# Execution Time Calculation for ChaCha20 Hardware Core

This document details the calculation of execution time for encrypting a 2MB message using the synthesized ChaCha20 hardware core, as observed from cocotb simulation logs.

## Simulation Output Summary

Simulation Output from Cocotb:  
\*\* SIM TIME (ns) = 24,374,990 ns  
\*\* REAL TIME (s) = 219.12 seconds  
\*\* Clock Period = 10 ns (i.e., 100 MHz clock)

## Hardware Execution Time

The execution time in hardware is derived from the simulation time, assuming a clock frequency of 100 MHz.

1. Total simulated time: 24,374,990 ns = 24.37 milliseconds  
2. Clock period: 10 ns  
3. Total cycles taken: 24,374,990 / 10 = 2,437,499 cycles

## Message Size & Block Breakdown

Message size: 2 MB = 2,097,152 bytes  
ChaCha20 block size: 64 bytes  
Total blocks: 2,097,152 / 64 = 32,768 blocks

## Average Latency per Block

Total latency: 24.37 ms  
Average latency per block: 24.37 ms / 32,768 ≈ 743 ns/block ≈ 74.3 cycles/block

## Final Summary

- Total encryption time (hardware): ~24.37 ms  
- Clock cycles taken: ~2.44 million  
- Latency per 64-byte block: ~743 ns (at 100 MHz), or ~74.3 cycles

From the SPI benchmark results from weekly challenge

| **Size (bytes)** | **Throughput (kbps)** | **Efficiency (%)** |
| --- | --- | --- |
| **64** | **3150.45** | 86.73% |
| 1024 | 3850.21 | 89.43% |

This means:

* **3150.45 kbps = 393.81 KBps** (64-byte granularity)
* Which is lower than the max 481.28 KBps used earlier.

**🔁 Updated Transfer Time Calculation (64B/block):**

* **Data Size**: 2MB = 2048 KB
* **Throughput @ 64B block size**: 393.81 KBps

**Transfer Time (each direction):**

2048 KB / 393.81 KBps ≈ 5.202 seconds

**🧠 Total Execution Time:**

| **Component** | **Time (s)** |
| --- | --- |
| Hardware execution | 0.02437 |
| SW → HW transfer | 5.202 |
| HW → SW transfer | 5.202 |
| **Total** | **10.43 s** ✅ |