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Range Decomposition: A low communication algorithm for solving PDEs on Massively Parallel Machines.

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The Range Decomposition (RD) algorithm uses nested iteration and adaptive mesh refinement locally before performing a global communication step. Only several such steps are observed to be necessary before reaching a solution within a small multiple of discretization error. The target application is peta- and exascale machines where traditional parallel numerical PDE communication patterns stifle scalability. The RD algorithm uses a partition of unity to equally distribute the error, and thus, the work. The computational advantages of this approach are that the decomposed problems can be solved using nested iteration and any multigrid cycle type, in parallel, without any communication until the partitioned solutions are summed. This offers potential advantages in the paradigm of expensive communication but very cheap computation. Performance models and numerical results demonstrate the enhanced performance.