BLUE WATERS
SUSTAINED PETASCALE COMPUTING

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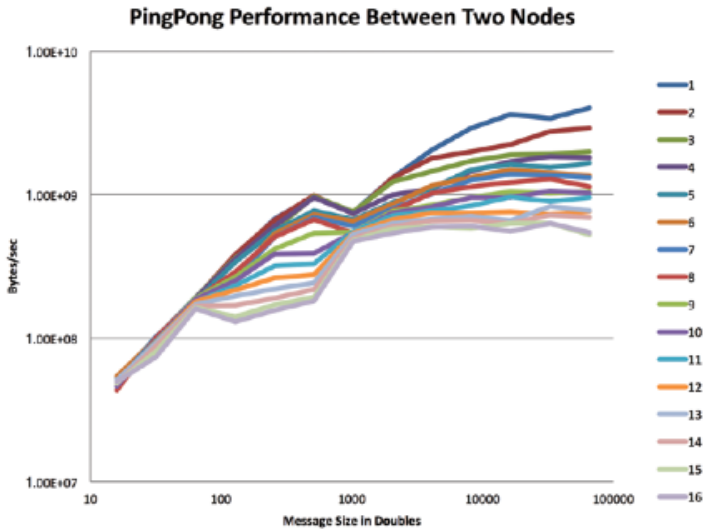
ALGORITHMS FOR EXTREME-SCALE SYSTEMS

Research Challenge

At an extreme scale, even small inefficiencies can cascade to limit the overall efficiency of an application. In order to achieve the performance required by applications that apply highly challenging scientific computations, new algorithms and programming approaches are needed. Developing more scalable versions of methods, such as Krylov methods, used in many science applications would immediately benefit performance. Also important is the development of techniques to improve communication between nodes by improving the methods used to exploit internode and intranode communication.



Communication performance between two nodes with 1–16 processes communicating at the same time. Note that as the number of communicating processes increases, the achieved performance per process drops, with nearly an order of magnitude loss between one and 16 communicating processes at large messages.

Methods & Codes

To address the challenges of parallelism and scale, the team developed several codes to benchmark these operations, to gather detailed timing results, and to perform experiments with different approaches. Additionally, researchers developed benchmark codes that better measure the achievable performance of the communication patterns commonly used in applications.

Results & Impacts

Early results using alternative Krylov formulations showed several performance effects that can provide a 200% or more improvement in performance at scale. Initial experiments using smaller core counts, in preparation for a later study using larger runs, will study the impact of network noise on highly parallel computers, and how parallel numeric algorithms can be developed that will perform well despite noise.

Why Blue Waters

Blue Waters provides one of the few environments available for large-scale experiments. Additionally, it provides a highly capable I/O system, which we plan to use in developing improved approaches to extreme scale I/O.