Parallelizing Single Source Shortest Path with OpenSHMEM

**Achievement:** Parallelized, implemented, and evaluated both label-setting and label-correcting single source shortest path (SSSP) algorithms (i.e., Dijkstra’s and Bellman-Ford) with the OpenSHMEM programming model on ORNL’s Titan supercomputer.

**Significance and Impact:** This work demonstrates the advantages of the OpenSHMEM programming model with irregular and graph analytics algorithms such as SSSP on extreme-scale systems such as Titan.

**Research Details:**
- Parallelized both Dijkstra and Bellman-Ford SSSP algorithms for use on extreme-scale systems while exploring synchronous and asynchronous approaches to relax edges between vertices within the graph and determine when convergence occurs.
- Implemented the parallelized algorithms using the OpenSHMEM programming model.
- Evaluated the prototype implementations on ORNL’s Titan system with many data-sets including both synthetic (i.e., Recursive Matrix and small-world graphs) and real-world graphs (i.e., Facebook, Twitter, LiveJournal, and the road maps of California and Texas) and compared these performance characteristics with those provided by the Parallel Boost Graph Library (Parallel BGL).

**Sponsor/Facility:** Work was performed with support from ORNL

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**Overview:**
Single Source Shortest Path (SSSP) is one of the widely occurring graph problems where the paths are discovered from an origin vertex to all other vertices in the graph. In this paper, we discuss our experience parallelizing SSSP using OpenSHMEM. We start with the serial Dijkstra and Bellman-Ford algorithms, parallelize these algorithms, and adapt them to the Partitioned Global Address Space (PGAS) programming model. We implement the parallel algorithms using OpenSHMEM and introduce a series of optimizations to achieve higher scaling and performance characteristics. The implementation is evaluated.
on Titan with various graphs including synthetic Recursive Matrix (R-MAT) and small-world network graphs as well as real-world graphs from Facebook, Twitter, LiveJournal, and the road maps of California and Texas.