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| 1. WORK PROPOSAL NO. ERKJ247 | | | | | 2. REVISION NO.  000 | | 3. DATE PREPARED  07/30/2012 | | | | | | 94 | | |
| 4. WORK PROPOSAL TITLE: MCREX: Using Monte Carlo Algorithums to Achieve Resiliency and Performance at Scale for Linear and Non-linear Solver Applications | | | | | | | | | | | 5. BUDGET AND REPORTING CODE  KJ0402000 | | | | |
| 6. WORK PROPOSAL TERM  BEGIN: 10/01/2012 END: 09/30/2015 | | | | | | PATENT STATUS  This proposal is being transmitted in advance of patent review for evaluation purposes only. No further dissemination or publication shall be made without prior approval of the Assistant General Counsel for Patents, DOE. | | | | | | 7. Is This Work Proposal Included in the Institutional Plan?  Yes No | | | |
| NAME: (Last, First, MI) (Phone Number)  8. HEADQUARTERS/OPERATIONS OFFICE PROGRAM MANAGER: Pao, Karen (301) 903-5384 | | | | | | 11. HEADQUARTERS ORGANIZATIONS: **Science** | | | | | | 14. DOE ORGANIZATION CODE:  **SC** | | | |
| 9. OPERATIONS OFFICE WORK PROPOSAL REVIEWER: Lin, Wayne C (865)576-0639 | | | | | | 12. FIELD OFFICE:  **Oak Ridge Operations** | | | | | | 15. DOE ORGANIZATION CODE:  **ON** | | | |
| 10. CONTRACTOR WORK PROPOSAL PRINCIPAL INVESTIGATOR(S)/MANAGER: Evans, Thomas M (865)576-3535 | | | | | | 13. CONTRACTOR NAME: **Oak Ridge National Laboratory Managed by UT-Battelle, LLC For the U.S. Department of Energy Post Office Box 2008 Oak Ridge, TN 37831** | | | | | | 16. DOE CONTRACTOR CODE:  **41** | | | |
| 17. WORK PROPOSAL DESCRIPTION (Approach, anticipated benefits in 200 words or less)  The next generation of computational science applications will require numerical solvers that are capable of high performance on proposed HPC platforms. In order to meet this goal, solvers must be resilient to soft and hard system failures, provide high concurrency on heterogeneous hardware configurations, and retain numerical accuracy and efficiency. In light of these requirements, a natural avenue of inquiry would be to adapt the current stable of numerically efficient solvers to this new high-performance computing regime. However, an alternative approach would be to investigate different classes of algorithms that can address issues of resiliency, particularly fault tolerance and hard processor failures, naturally. In this proposal, the team will investigate new stochastic methods for solving linear systems, otherwise termed Monte Carlo Resilient, Exascale (MCREX) solvers. The family of methods that the team has proposed builds on the sequential Monte Carlo work of Halton, 1962. While showing significant promise, this class of solvers has not made inroads into the broader computational science community. The methods that the team has initially developed use Monte Carlo to accelerate a fixed-point iteration; therefore, the team has called them Monte Carlo Synthetic Acceleration (MCSA). Preliminary work using MCSA has demonstrated that they are at least as efficient as Jacobi-preconditioned Conjugate Gradient (PCG) on sparse, SPD systems. These initial results demonstrate that very good efficiency could be attained on non-symmetric systems; thus making MCSA an ideal solver in non-linear Newton schemes. Furthermore, Monte Carlo methods have the benefit of addressing resiliency in a natural way; soft errors can be treated as high variance samples and lost histories from processor failures can be easily discarded without affecting the quality of the solution. | | | | | | | | | | | | | | | |
| 18. CONTRACTOR WORK PROPOSAL MANAGER: (Name and Phone No.)  \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ (Signature) Nichols, Jeffrey A (865)574-6224 (Date) | | | | | | | | | | 19. OPERATIONS OFFICE REVIEW OFFICIAL  \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ (Signature) (Date) | | | | | |
| 20. DETAIL ATTACHMENTS:  (See instructions for page 3) | | | | | | | | | | | | | | | |
|  | a. Facility Requirements |  | e. Approach | | | |  | i. NEPA Requirements | | | | |  | m. ES&H Considerations |
|  | b. Publications |  | f. Technical Progress | | | |  | j. Milestones | | | | |  | n. Human/Animal Subjects |
|  | c. Purpose |  | g. Future Accomplishments | | | |  | k. Deliverables | | | | |  | o. Other (Specify) |
|  | d. Background |  | h. Relationships To Other Projects | | | |  | l. Perform Measures/Expectations | | | | | | |

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| 21. STAFFING (in staff years) | FY 2012 | FY 2013 | FY 2014 | | | FY 2015 | FY 2016 | | TOTAL TO COMPLETE |
| REQUEST | | AUTHOR. |
| a. SCIENTIFIC / OTHER DIRECT - ORNL |  | 1.4 | 1.4 | |  | 1.4 | <!STAFFING\_SCI\_FY5!> | | <!STAFFING\_SCI\_FYT!> |
| b. OTHER DIRECT - OTHER SITES |  |  |  | |  |  | <!STAFFING\_OTH\_FY5!> | | <!STAFFING\_OTH\_FYT!> |
| c. TOTAL DIRECT |  | 1.4 | 1.4 | |  | 1.4 | <!STAFFING\_TOT\_FY5!> | | <!STAFFING\_TOT\_FYT!> |
| 22. OPERATING EXPENSE (in Thousands) |  |  |  | |  |  |  | |  |
| a. TOTAL OBLIGATIONS |  | 433 | 445 | |  | 462 | <!OPER\_OBS\_TOT\_FY5!> | | <!OPER\_OBS\_TOT\_FYT!> |
| COSTS: |  |  |  | |  |  |  | |  |
| 1) WAGE POOL AND ORG. BURDEN | 0 | 309 | 320 | |  | 333 | <!OPER\_COSTS\_WP\_FY5!> | | <!OPER\_COSTS\_WP\_FYT!> |
| 2) MATERIALS AND SERVICES |  | 13 | 10 | |  | 10 |  | |  |
| 3) SUBCONTRACTS AND CONSULTANTS | 0 | 0 | 0 | |  | 0 | <!OPER\_COSTS\_SUB\_FY5!> | | <!OPER\_COSTS\_SUB\_FYT!> |
| 4) INDIRECT COSTS |  | 111 | 115 | |  | 119 |  | |  |
| b. TOTAL COSTS |  | 433 | 445 | |  | 462 | <!OPER\_COSTS\_TOT\_FY5!> | | <!OPER\_COSTS\_TOT\_FYT!> |
| 23. EQUIPMENT (in Thousands) |  |  |  | |  |  |  | |  |
| a. EQUIPMENT OBLIGATIONS |  |  |  | |  |  |  | |  |
| b. EQUIPMENT COSTS |  |  |  | |  |  |  | |  |
| 24. MILESTONE SCHEDULE (TASKS:) | | DOLLARS (in Thousands) | | | | SCHEDULE (DATE) | | | |
| PROPOSED | | AUTHORIZED | | PROPOSED | | AUTHORIZED | |
| Demonstrate convergence properties and performance of MCSA algorithm on sparse symmetric and non-symmetric systems. | |  | |  | | 09/13 | | 00/00 | |
| Show resiliency of MCSA algorithm for soft and hard errors while solving the linear advection- diffusion and non-linear Navier-Stokes equations. | |  | |  | | 09/14 | | 00/00 | |
| Show parallel performance of MCSA algorithm on existing HPC architectures and demonstrate scaling to exascale systems using the MCSA performance model. | |  | |  | | 09/15 | | 00/00 | |
|  | |  | |  | |  | |  | |
|  | |  | |  | |  | |  | |
| 25. REPORTING REQUIREMENTS (DESCRIPTION:)  Results will be reported in periodic highlights to the U. S. Department of Energy and in journals and conference proceedings. | | | | | | | | | |

o. Other

(1) OBLIGATIONS FOR OPERATING EXPENSES-Budget Authority (B/A)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Obligation Estimates | | | | |
|  | FY 2012 |  | FY 2013 |  | FY 2014 |
| Cost (B/O) Estimates | 0 |  | 433 |  | 445 |
| Less: Uncosted Balance (--) at 10/01 | 0 |  | 0 |  | 0 |
| Plus: Commitments for Continued Operations | 0 |  | 0 |  | 0 |
| Outstanding Commitment Balance | 0 |  | 0 |  | 0 |
| TOTAL OBLIGATIONS--CHANGE | 0 |  | 433 |  | 445 |

(2) CAPITAL EQUIPMENT OBLIGATIONS AND COSTS

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | | Obligation and Cost Estimates | | | | | | | | | | | | |
|  | | FY 2012 | | | | |  | FY 2013 | | |  | FY 2014 | | |
| Equipment Items (List) |  | Beginning Uncosted Balance |  | Oblig |  | Cost |  | Oblig |  | Cost |  | Oblig |  | Cost |