

January 2006 Workshop REPORT on Dynamic Data Driven Applications Systems (DDDAS)

Executive Summary

“DDDAS entails the ability to dynamically incorporate additional data into an executing application, and in reverse, the ability of an application to dynamically steer the measurement process”

Fostering and nurturing research and technical communities to develop DDDAS capabilities began a few years ago with the NSF DDDAS March 2000 Workshop (www.nsf.gov/cise/cns/dddas/), and continued by seeding efforts on DDDAS through NSF's ITR program, and presently more systematically through the DDDAS Program Solicitation launched in FY05. Through these initial efforts, a wealth of new multidisciplinary research advances, as well as novel approaches and methods have begun to emerge, pushing the current boundaries to enable DDDAS capabilities. The solicitation articulates the DDDAS concept, its beneficial impact to many research and technology areas, the research and technology advances that can be enabled by DDDAS and those that are needed to enable DDDAS, the need for synergistic multidisciplinary work among several research and technology communities, and the opportunities of collaboration among multiple sectors: academia, industry, national laboratories, US government agencies, and international partners. The DDDAS solicitation provides the venue for systematic support of research and technology development driven by and aimed at enabling and applying the DDDAS concept. The projects that have begun include many areas of National and International priority, and span synergistic advances in new methods in modeling and analysis, research in measurement, data collection and management, mathematical and statistical algorithms, and research on new systems software methods and software infrastructure frameworks, and the enablement of individual research advances in collaboration with other strategic investigators and organizations. The report captures the proceedings of the Jan 19-20, 2006 Workshop.

The projects funded cover a broad set of technical and scientific areas, and are already making research and technology advances in areas and aspects emphasized in the solicitation. The Working Groups discussions at the workshop elaborated on some of the research, technology, education and broader impacts, and discussed how the projects that were started have created a strong initial set of efforts that: a) strongly attest to the value of the DDDAS concept to enable novel advances in many areas of science and engineering, and the potential of broader technological, societal and educational impact, including impact on cyberinfrastructure and testbeds efforts; b) address many of the challenges articulated in the solicitation to be investigated and inspired further pursuits; inspired investigators that had some initial thinking related to the DDDAS concept to expand their initial objectives and shape a more comprehensive project; have put in place a range of projects with opportunity of vertical (multidisciplinary within the group) and horizontal (across groups) cross fertilization of ideas and advances; c) are expected to be strengthened and multiplied with future project initiated through follow-up proposal calls under the DDDAS program; and d) affirmed the value of such a program to support the needed multidisciplinary and coordinated work, and that the advances needed cannot be enabled by the individual communities working in an isolated fashion. The solicitation has brought together a broad range of experts to work on such problems, further advancing the state of the art, and articulating important challenges and opportunities. This establishes that the solicitation in it's current form has the required scope and emphasis both in terms of the multidisciplinary research and technology development required and provides the impetus to foster the present projects, nurture and inspire additional new research areas and impact future research directions.

The funded projects under the DDDAS rubric, with the multidisciplinary emphasis of the program, bridge the different research areas pursued in both the traditional disciplinary lines and across different academic units, different institutional organizations, and different organizations within funding agencies. The projects funded illustrate that there can be synergistic research endeavors established. Such endeavors not only have the potential to make major breakthroughs and advances in the challenges addressed within these projects, but a) they also demonstrate that they can advance and expand the frontiers within the scope of individual disciplines and organizations, and b) there exist several unique aspects of the DDDAS efforts, *not* present in specialized domains, which can expose and fertilize new research and technology directions and enable new capabilities of broad impact. Recognizing that multi-disciplinary research under DDDAS is attracting interest from multiple sectors: academe, industry, and federal agencies. This workshop, in fact, had participation from agencies and national laboratories (such as OSD, JFCOM-J9, NASA, NOAA, NIH, CIA, NIST, ONR, NRL, AFOSR, and LANL), as well as industry.

The ensuing DDDAS community that is being established brings together considerable skill and leadership. However, continued leadership in this program and the full impact of these projects will depend critically on continued growth and expansion of these kinds of multidisciplinary projects and collaborations, sustenance

of existing newly developed communities, and further support and nurturing the expertise and expansion of emergent communities.

The DDDAS Co-ordination Committee:
Dr. Frederica Darema, Lead, NSF/CISE
Dr. John Cherniavsky, NSF/EHR
Dr. Juan Figueroa, NSF/ENG/OII
Dr. Marvin Goldberg, NSF/MPS
Dr. Jeanne Hudson, NSF/OISE
Dr. Daniel Newlon, NSF/SBE
Dr. Mario Rotea, NSF/ENG
Dr. Robert Bohn, NOAA
Dr. Peter Lyster, NIH/NIGMS
Dr. Charles Friedman, NIH/NLM

The Workshop Working Groups Co-Chairs:
Prof. Kim Baldrige, University of California at San Diego
Prof. George Biros, University of Pennsylvania
Prof. Alok Chaturvedi, Purdue University
Prof. Craig Douglas, University of Kentucky
Prof. Jonathan How, MIT
Prof. Manish Parashar, Rutgers University
Prof. Joel Saltz, Ohio State University
Prof. Ed Seidel, Louisiana State University
Prof. Alan Sussman, University of Maryland

REPORT SECTIONS

Introduction

Representative DDDAS Technology Areas

- A. Applications**
- B. Mathematical and Statistical Algorithms**
- C. Measurement Systems**
- D. Systems Software**

Implications, Outreach and Outlook

- A. Community Outreach
- B. Standards**
- C. Community testbeds**
- D. Impact to Cyber Infrastructure**
- E. International, Interagency, Multi-sector Co-operation**

Summary