THE GRADUATE SCHOOL
of
THE UNIVERSITY OF COLORADO AT BOULDER

DISSERTATION DEFENSE
of

David Appelhans

FOR THE DEGREE

DOCTOR OF PHILOSOPHY

Date/Time: November 18, 2014 from 11:00 A.M.

Bldg./Rm: 1320 Grandview Ave

Examining Committee Members:
Tom Mantueffel
Steve McCormick
John Ruge
Marian Brezina
Xiao-Chuan Cai
and Per-Gunnar Martinsson

OUTLINE OF STUDIES

Major Field: Applied Math

BIOGRAPHICAL NOTES

David Appelhans, a Colorado native, previously attended the Colorado School of Mines where he earned a bachelors of science in Engineering Physics, and a masters degree in Applied Physics.

For the last 4 years David has worked with the Grandview computational group at the University of Colorado, Boulder. When he is not working on implementing new algorithms, he enjoys rock climbing and remodeling houses.

After getting married in January, David will be taking a job with the research division of IBM.

THESIS

Trading Computation for Communication: A Low Communication Algorithm for the Parallel Solution of PDEs Using Range Decomposition, Nested Iteration, and Adaptive Mesh Refinement

Faculty Advisor Tom Mantueffel

ABSTRACT

In this defense I propose a new algorithm for solving PDEs on massively parallel computers. 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. This talk introduces the method and explains the details of the communication step. Two performance models are developed and numerical results for the Laplace problem with Dirichlet boundary conditions demonstrate the enhanced performance.