TM blocks
- Too many defined as “more blocks w/ TM bits set than blocks in a way”
- Conflict with another transaction or non-transactional access
- identified through incoming coherence traffic
- Explicit xabort() instruction when transactional code concludes transaction is not useful
- Other, unspecified, but arbitrary conditions left up to the micro architects
- I speculate that these are related to internal buffers of fixed capacity

Lab Logistics

You will be using Intel Transactional Memory, make sure to use a machine that supports it

`ece029, ece030, ece031`

You can double check the TSX is enabled using the binary:

```
./has-tsx
```

Task 1: Giga-Updates Per Second (GUPS) Kernel

NoSync:

```
for(int i = 0; i < num_iters; i++){
  size_t ind = rand() % kv_entries;
  kv[ind]++;
}
```

KV	1	0	1	2	2	2	1	1	10th iteration
KV	1	0	1	2	3	2	1	1	11th iteration

Task 1: GUPS Kernel

Parameters:

num_entries - Number of entries in the Key - Value array

num_threads - Number of threads running a kernel

num_iters - number of times each thread will run the kernel

Task 1: GUPS Kernel

Fix synchronization problems using:

1. pthread_spinlock_t
2. __sync_fetch_and_add
3. __sync_bool_compare_and_swap
4. Transactional Memory

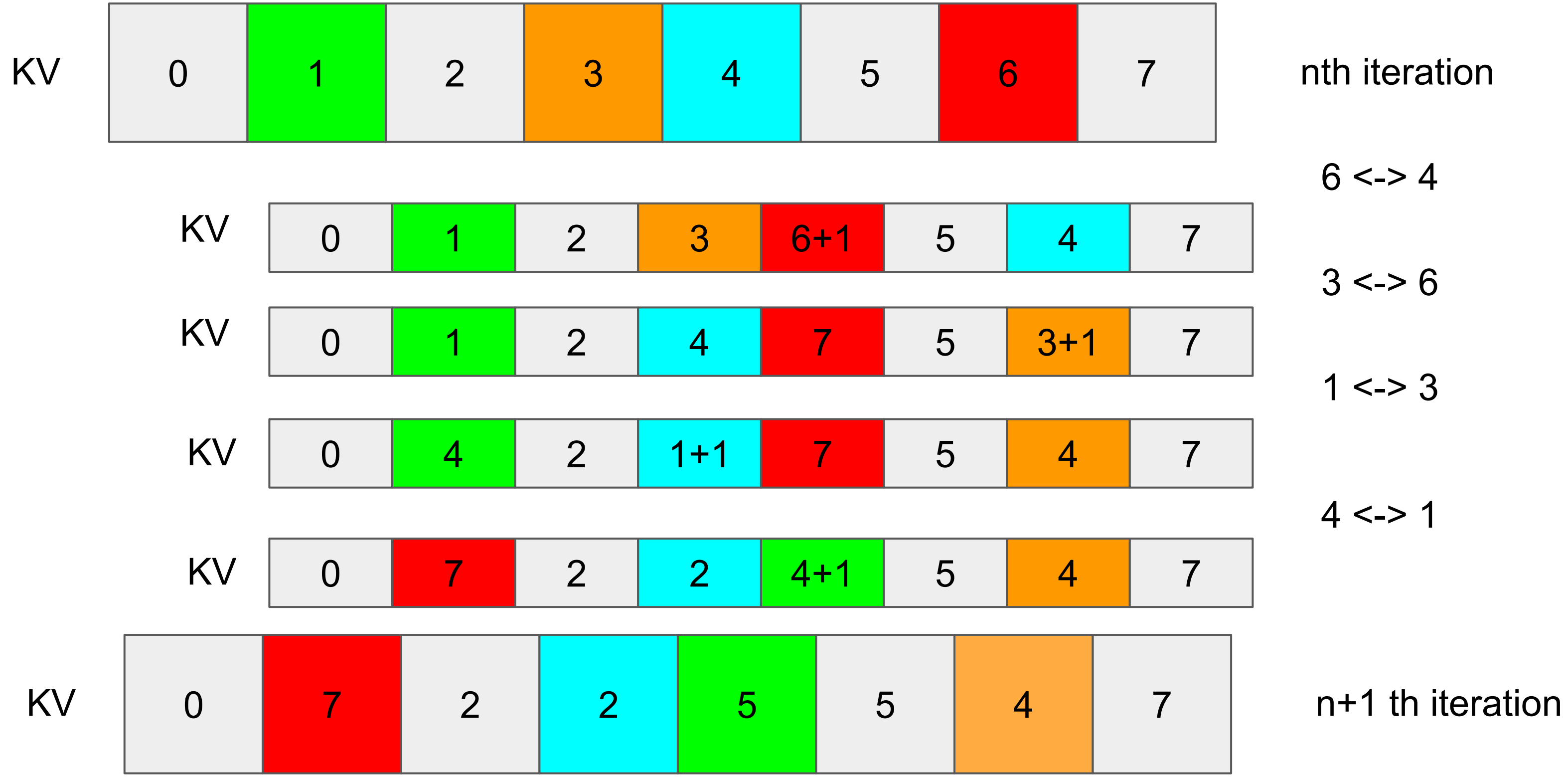
All fixes should have the same sum!

Task 2: Swap Within Array Partition Set (SWAPS) Kernel

```
for(int i = 0; i < num_iters; i++){
    uniq_list(kv_entries, num_swaps, inds);
    for(int j = 0; j < num_swaps; j++){
        int j2 = j == 0 ? (num_swaps-1) : j-1;
        unsigned long t = kv[ inds[j2] ];
        kv[ inds[j2] ] = kv[ inds[j] ];
        kv[ inds[j] ] = t+1;
    }
}
```

SWAPS Kernel

inds			
6	3	1	4



KV	0	1	2	3	4	5	6	7	nth iteration

6 <-> 4

KV	0	1	2	3	6+1	5	4	7

3 <-> 6

KV	0	1	2	4	7	5	3+1	7

1 <-> 3

KV	0	4	2	1+1	7	5	4	7

4 <-> 1

KV	0	7	2	2	4+1	5	4	7

KV	0	7	2	2	5	5	4	7	n+1 th iteration

Task 2: SWAPS Kernel

Parameters:

num_entries - Number of entries in the Key - Value array

num_threads - Number of threads running a kernel

num_iters - number of times each thread will run the kernel

num_swaps - number of swaps per kernel execution

Useful resource

A Primer on Memory Consistency and Cache Coherence

- Daniel J. Sorin Mark D. Hill David A. Wood