COS226 Assignment 1

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1 Introduction

In this report we evaluate the performance and fairness of TTAS and CLH locks under different contention levels (LOW, MEDIUM, HIGH) and player counts (2, 8, 16).

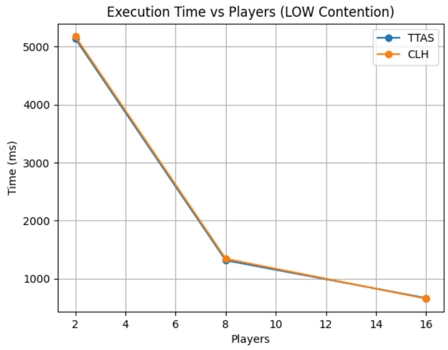
2 Setup

Contention was simulated with 'think time', and 'work iterations' which would simulate time spent before requesting critical section again, and time spent inside the critical section. For TTAS the min and max delay is 1000 and 1 000 000 micro seconds respectively.

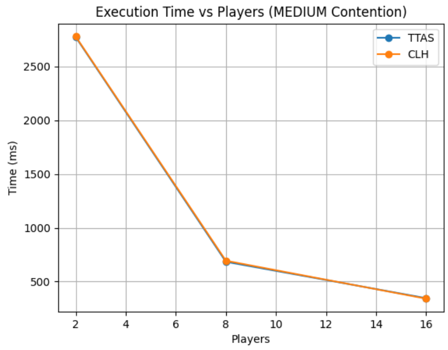
3 Results

3.1 Execution Time Graphs

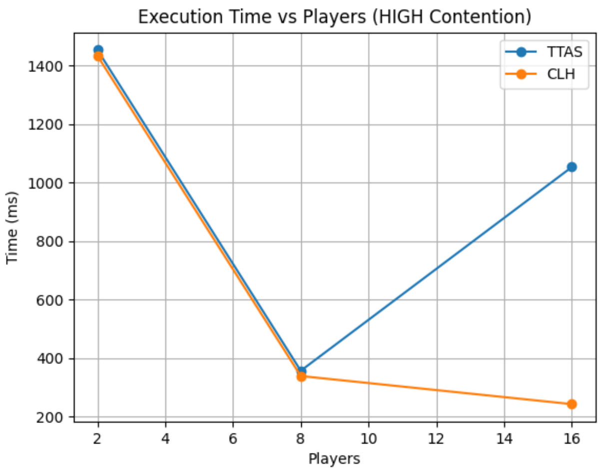
Figure 1 shows the execution time as the number of players increases.



(a) Low contention



(b) Medium contention



(c) High contention

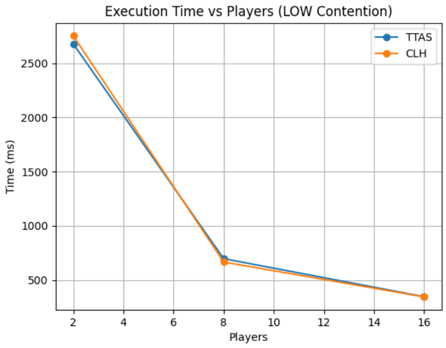
Figure 1: Execution time as the number of players increases. Subfigures (a), (b), and (c) correspond to Low, Medium, and High contention respectively.

3.2 Execution Time Discussion

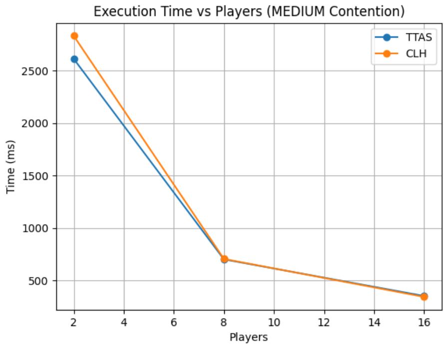
Low and medium contention has largely similiar results, with execution time being nearly identical regardless of the amount of players. This result will be discussed in detail. High contention has similiar execution for 2 and 8 players however at 16 players the difference in these locks reallt shows. CLH is almost 4 time faster than TTAS and this is because CLH avoids busy spinning on the shared lock because each thread spins on a local variable which reduces cache coherence traffic.

For low and medium contention there simply isn't enough contention for either. This is mainly because of modern CPU's and thread optimization. This leads to execution-time being almost entirely determined by work inside the critical section. Hence the similiar execution-time until the lock becomes the bottleneck at high contention. See below a graph where think time is constant (5ms) and work time is (1 000, 100 000, 1 000 000) for low, medium, and high contention respectively.

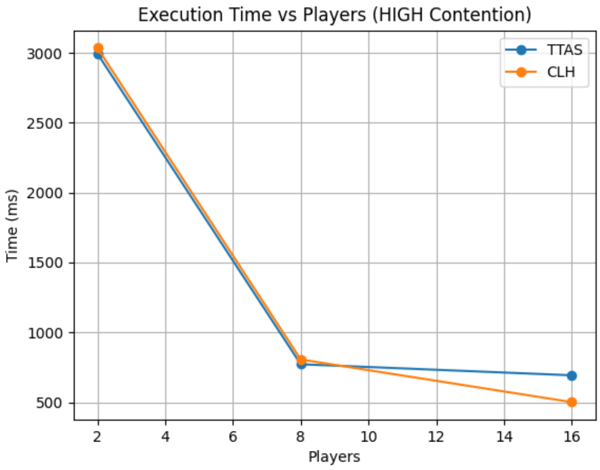
As seen in Figure 2 , the results are still largely the same with slight differences. This can differ on a machine with less threads or by using much greater work time.



(a) Low contention



(b) Medium contention



(c) High contention

Figure 2: Execution time as the number of players increases (with constant think time). Subfigures (a), (b), and (c) correspond to Low, Medium, and High contention respectively.

3.3 Fairness Table

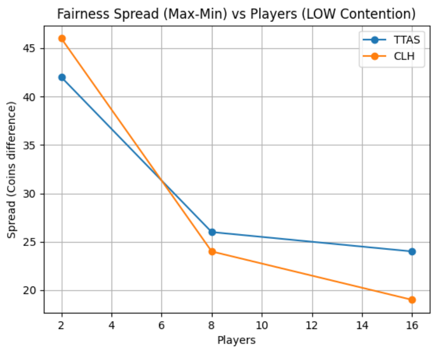
Table 1 compares the fairness spread (Max–Min coins taken).

Lock	Players	Contention	Min	Max	Spread
TTAS	2	LOW	979	1021	42
	2	MED	988	1012	24
	2	HIGH	999	1001	2
	8	LOW	235	261	26
	8	MED	239	263	24
	8	HIGH	228	263	35
	16	LOW	114	138	24
	16	MED	113	139	26
	16	HIGH	77	163	86
CLH	2	LOW	977	1023	46
	2	MED	992	1008	16
	2	HIGH	998	1002	4
	8	LOW	236	260	24
	8	MED	233	259	26
	8	HIGH	233	263	30
	16	LOW	113	132	19
	16	MED	115	133	18
	16	HIGH	113	135	22

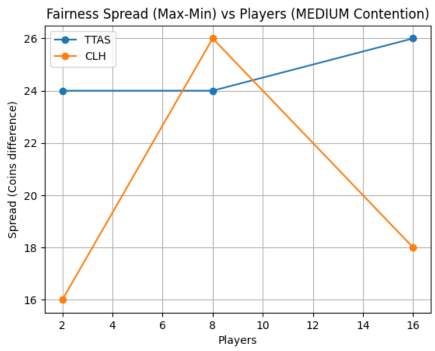
Table 1: Fairness comparison (Min–Max coins taken and Spread) between TTAS and CLH locks across players and contention levels.

3.4 Fairness Graphs

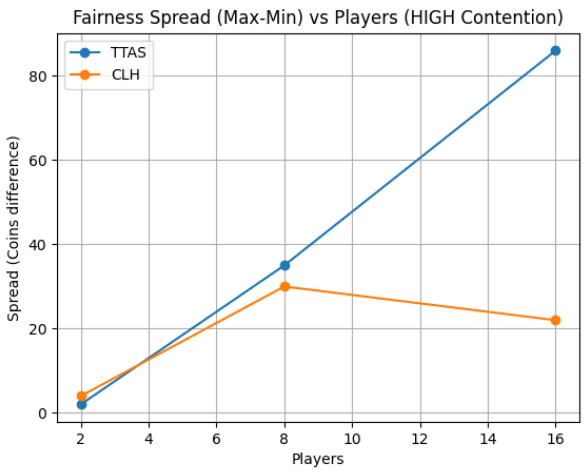
Figure 3 shows the fairness as the number of players increases.



(a) Low contention



(b) Medium contention



(c) High contention

Figure 3: Fairness as the number of players increases. Subfigures (a), (b), and (c) correspond to Low, Medium, and High contention respectively.

3.5 Fairness Discussion

The fairness measured is how evenly threads acquire the lock and take resources from the treasure chest.

Under low contention, both TTAS and CLH exhibit relatively small spreads because threads don't often block eachother.

Under medium contention the difference appears with CLH generally maining a lower spread than TTAS. Although with 8 players the difference is larger for CLH - but still relatively similiar to TTAS.

Under high contention there is a clear distinction. CLH consistently provides lower spread (with results varying slightly from run to run). This is becuase CLH provides more uniform access while TTAS can favour certain threads and uses a shared variable for spinning. CLH uses a queue-based design for a roughly FIFO order which reduces contention-related spread.

4 Final Comparison

Both locks will provide similiar performance with low contention (2, 8 players and Low, Medium conention). The difference appears when the lock is under a lock of contention, this allows CLH's queue-based design to outperform TTAS in both execution-time and fairness by large margins. TTAS may favour certain threads and skew fairness thus TTAS should only be used in simpler, and predictable environments where threads don't do extreme work in critical sections.

5 Conclusion

CLH demonstrates better fairness as contention and thread count increase, while TTAS can lead to uneven distribution under heavy load and should be used in predictable environments.

All data and source code for this report are available on github under 'A1'. Visit GitHub for all graphs and source code.