SANDIA REPORT

SAND2007-xxxx
Unlimited Release
Printed August 2007

DRAFT: Meros User's Guide [a]

Victoria E. Howle, Robert Shuttleworth, Ray Tuminaro

Prepared by
Sandia National Laboratories
Albuquerque, New Mexico 87185 and Livermore, California 94550

Sandia is a multiprogram laboratory operated by Sandia Corporation,
a Lockheed Martin Company, for the United States Department of Energy's
National Nuclear Security Administration under Contract DE-AC04-94-AL85000.

[a] For **Meros**™ Version 2.0 in **Trilinos**™ Release 8.0

Sandia National Laboratories

Issued by Sandia National Laboratories, operated for the United States Department of Energy by Sandia Corporation.

Printed in the United States of America. This report has been reproduced directly from the best available copy.

Available to DOE and DOE contractors from
U.S. Department of Energy
Office of Scientific and Technical Information
P.O. Box 62
Oak Ridge, TN 37831

Telephone:	(865) 576-8401
Facsimile:	(865) 576-5728
E-Mail:	reports@adonis.osti.gov
Online ordering:	http://www.osti.gov/bridge

Available to the public from
U.S. Department of Commerce
National Technical Information Service
5285 Port Royal Rd
Springfield, VA 22161

Telephone:	(800) 553-6847
Facsimile:	(703) 605-6900
E-Mail:	orders@ntis.fedworld.gov
Online ordering:	http://www.ntis.gov/help/ordermethods.asp?loc=7-4-0#online

SAND2007-xxxx
Unlimited Release
Printed August 2007

DRAFT: Meros User's Guide †

Victoria E. Howle ‡ Robert Shuttleworth § Ray Tuminaro ¶

Abstract

meros abstract

† For **Meros**™ Version 2.0 in **Trilinos**™ Release 8.0

‡ Sandia National Laboratories, PO Box 969, MS 9159 Livermore, CA 94551, vehowle@sandia.gov.

§ Applied Mathematics and Scientific Computing Program and Center for Scientific Computation and Mathematical Modeling, University of Maryland, College Park, MD 20742. rshuttle@math.umd.edu

¶ Sandia National Laboratories, PO Box 969, MS 9159, Livermore, CA 94551, rstumin@sandia.gov.

Contents

Appendix

1 Introduction

Meros is a segregated preconditioning package. Provides scalable block preconditioning for problems that coupled simultaneous solution variables such as Navier-Strokes problems.

Adding a citation to test bib[1].

2 Block Methods

2.1 Pressure Convection-Diffusion (PCD)

Factory for building pressure convection-diffusion style block preconditioner. This class of preconditioners were originally proposed by Kay, Loghin, and Wathen (ref) and Silvester, Elman, Kay, and Wathen (ref).

Meros 1.0 currently implements the PCD preconditioner, a.k.a. Fp preconditioner.

The LDU factors of a saddle point system are given as follows:

$$\begin{bmatrix} A & B^T \\ B & C \end{bmatrix} = \begin{bmatrix} I & \\ BF^{-1} & I \end{bmatrix} \begin{bmatrix} F & \\ & -S \end{bmatrix} \begin{bmatrix} I & F^{-1}B^T \\ & I \end{bmatrix}, \tag{1}$$

where S is the Schur complement $S = BF^{-1}B^T - C$. A pressure convection-diffusion style preconditioner is then given by

$$P^{-1} = \begin{bmatrix} F & B^T \\ & -\tilde{S} \end{bmatrix}^{-1} = \begin{bmatrix} F^{-1} & \\ & I \end{bmatrix} \begin{bmatrix} I & -B^T \\ & I \end{bmatrix} \begin{bmatrix} I & \\ & -\tilde{S}^{-1} \end{bmatrix} \tag{2}$$

where for $\tilde{S}$ is an approximation to the Schur complement S.

To apply the above preconditioner, we need a linear solver on the (0,0) block and an approximation to the inverse of the Schur complement.

To build a concrete preconditioner object, we will also need a 2x2 block Thyra matrix or the 4 separate blocks as either Thyra or Epetra matrices. If Thyra, assumes each block is a Thyra EpetraMatrix.

2.2 Least Squares Commutator (LSC)

Factory for building least squares commutator style block preconditioner.

Note that the LSC preconditioner assumes that we are using a stable discretization an a uniform mesh.

The LDU factors of a saddle point system are given as follows:

$$\begin{bmatrix} A & B^T \\ B & C \end{bmatrix} = \begin{bmatrix} I & \\ BF^{-1} & I \end{bmatrix} \begin{bmatrix} F & \\ & -S \end{bmatrix} \begin{bmatrix} I & F^{-1}B^T \\ & I \end{bmatrix}, \tag{3}$$

where S is the Schur complement $S = BF^{-1}B^T - C$. A pressure convection-diffusion style preconditioner is then given by

$$P^{-1} = \begin{bmatrix} F & B^T \\ & -\tilde{S} \end{bmatrix}^{-1} = \begin{bmatrix} F^{-1} & \\ & I \end{bmatrix} \begin{bmatrix} I & -B^T \\ & I \end{bmatrix} \begin{bmatrix} I & \\ & -\tilde{S}^{-1} \end{bmatrix} \tag{4}$$

where for $\tilde{S}$ is an approximation to the Schur complement S.

To apply the above preconditioner, we need a linear solver on the (0,0) block and an approximation to the inverse of the Schur complement.

To build a concrete preconditioner object, we will also need a 2x2 block Thyra matrix or the 4 separate blocks as either Thyra or Epetra matrices. If Thyra, assumes each block is a Thyra EpetraMatrix.

2.3 SIMPLE

3 Examples

A Meros `configure` Options

References

[1] H. C. ELMAN, D. J. SILVESTER, AND A. J. WATHEN, *Finite Elements and Fast Iterative Solvers*, Oxford University Press, Oxford, 2005.

DISTRIBUTION:

1 An Address
99 99^{th} street NW
City, State

3 Some Address
and street
City, State

12 Another Address
On a street
City, State
U.S.A.

1	MS 1319	Rolf Riesen, 1423
1	MS 1110	Another One, 01400
1	M9999	Someone, 01234
2	MS 9018	Central Technical Files, 8944
2	MS 0899	Technical Library, 4536

Sandia National Laboratories