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PARALLEL SCALING PERFORMANCE ON TACC

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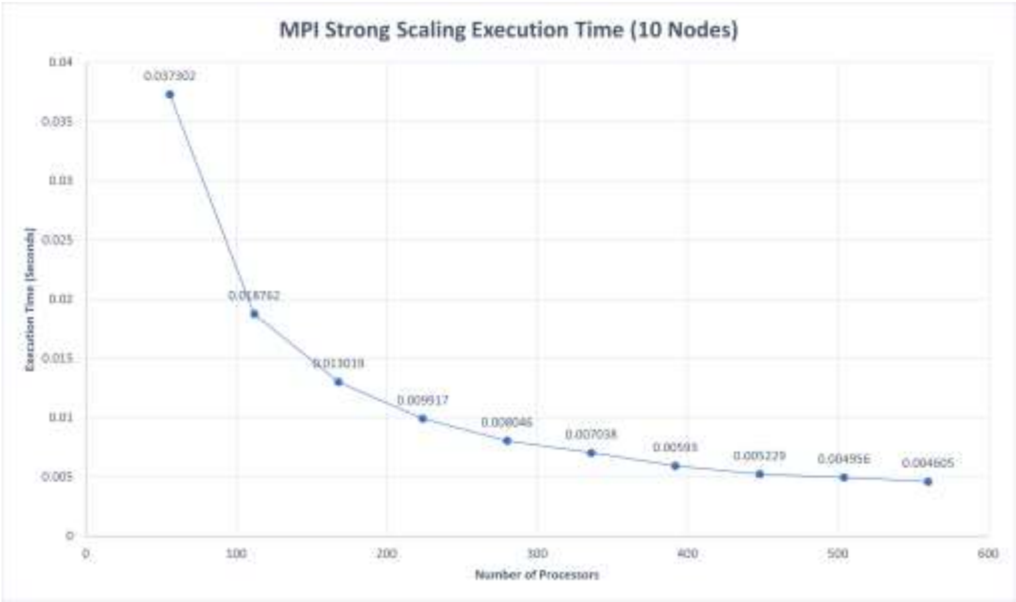
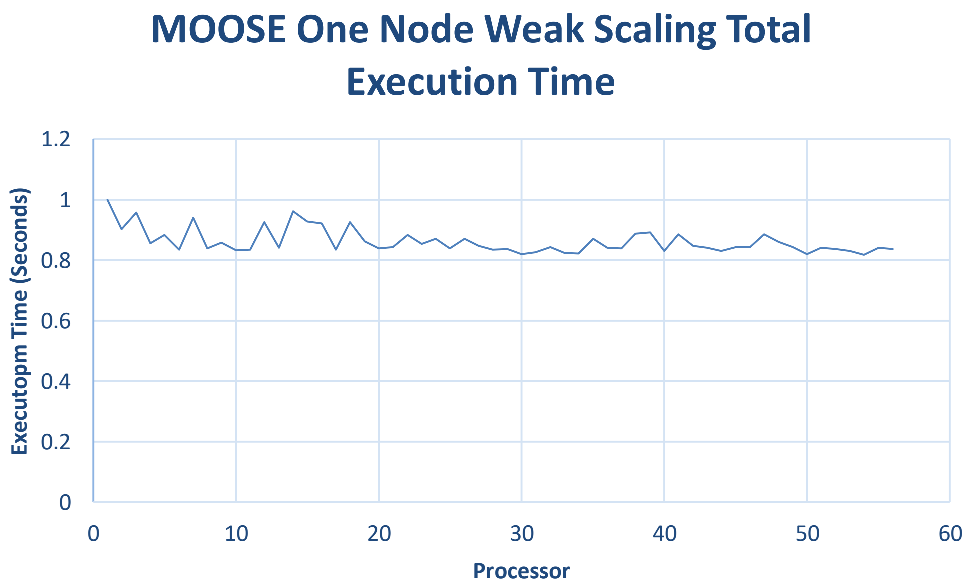
Introduction



Example of strong scaling on Frontera



Example of weak scaling on Frontera

- Evaluate the scale performance of a simple MPI program to benchmark the performance of MPI on Frontera
- Numerically approximate the heat conduction problem using finite element principles.
- Model the weak and strong scalability of MOOSE using MPI on Frontera
- Perform scalability on linear and non-linear heat conduction via weak and strong scaling

What is Performance Testing?

Strong Scaling

- The number of processors are increased ↑
- The workload per processors are decreased ↓
- Overall problem size is constant ●

Weak Scaling

- The number of processors are increased ↑
- The workload per processors is constant ●
- Overall problem size is increased ↑

Strong Scaling Efficiency

$$E_s = \frac{t(1)}{t(N) * N}$$

- Common statistic used for strong scaling that ranges from 0 to 1
- t(1) execution time for one processor
- t(N) execution time for N processors
- N represents the number of processors

Weak Scaling Efficiency

$$E_s = \frac{t(1)}{t(N)}$$

- Common statistic used for weak scaling that ranges from 0 to 1
- t(1) execution time for one processor
- t(N) execution time for N processors
- N represents the number of processors

MPI Performance Test

- MPI (Message Passing Interface) is a standard parallel programming library.
- MPI structure is the foundation for parallelism for many code libraries such as PETSc, MPICH, Open MPI, etc.
- MPICH was used as the base comparison for scaling performance between MOOSE.
- The MPI execution times were relatively fast compared to MOOSE execution times.

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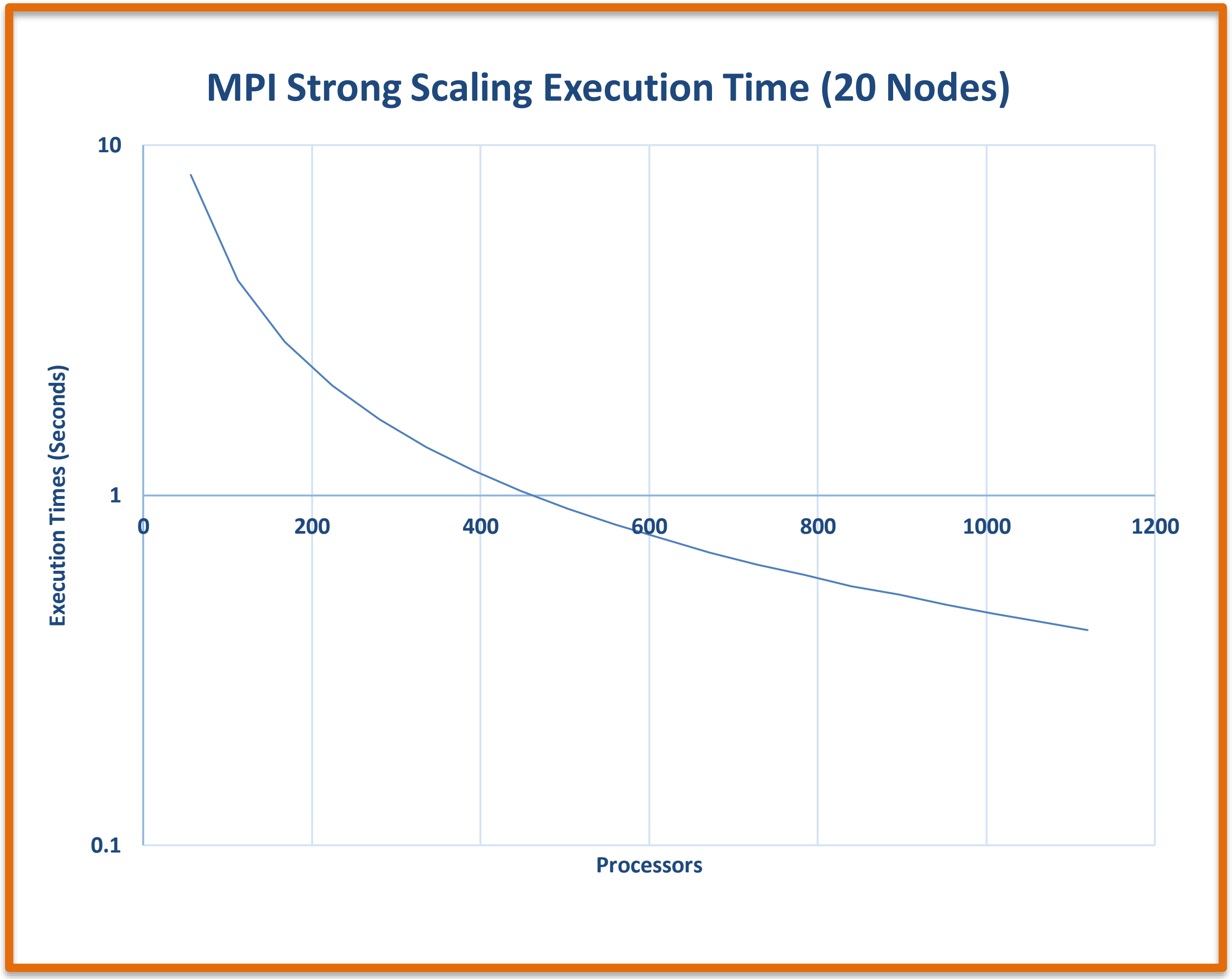
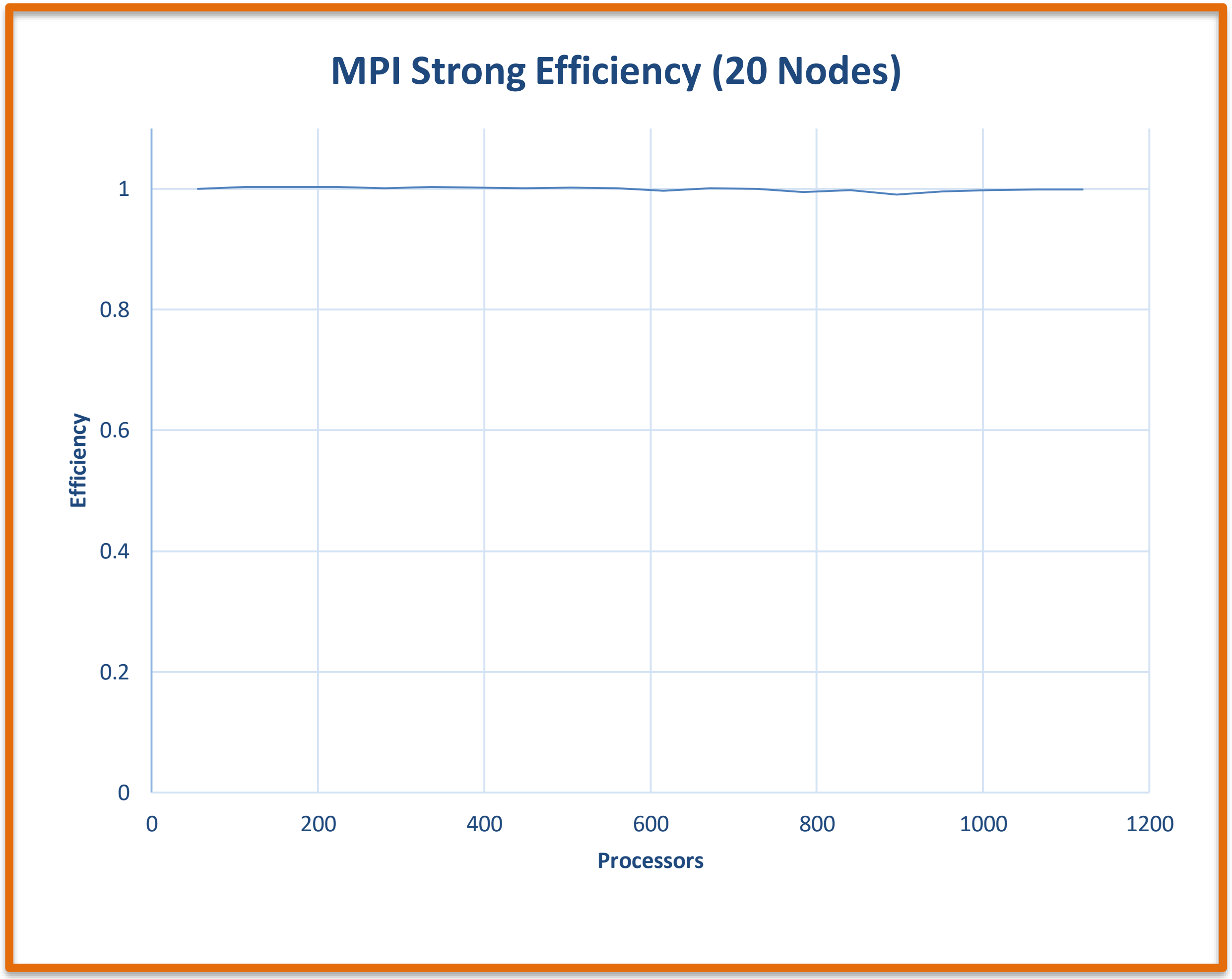
MPI Strong Scaling Performance Test





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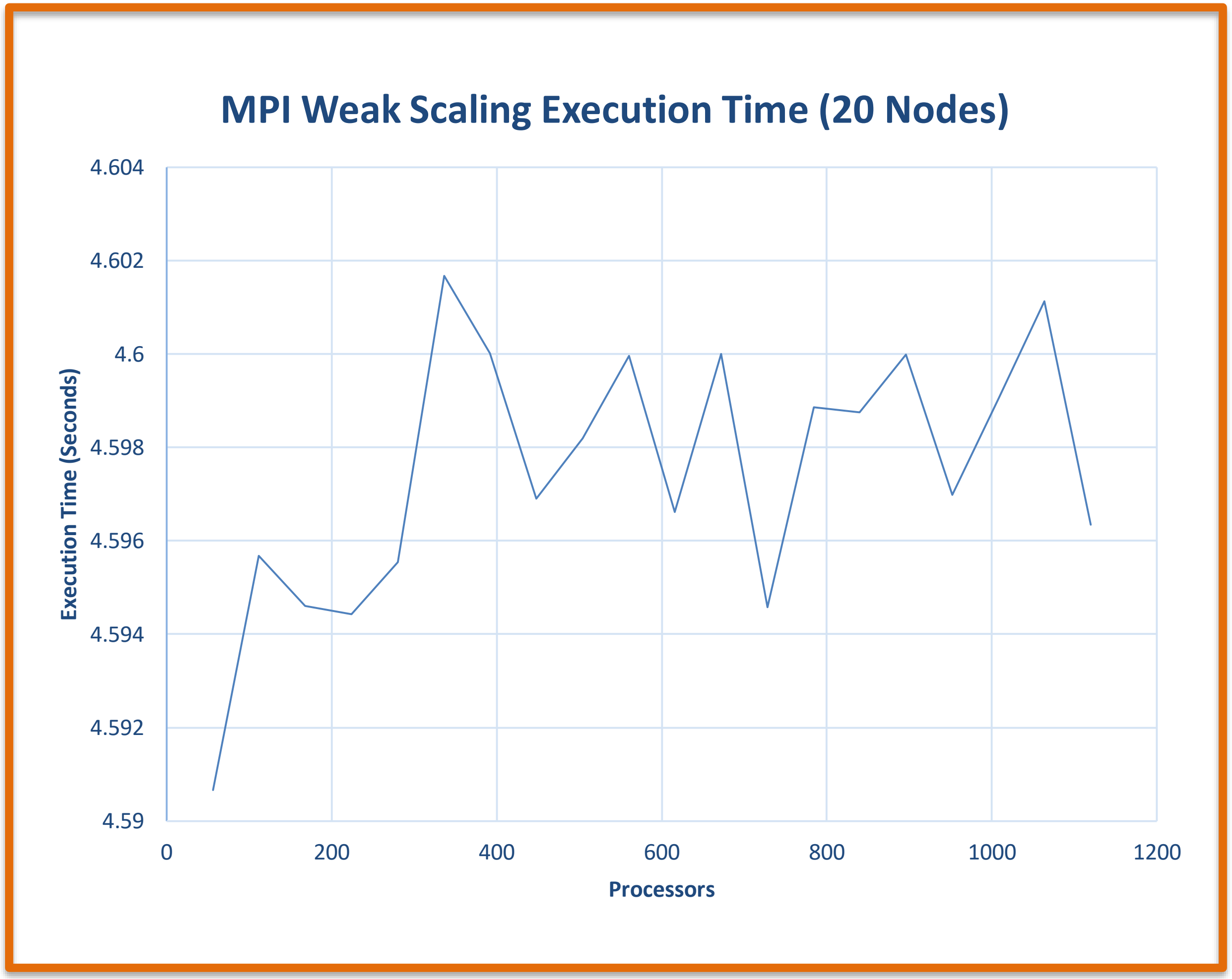
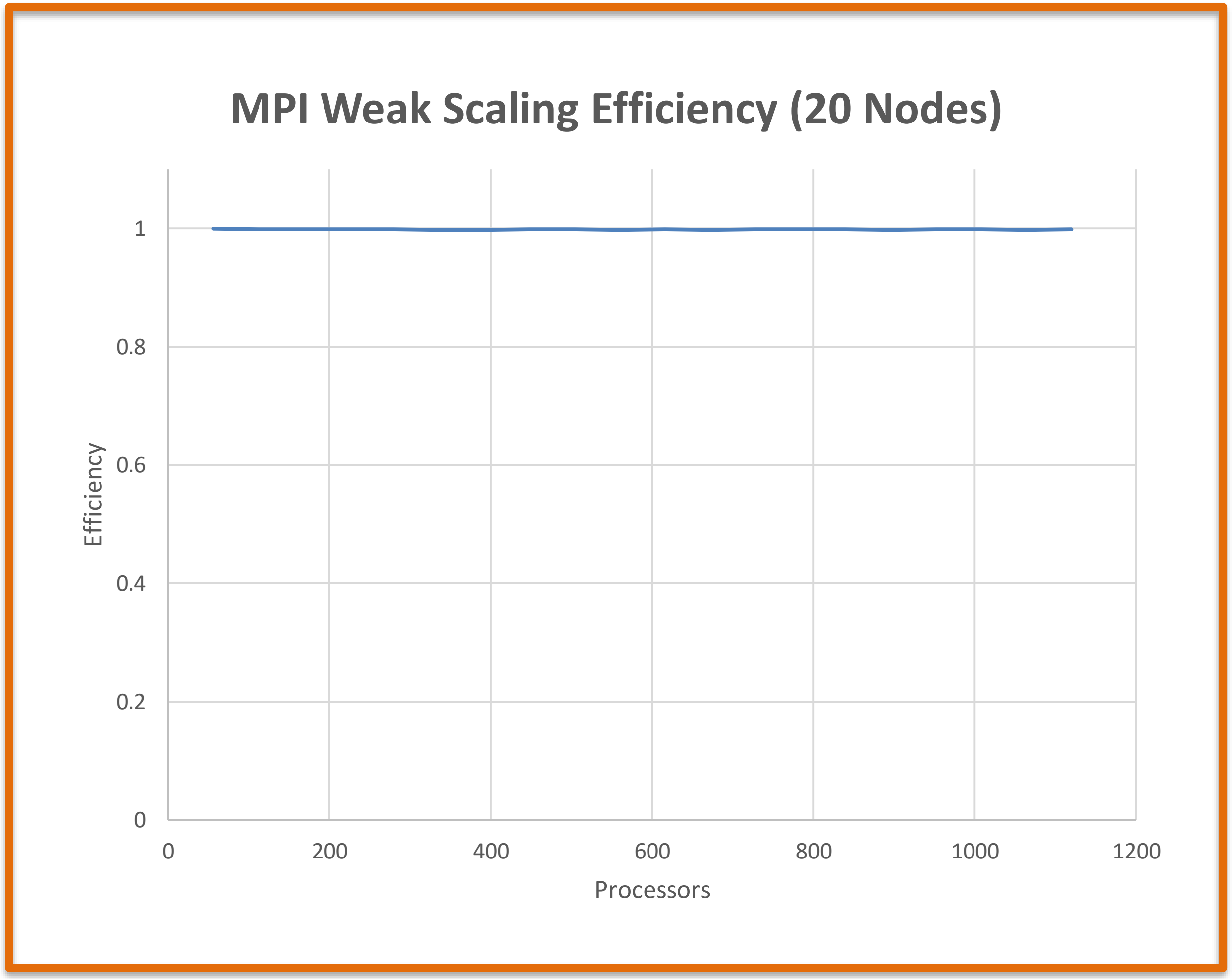
MPI Weak Scaling Performance Test





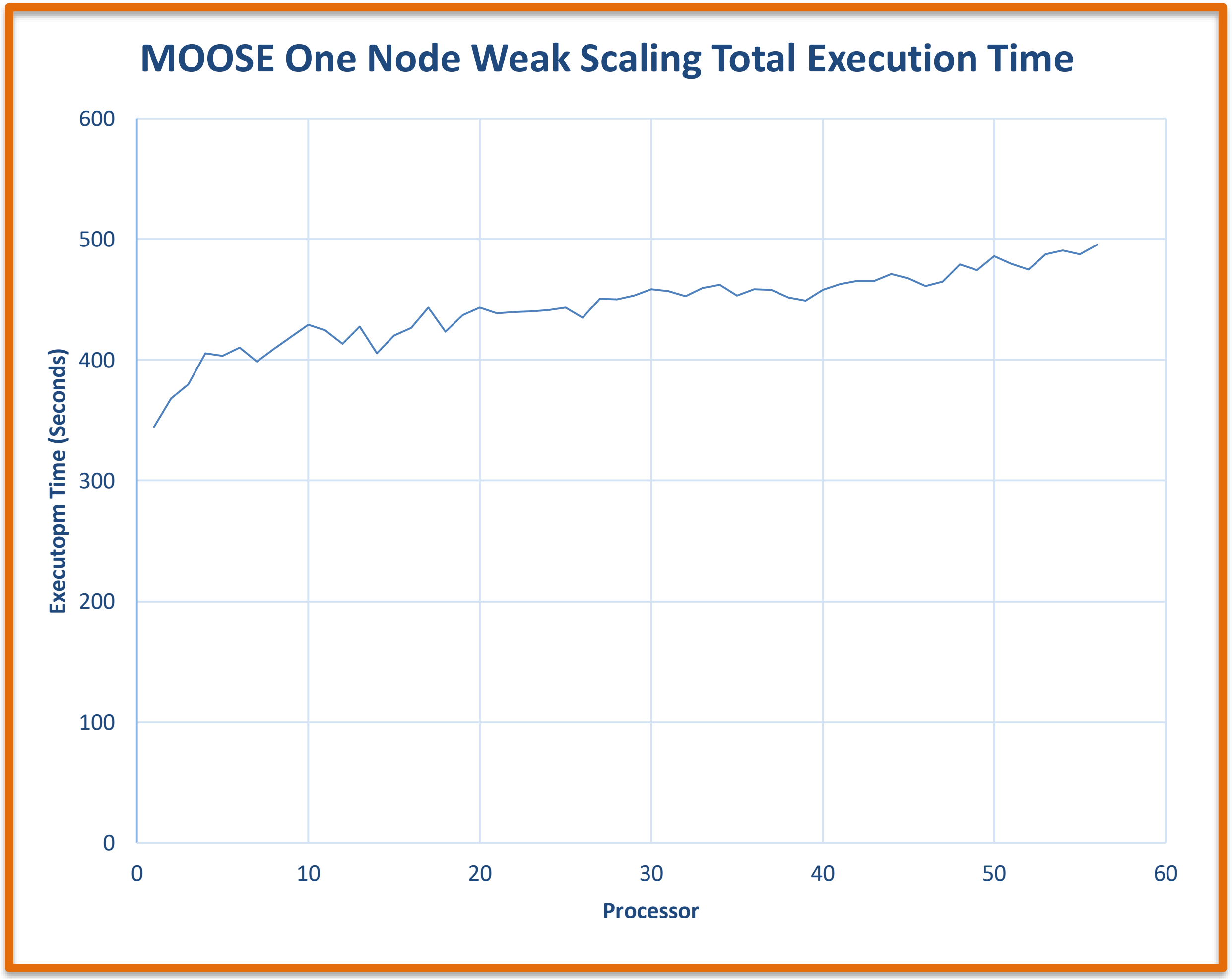
MOOSE Scaling Performance

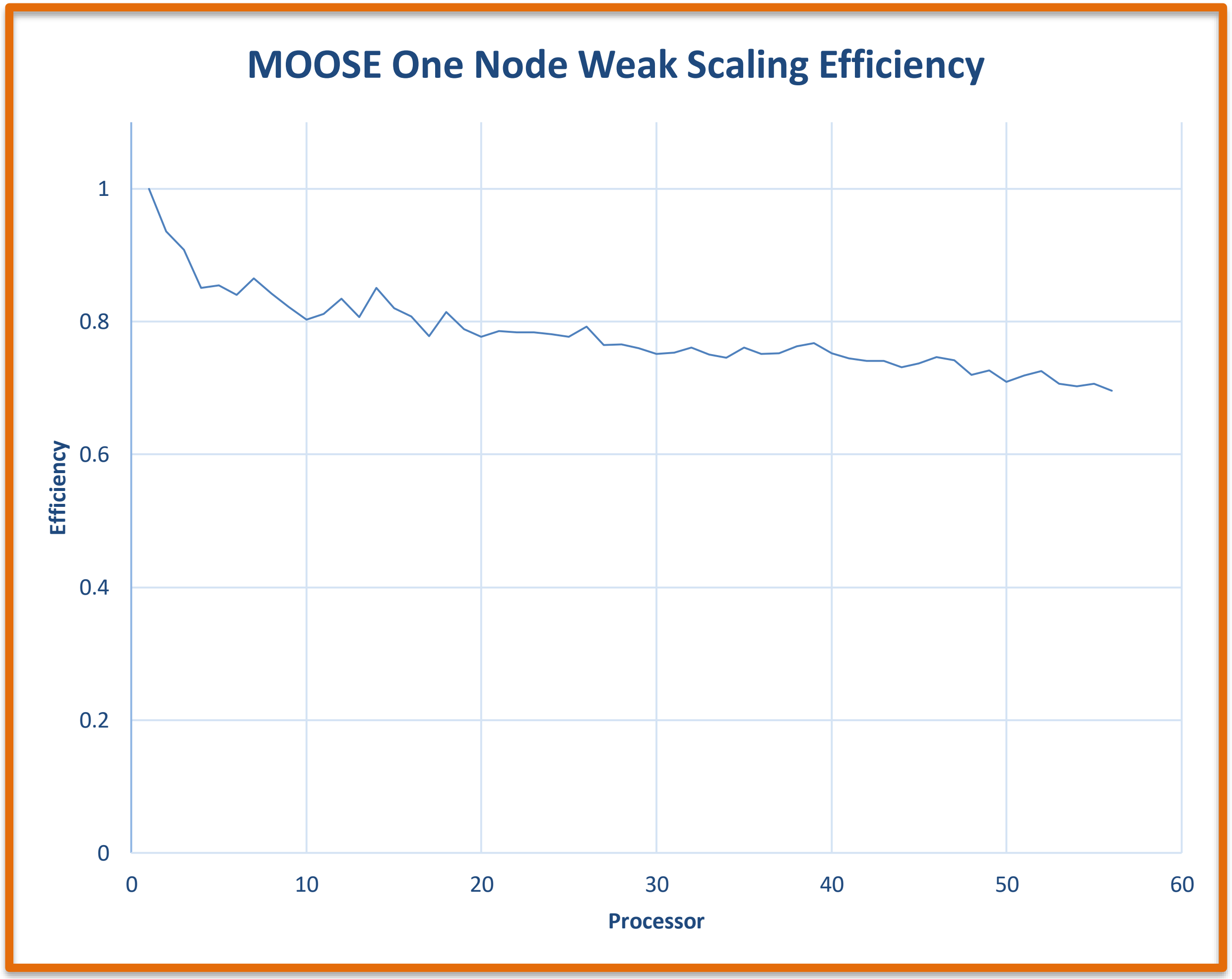
- Developed a linear and non-linear heat conduction model using MOOSE (finite-element, multiphysics framework)
- Performed strong and weak scaling on linear and non-linear simulation models
- Computed strong and weak scaling efficiency on an intranode and internode study
- Evaluated potential performance flaws in scaling and compared results with MPI performance tests.

Heat Conduction Equation

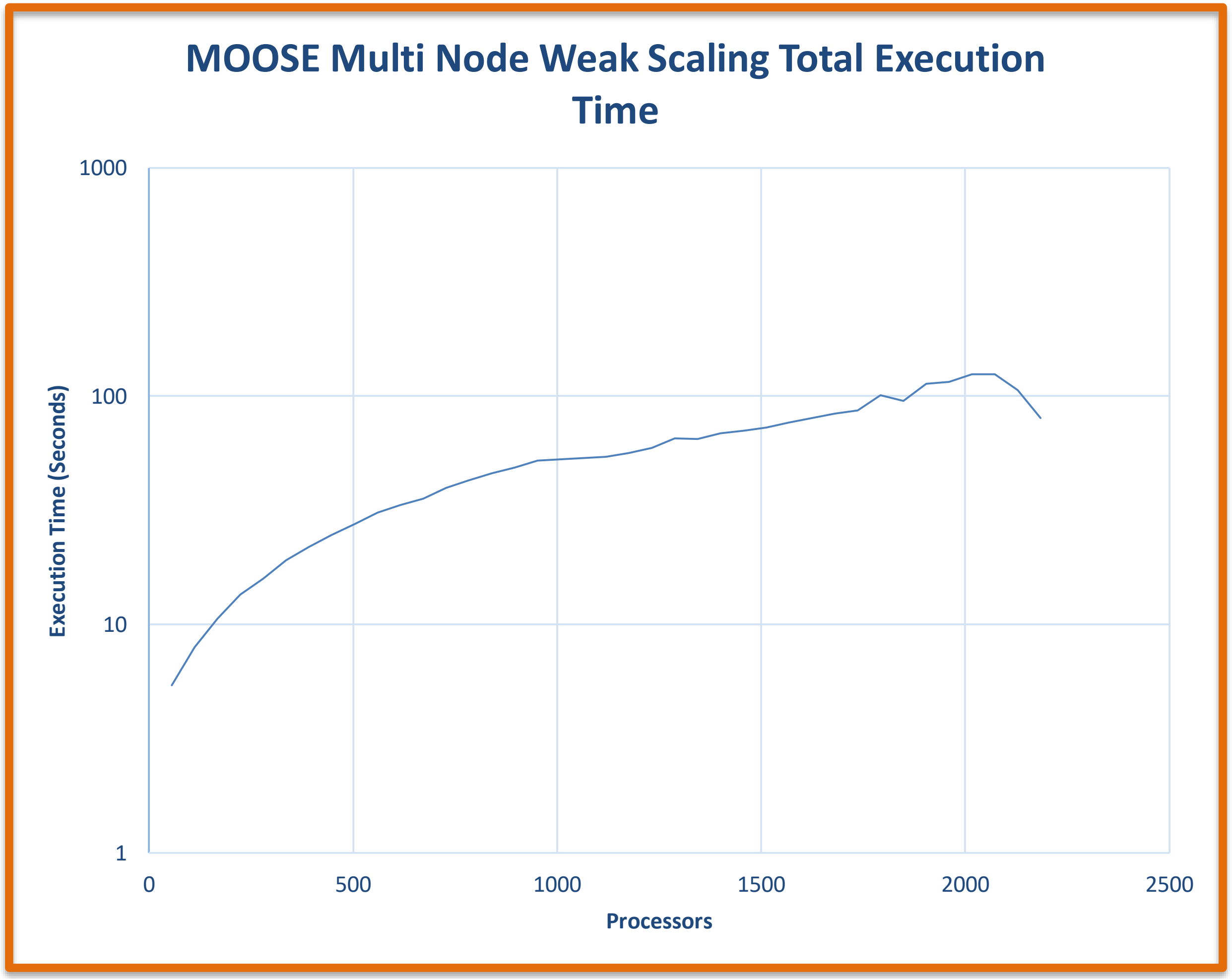
$$\nabla \cdot k(T)\nabla T = 0$$

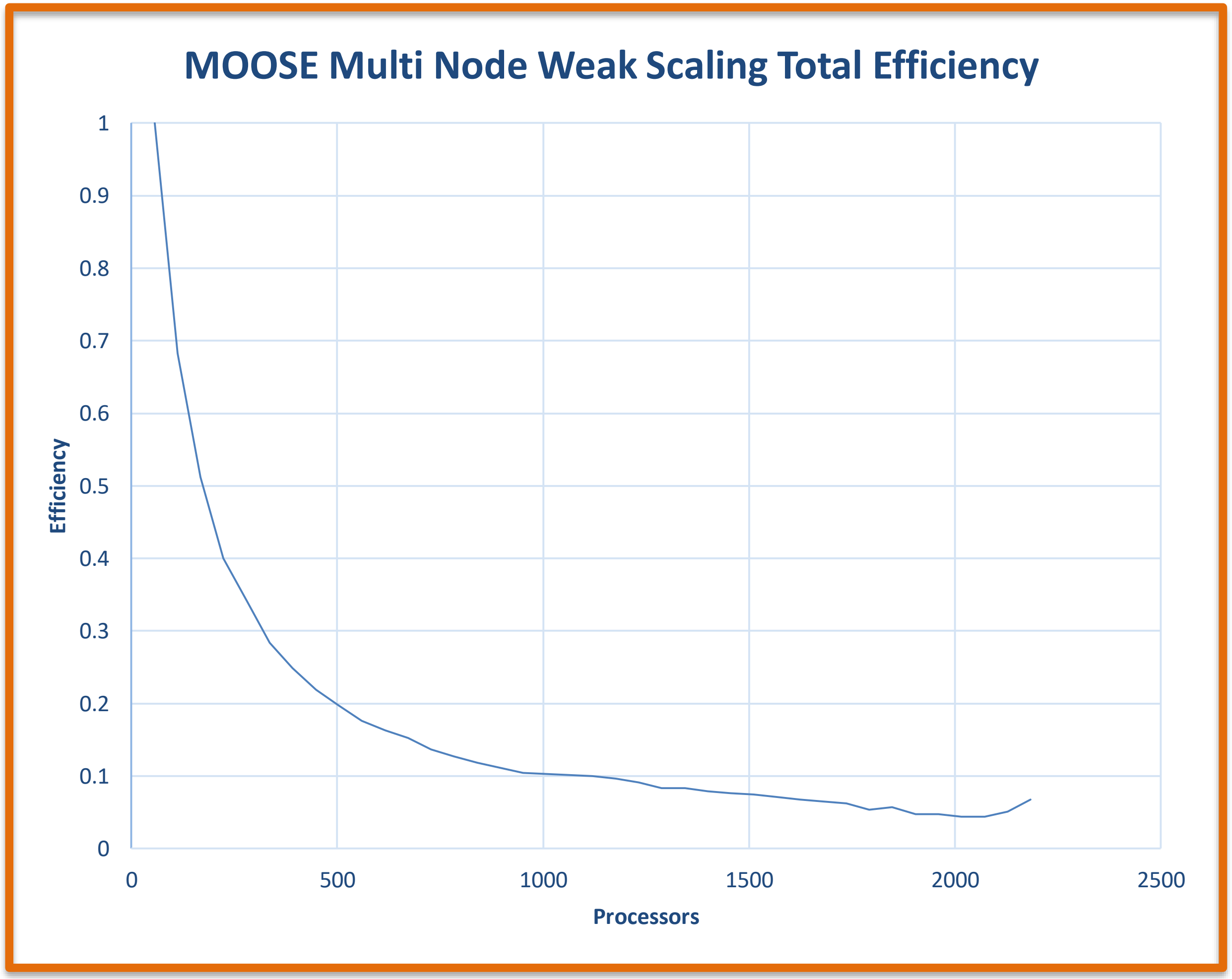
MOOSE Weak Scaling Performance Test Intranode





MOOSE Weak Scaling Performance Test Internode





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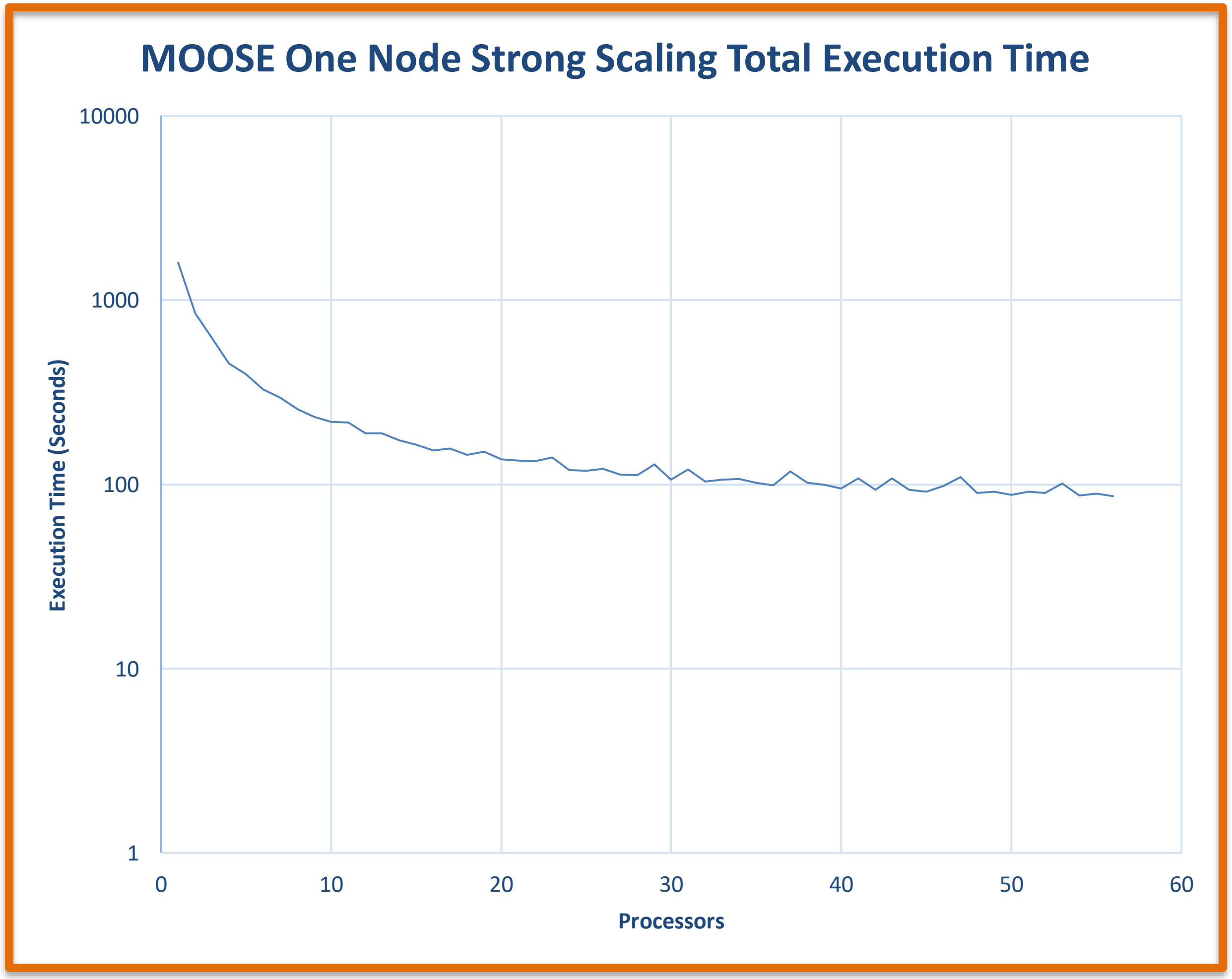
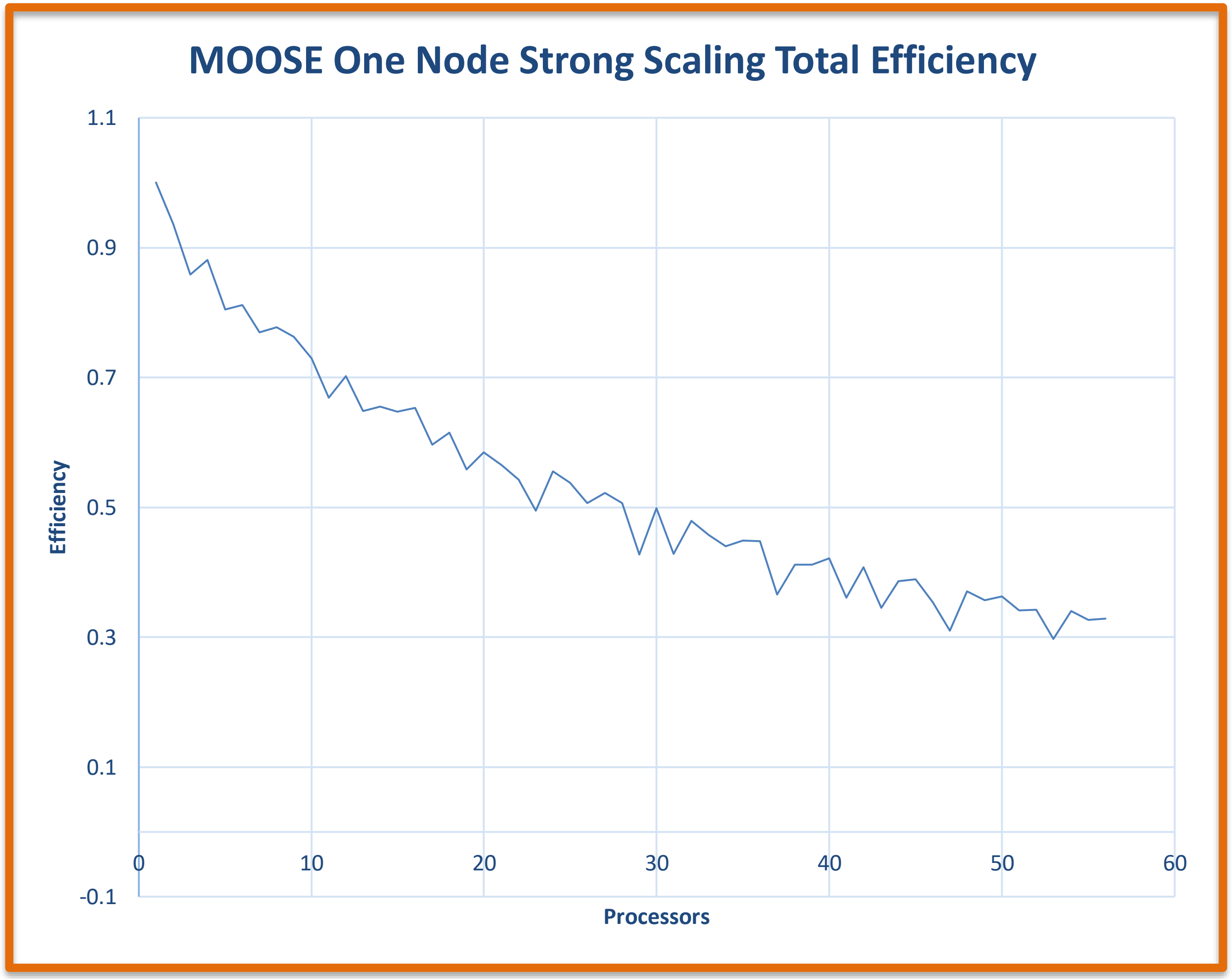
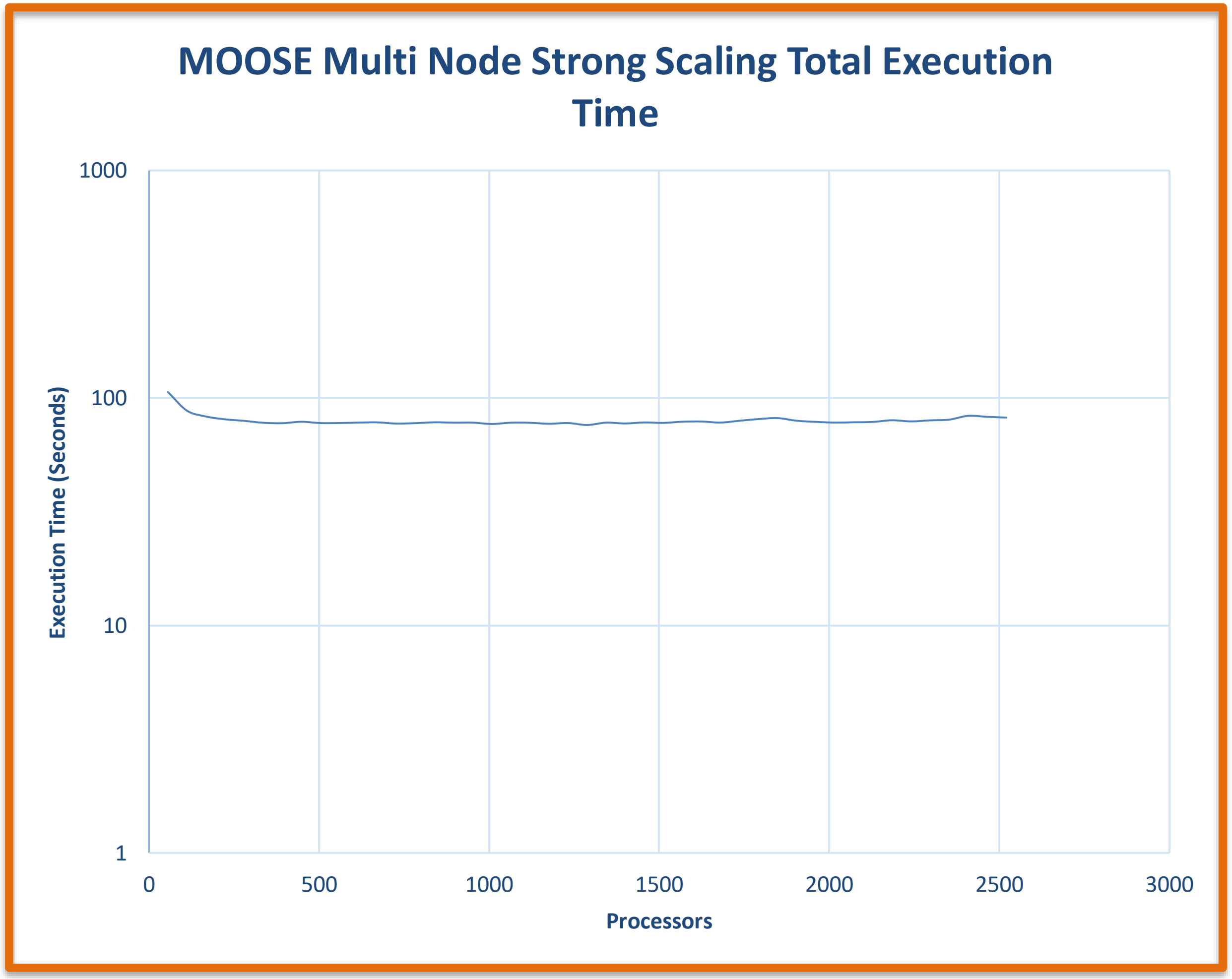
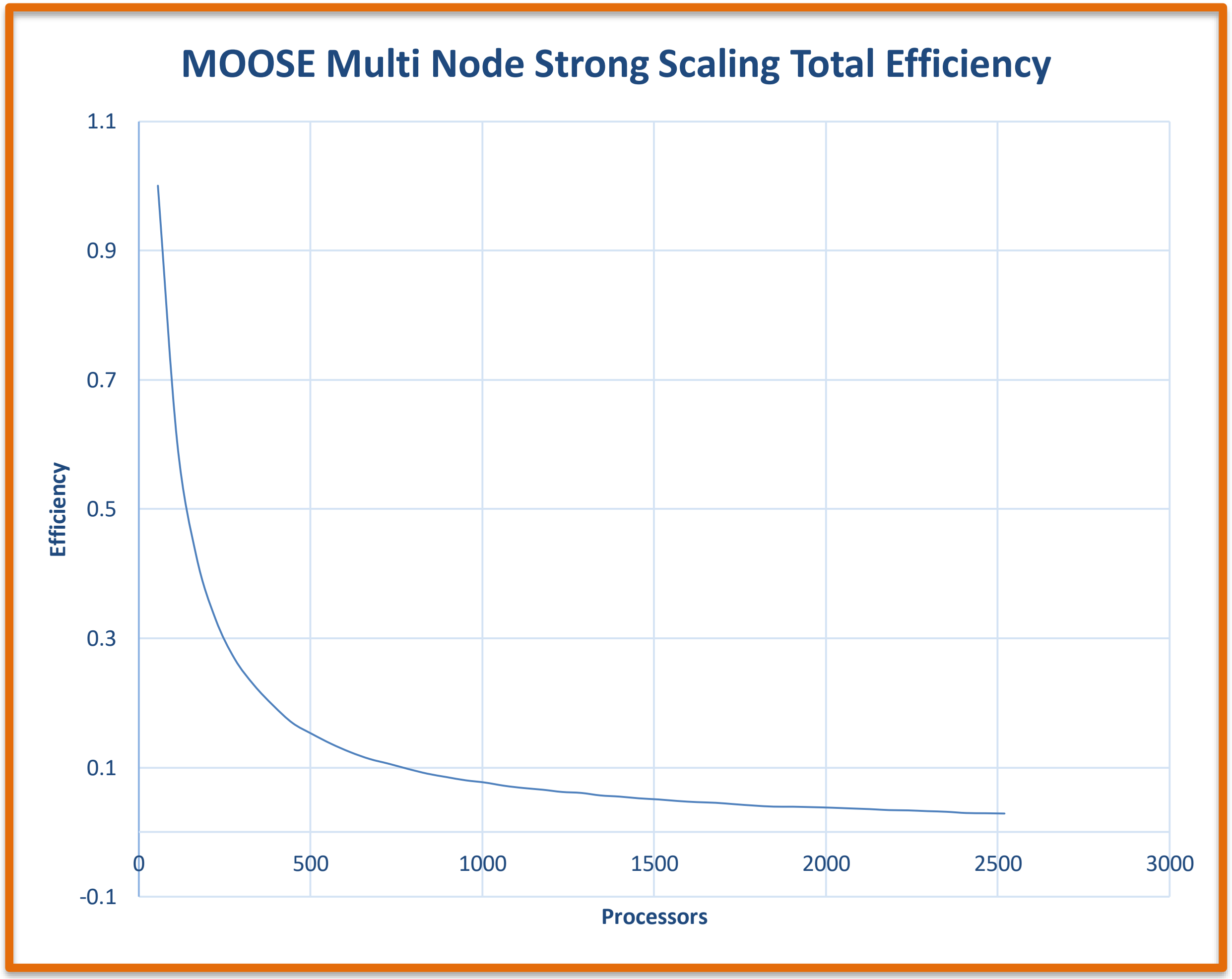
MOOSE Strong Scaling Performance Test Intranode





MOOSE Strong Scaling Performance Test Internode





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