OpenSHMEM Implementation of HPCG Benchmark

Achievement: Ported the High Performance Conjugate Gradient (HPCG) benchmark to an OpenSHMEM and MPI one-sided implementation.

Significance and Impact: This work demonstrates that an OpenSHMEM implementation of HPCG is able to obtain similar performance to the original MPI version.

Research details:
- Generated an OpenSHMEM version based on one-sided communication and a “pure” version
- Benchmarking of the MPI (2 sided), MPI (1 sided) and OpenSHMEM codes:
  - Tests run on the Cray XK7/Titan at OLCF (native Cray SHMEM implementation)
  - Tests run on an SGI Cluster (native SGI MPT implementation of SHMEM)
  - Tests run on the Eos Cray XC30 at OLCF (native Cray SHMEM)
- Using the timings generated for the different portions of the calculations, analyzed the performance

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Overview:
We describe the effort to implement the HPCG benchmark using OpenSHMEM and MPI one-sided communication. Unlike the High Performance LINPACK (HPL) benchmark that places emphasis on large dense matrix computations, the HPCG benchmark is dominated by sparse operations such as sparse matrix-vector product, sparse matrix triangular solve, and long vector operations. The MPI one-sided implementation is developed using the one-sided OpenSHMEM implementation. Preliminary results comparing the original MPI, OpenSHMEM and MPI one-sided implementations on an SGI cluster, Cray XK7 and Cray XC30 are presented. The results suggest the MPI, OpenSHMEM and MPI one-sided implementations all obtain similar overall performance but the MPI one-sided implementation seems to slightly increase the run time for multigrid preconditioning in HPCG on the Cray XK7 and Cray XC30.