Implementation of Parallel Radix Sort using MPI

CSE 633: Parallel Algorithms

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What is Radix Sort?

It is a non-comparison based sort, best suited for sorting Integers

Comes under stable sorting algorithm

Two types of radix sort, LSD and MSD

Uses counting sort

An Example

Let n be the number of integers
If **i** is the largest integer, let **k** be the number of digits in **i**.

For integers from 1 to 9999, i = 9999 and k = 4

Example set of integers:

10, 5, 6, 24, 14, 3

n = 6, **i = 24**, **k = 2**

Example (Cont.)

Input: 10, 05, 06, 24, 14, 03

1. Sort by units place

10, 03, 24, 14, 05, 06

Note: If two numbers are same, preserve the initial order. (Stable sort)

2. Sort by tens place

03, 05, 06, 10, 14, 24

Analysis

It takes O(n) time to sort by units place
It takes another O(n) to sort by tens place

Total Sorting time: O(*k*n)

In the example k = 2, therefore running time is O(kn)

What if **i** (Largest integer) is unknown?
Do an iteration over the data to find the largest Integer

Parallel Implementation

Step 1: If the data is initially present in a single processor, distribute it to all other processors

Step 2: Convert the numbers to base 2 (Binary)

In base 10, we proceeded from Least Significant Digit to Most Significant Digit

For parallel implementation we choose a group of g bits

Parallel Implementation (Step 2)

If **p** = Number of processors

Then we choose **g** such that,

$$\mathbf{2^g = p}$$

$$\mathbf{g = \log_{2\ P}}$$

For example,

if **p = 4**, then **g = 2**. We take 2 bits at a time

00, 01, 10, 11

Parallel Implementation

Step 3: Do an interprocess communication such that

All numbers ending in bits 00 are sent to Processor *P0*
All numbers ending in bits 01 are sent to Processor *P1*
and so on…

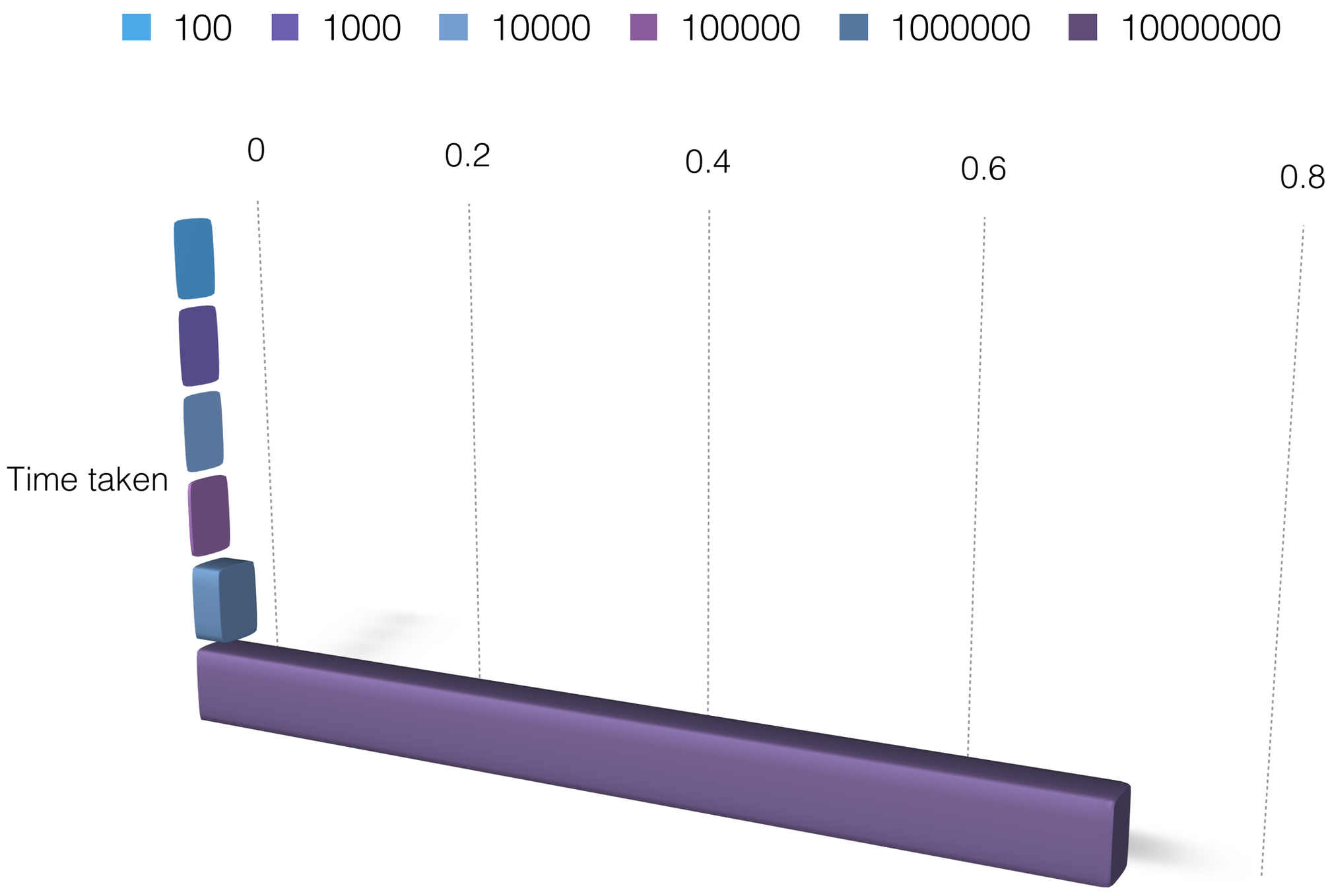
Step 4: Perform counting sort locally on these processors

Step 5: Calculate the global prefix-sum of the number of integers in each processor

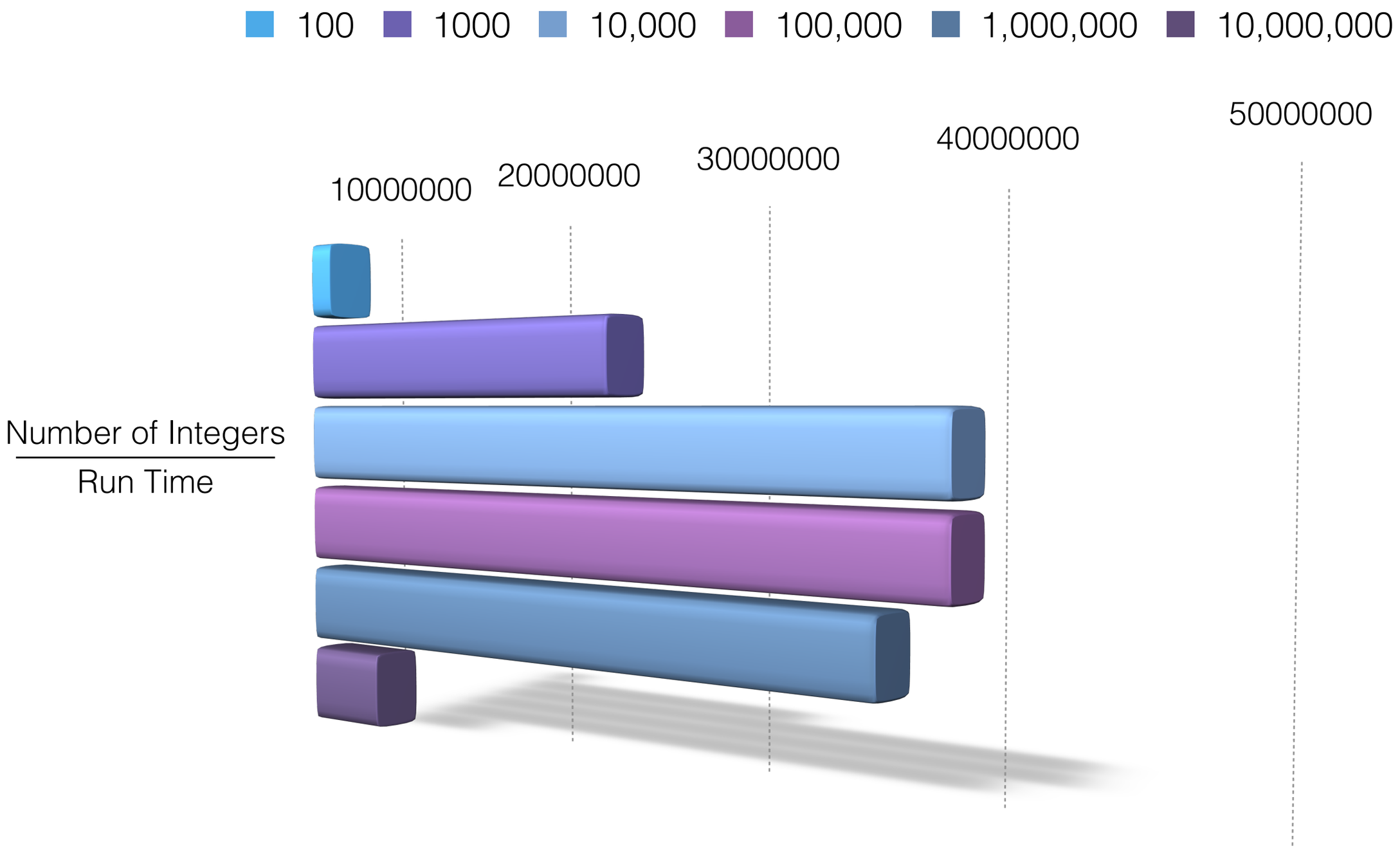
Step 6: Using the index calculated in previous step put back the integers in a temporary array and this serves as input to next iteration.

Charts

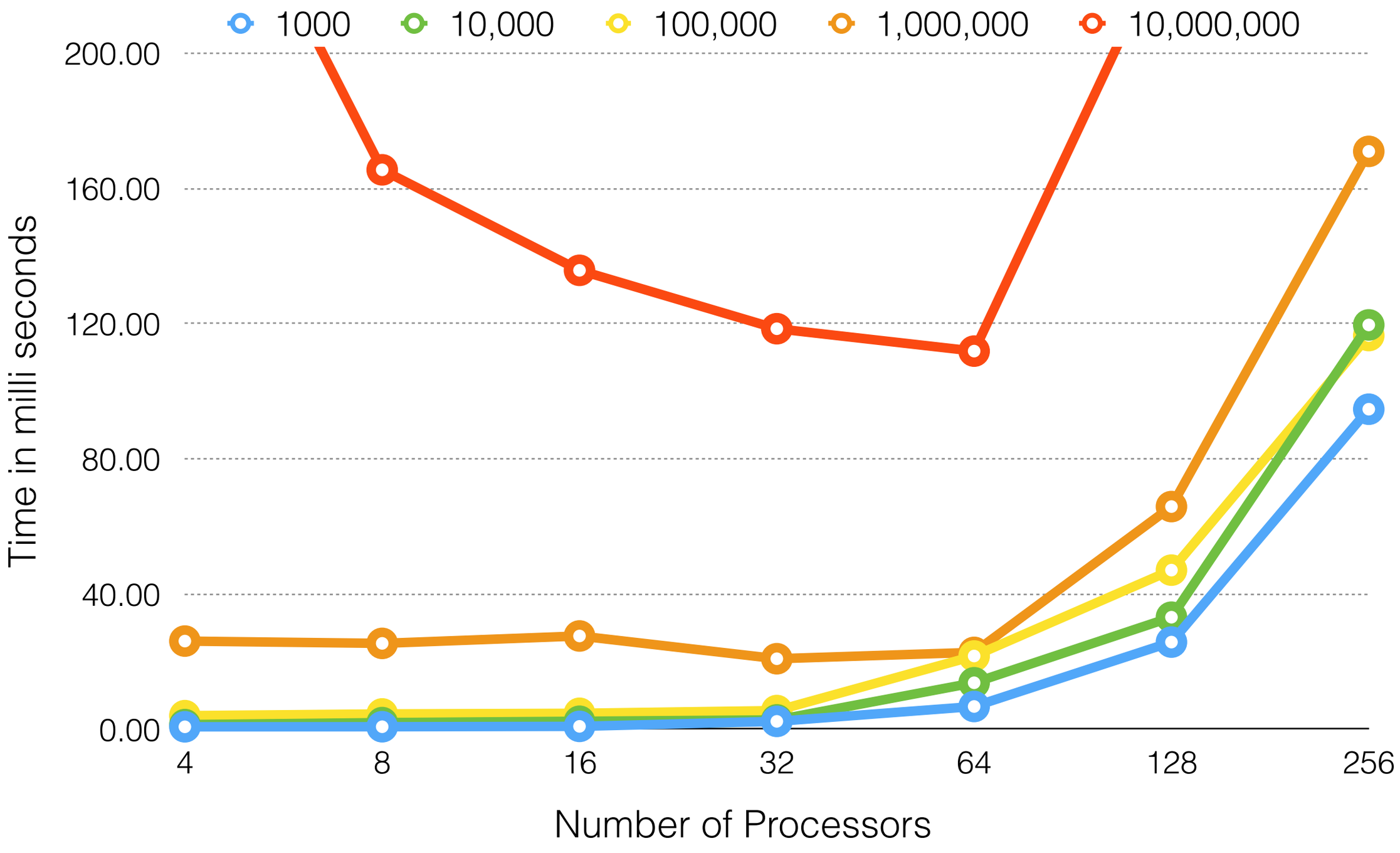
Serial: Run time



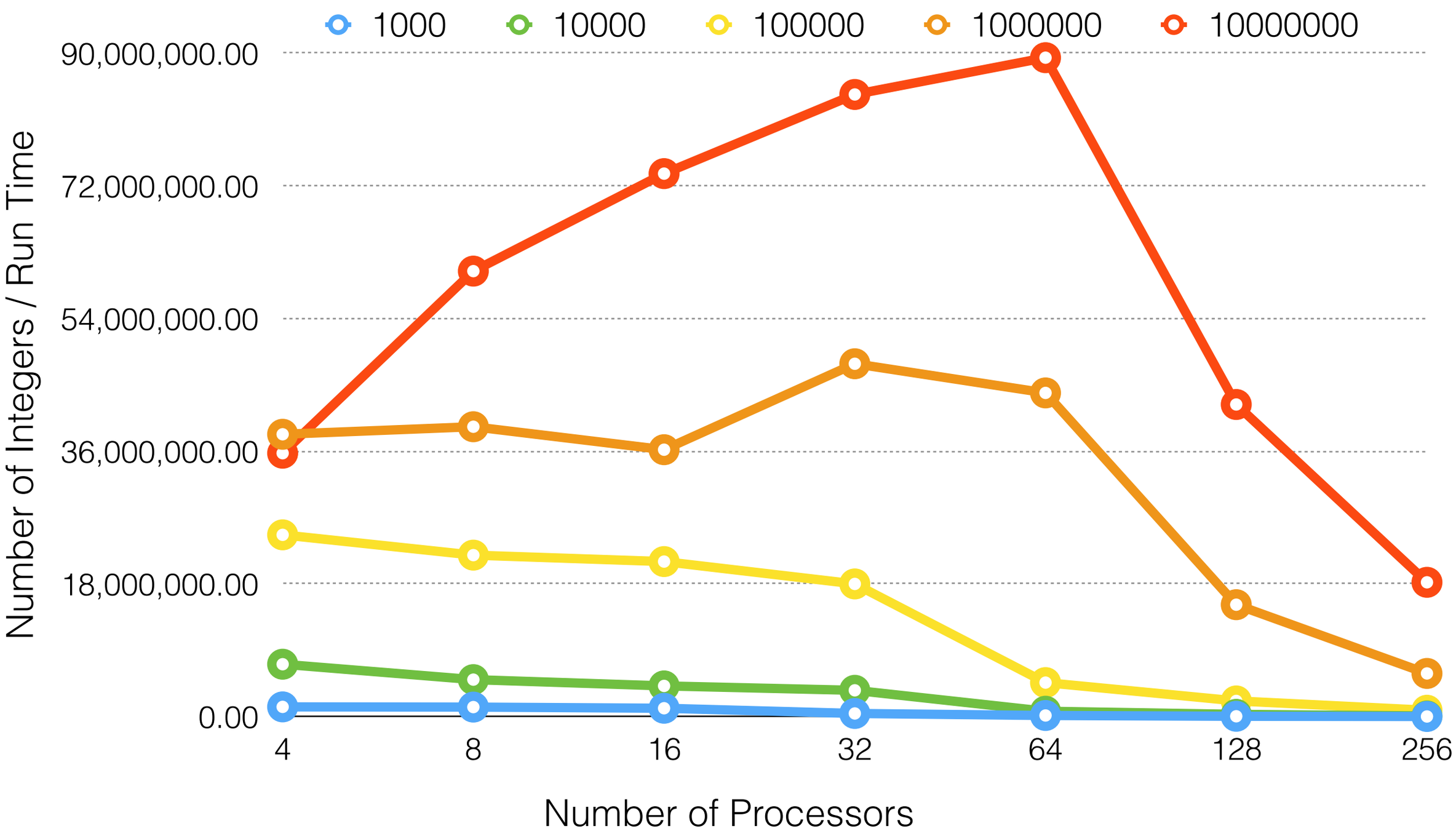
Serial: Speed of Processing



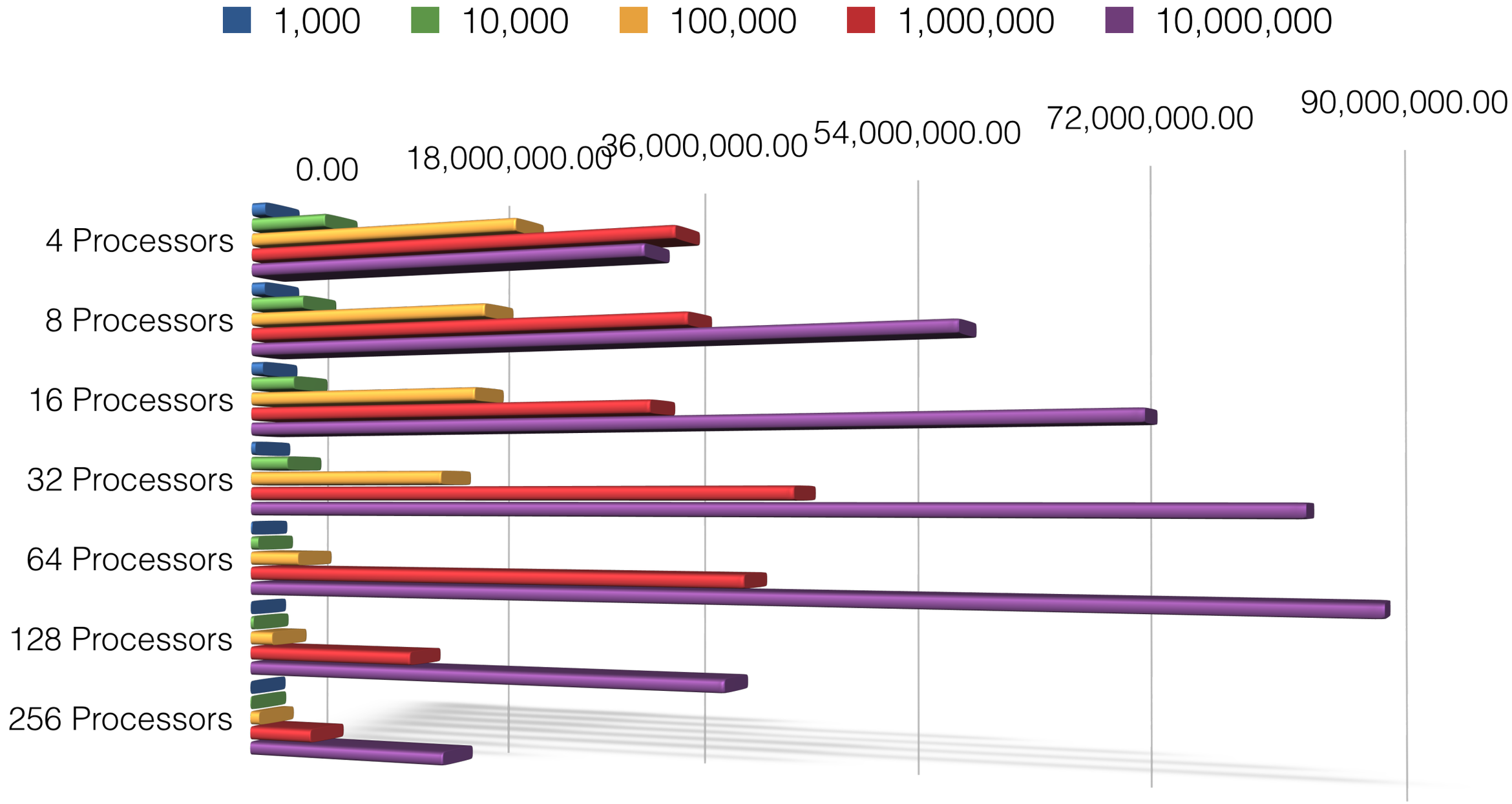
Parallel: Run Time



Parallel: Speed of Processing



Parallel: Speed of Processing



Thank You!