

## CS575 Project 2

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### 1. Machine Configuration: OSU ENGR

```
Architecture:          x86_64
CPU op-mode(s):        32-bit, 64-bit
Byte Order:            Little Endian
CPU(s):                24
On-line CPU(s) list:   0-23
Thread(s) per core:    2
Core(s) per socket:    6
Socket(s):             2
NUMA node(s):          2
Vendor ID:             GenuineIntel
CPU family:            6
Model:                 44
Model name:            Intel(R) Xeon(R) CPU           X5650   @ 2.67GHz
Stepping:              2
CPU MHz:               2659.791
BogoMIPS:              5319.58
Virtualization:        VT-x
L1d cache:             32K
L1i cache:             32K
L2 cache:              256K
L3 cache:              12288K
NUMA node0 CPU(s):     0,2,4,6,8,10,12,14,16,18,20,22
NUMA node1 CPU(s):     1,3,5,7,9,11,13,15,17,19,21,23
```

## 2. Results

```
Threads: 1 ; Nodes on each side edge: 512 ; Volume: 3.8790 ; Mega heights / sec: 3.588
Threads: 1 ; Nodes on each side edge: 1024 ; Volume: 3.8778 ; Mega heights / sec: 3.198
Threads: 1 ; Nodes on each side edge: 2048 ; Volume: 3.8901 ; Mega heights / sec: 3.043
Threads: 1 ; Nodes on each side edge: 3072 ; Volume: 3.9168 ; Mega heights / sec: 3.606
Threads: 1 ; Nodes on each side edge: 4096 ; Volume: 3.7771 ; Mega heights / sec: 3.577
Threads: 1 ; Nodes on each side edge: 5120 ; Volume: 4.0000 ; Mega heights / sec: 3.326
Threads: 1 ; Nodes on each side edge: 6144 ; Volume: 3.1967 ; Mega heights / sec: 3.439
Threads: 2 ; Nodes on each side edge: 256 ; Volume: 3.8788 ; Mega heights / sec: 5.538
Threads: 2 ; Nodes on each side edge: 512 ; Volume: 3.8789 ; Mega heights / sec: 7.356
Threads: 2 ; Nodes on each side edge: 1024 ; Volume: 3.8780 ; Mega heights / sec: 4.031
Threads: 2 ; Nodes on each side edge: 2048 ; Volume: 3.8779 ; Mega heights / sec: 6.207
Threads: 2 ; Nodes on each side edge: 3072 ; Volume: 3.8665 ; Mega heights / sec: 6.370
Threads: 2 ; Nodes on each side edge: 4096 ; Volume: 3.8119 ; Mega heights / sec: 4.004
Threads: 2 ; Nodes on each side edge: 5120 ; Volume: 3.6867 ; Mega heights / sec: 5.954
Threads: 2 ; Nodes on each side edge: 6144 ; Volume: 3.9985 ; Mega heights / sec: 6.112
Threads: 4 ; Nodes on each side edge: 256 ; Volume: 3.8788 ; Mega heights / sec: 5.396
Threads: 4 ; Nodes on each side edge: 512 ; Volume: 3.8789 ; Mega heights / sec: 4.779
Threads: 4 ; Nodes on each side edge: 1024 ; Volume: 3.8789 ; Mega heights / sec: 10.817
Threads: 4 ; Nodes on each side edge: 2048 ; Volume: 3.8797 ; Mega heights / sec: 8.123
Threads: 4 ; Nodes on each side edge: 3072 ; Volume: 3.8701 ; Mega heights / sec: 12.100
Threads: 4 ; Nodes on each side edge: 4096 ; Volume: 3.8769 ; Mega heights / sec: 10.419
Threads: 4 ; Nodes on each side edge: 5120 ; Volume: 3.8634 ; Mega heights / sec: 9.217
Threads: 4 ; Nodes on each side edge: 6144 ; Volume: 3.9359 ; Mega heights / sec: 7.493
Threads: 8 ; Nodes on each side edge: 256 ; Volume: 3.8788 ; Mega heights / sec: 9.830
Threads: 8 ; Nodes on each side edge: 512 ; Volume: 3.8789 ; Mega heights / sec: 11.854
Threads: 8 ; Nodes on each side edge: 1024 ; Volume: 3.8789 ; Mega heights / sec: 10.912
Threads: 8 ; Nodes on each side edge: 2048 ; Volume: 3.8782 ; Mega heights / sec: 12.870
Threads: 8 ; Nodes on each side edge: 3072 ; Volume: 3.8787 ; Mega heights / sec: 11.972
Threads: 8 ; Nodes on each side edge: 4096 ; Volume: 3.8803 ; Mega heights / sec: 11.515
Threads: 8 ; Nodes on each side edge: 5120 ; Volume: 3.8817 ; Mega heights / sec: 12.149
Threads: 8 ; Nodes on each side edge: 6144 ; Volume: 3.8810 ; Mega heights / sec: 18.163
Threads: 12 ; Nodes on each side edge: 256 ; Volume: 3.8788 ; Mega heights / sec: 6.730
Threads: 12 ; Nodes on each side edge: 512 ; Volume: 3.8789 ; Mega heights / sec: 5.870
Threads: 12 ; Nodes on each side edge: 1024 ; Volume: 3.8789 ; Mega heights / sec: 9.652
Threads: 12 ; Nodes on each side edge: 2048 ; Volume: 3.8787 ; Mega heights / sec: 11.101
Threads: 12 ; Nodes on each side edge: 3072 ; Volume: 3.8795 ; Mega heights / sec: 14.423
Threads: 12 ; Nodes on each side edge: 4096 ; Volume: 3.8793 ; Mega heights / sec: 13.976
Threads: 12 ; Nodes on each side edge: 5120 ; Volume: 3.8803 ; Mega heights / sec: 16.033
Threads: 12 ; Nodes on each side edge: 6144 ; Volume: 3.8659 ; Mega heights / sec: 20.497
Threads: 16 ; Nodes on each side edge: 256 ; Volume: 3.8788 ; Mega heights / sec: 3.411
Threads: 16 ; Nodes on each side edge: 512 ; Volume: 3.8789 ; Mega heights / sec: 6.516
Threads: 16 ; Nodes on each side edge: 1024 ; Volume: 3.8790 ; Mega heights / sec: 22.103
Threads: 16 ; Nodes on each side edge: 2048 ; Volume: 3.8790 ; Mega heights / sec: 12.100
Threads: 16 ; Nodes on each side edge: 3072 ; Volume: 3.8795 ; Mega heights / sec: 13.383
Threads: 16 ; Nodes on each side edge: 4096 ; Volume: 3.8787 ; Mega heights / sec: 23.617
Threads: 16 ; Nodes on each side edge: 5120 ; Volume: 3.8778 ; Mega heights / sec: 23.999
Threads: 16 ; Nodes on each side edge: 6144 ; Volume: 3.8695 ; Mega heights / sec: 28.260
```

### 3. Statistics

NumThreads	NumNodes	Volume	Performance
1	256	3.8788	2.868
1	512	3.879	3.588
1	1024	3.8778	3.198
1	2048	3.8901	3.043
1	3072	3.9168	3.606
1	4096	3.7771	3.577
1	5120	4	3.326
1	6144	3.1967	3.439
2	256	3.8788	5.538
2	512	3.8789	7.356
2	1024	3.878	4.031
2	2048	3.8779	6.207
2	3072	3.8665	6.37
2	4096	3.8119	4.004
2	5120	3.6867	5.954
2	6144	3.9985	6.112
4	256	3.8788	5.396
4	512	3.8789	4.779
4	1024	3.8789	10.817
4	2048	3.8797	8.123
4	3072	3.8701	12.1
4	4096	3.8769	10.419
4	5120	3.8634	9.217
4	6144	3.9359	7.493
8	256	3.8788	9.83
8	512	3.8789	11.854
8	1024	3.8789	10.912
8	2048	3.8782	12.87
8	3072	3.8787	11.972
8	4096	3.8803	11.515
8	5120	3.8817	12.149
8	6144	3.881	18.163
12	256	3.8788	6.73
12	512	3.8789	5.87
12	1024	3.8789	9.652
12	2048	3.8787	11.101
12	3072	3.8795	14.423

12	4096	3.8793	13.976
12	5120	3.8803	16.033
12	6144	3.8659	20.497
16	256	3.8788	3.411
16	512	3.8789	6.516
16	1024	3.879	22.103
16	2048	3.879	12.1
16	3072	3.8795	13.383
16	4096	3.8787	23.617
16	5120	3.8778	23.999
16	6144	3.8695	28.26

Table 1: Performance vs number of nodes and number of threads

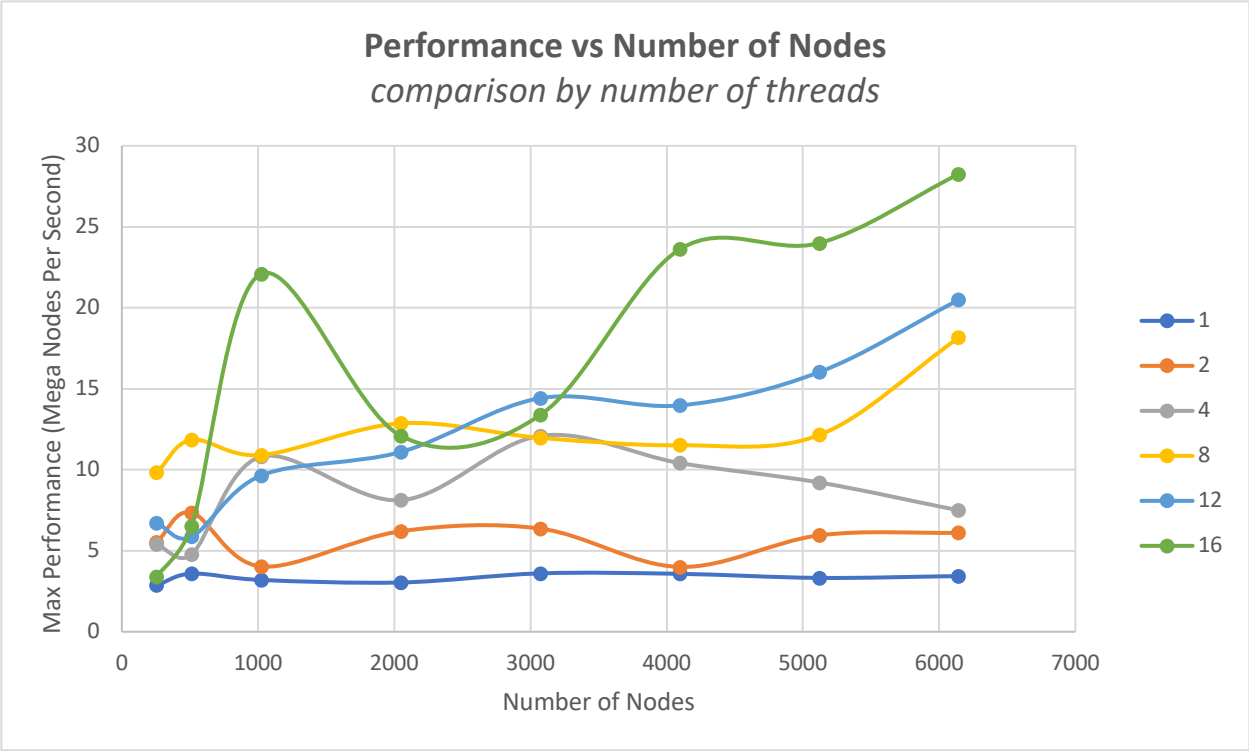
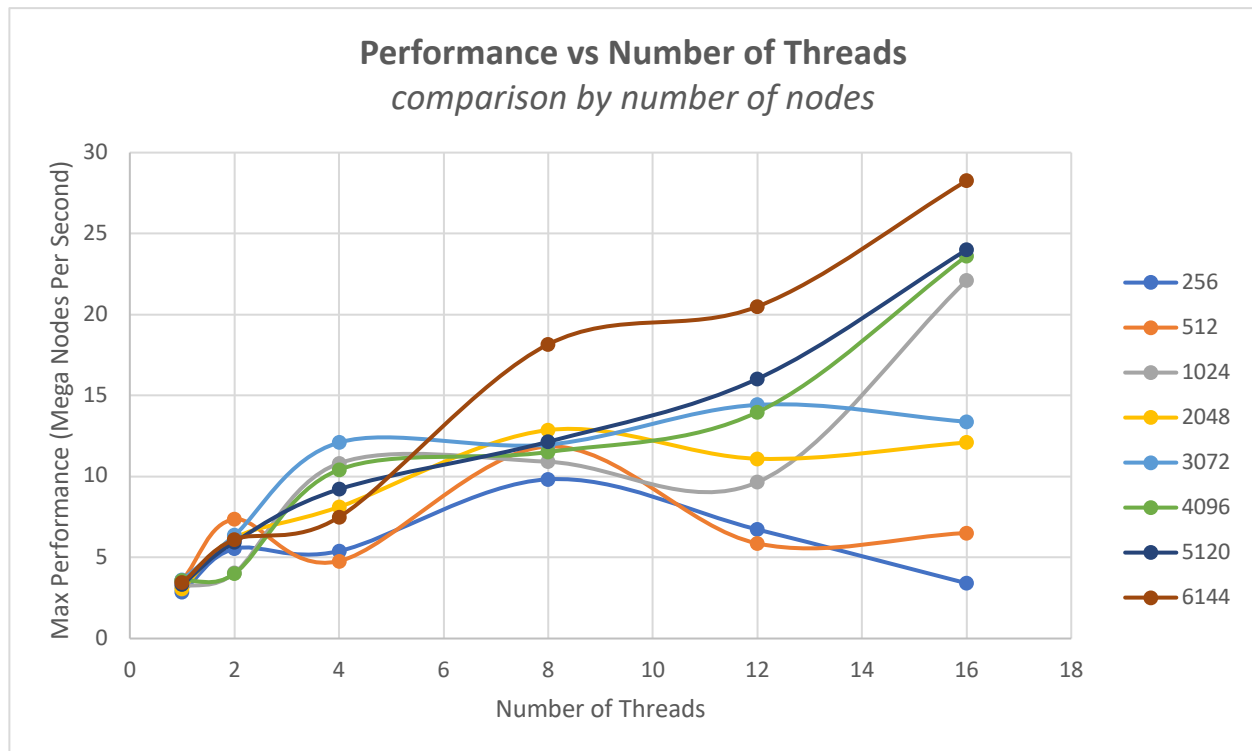


Figure 1



**Figure 2**

As shown in Figure 1, as the number of nodes increases, there is no significant pattern to learn how the performance behave. The reason why is probably because at the time I am running this program, there might be some students are running theirs too.

As shown in Figure 2, as the number of threads increases, the performance increases. However, the patterns are still short in consistency. It is reasonable probably because there is synchronous operation of tasks at the same time.

- The average volume is about 7.73
- In 6144 node: 16-thread-to-1-thread speedups =  $28.26 / 3.439 = 8.217505089 \approx 8.22$
- Parallel fraction =  $16 / 15 * (1 - 1 / 8.22) = 0.936901865 \approx 0.94$
- Maximum speedup =  $1 / (1 - 0.94) = 16.6666667 \approx 16.67$