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Analyzing the Factors that Cause Parallel Performance Degradation in Parallel Graph-Based Computations Using Graph500

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Abstract : Recently, graph-based computations have become more important in large-scale scientific computing as they can provide a methodology to model many types of relations between independent objects. They are being actively used in fields as varied as biology, social networks, cybersecurity, and computer networks. At the same time, graph problems have some properties such as irregularity and poor locality that make their performance different than regular applications performance. Therefore, parallelizing graph algorithms is a hard and challenging task. Initial evidence is that standard computer architectures do not perform very well on graph algorithms. Little is known exactly what causes this. The Graph500 benchmark is a representative application for parallel graph-based computations, which have highly irregular data access and are driven more by traversing connected data than by computation. In this paper, we present results from analyzing the performance of various example implementations of Graph500, including a shared memory (OpenMP) version, a distributed (MPI) version, and a hybrid version. We measured and analyzed all the factors that affect its performance in order to identify possible changes that would improve its performance. Results are discussed in relation to what factors contribute to performance degradation.

Keywords : graph computation, graph500 benchmark, parallel architectures, parallel programming, workload characterization.
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