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LEAD LEARNING COMMUNITIES

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1. INTRODUCTION

Each year across the United States, floods, tornadoes, hail, strong winds, lightning, and winter storms – *so-called mesoscale weather events* – cause hundreds of deaths, routinely disrupt transportation and commerce, and result in annual economic losses greater than $13B. Although mitigating the impacts of such events would yield enormous societal and economic benefits, the ability to do so is stifled by information technology (IT) frameworks that cannot accommodate the *real-time, on-demand, and dynamically-adaptive* needs of mesoscale weather research; its disparate, high volume data sets and streams; and its tremendous computational demands.

In response to this pressing need for a comprehensive national cyberinfrastructure in mesoscale meteorology, Linked Environments for Atmospheric Discovery – LEAD - will address the challenges needed to create an integrated, scalable framework for identifying, accessing, preparing, assimilating, predicting, managing, analyzing, mining, and visualizing a broad array of meteorological data and model output, independent of format and physical location. The transforming element of LEAD is *dynamic workflow orchestration and data management*, which will enable the use of analysis tools, forecast models, and data repositories as *dynamically-adaptive, on-demand* systems that can a) change configuration rapidly and automatically in response to weather; b) continually be steered by new data; c) respond to decision-driven inputs from users; d) initiate other processes automatically; and e) steer remote observing systems to optimize data collection for the problem at hand.

What will the development of LEAD technologies and capabilities mean to the communities of researchers, educators, and students that stand to be the principal beneficiaries? To ensure that the technologies can be utilized by these groups, LEAD embraces a fully integrated strategy that engages users from the various communities to facilitate an ongoing exchange of ideas between the users groups and IT and meteorology researchers and developers. This plan assures the active participation of users in the development, design, and refinement of LEAD technologies. As new prototypes are developed, users will test various features in their own productivity environments and participate in the evaluation and refinement

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of prototypes by providing feedback to developers.

2. LEAD LEARNING COMMUNITIES

To address this challenge, the LEAD Education and Outreach initiative serves two different but connected functions. The first is to advise and provide input to IT developers to ensure that LEAD technologies address the needs of its community, ranging from specific meteorology and IT research problems to the educational needs of middle and high school educators and students. The second expands on LEAD's commitment to educate the community (pre-college, undergraduate, and graduate) on how to utilize the various capabilities made possible through LEAD IT research.

LEAD has established a three-phase plan to carry out these functions. The *first phase* establishes education objectives to help shape the evolution and the user environment of LEAD and fuse the goals and enabling technologies into applications that are scalable and congruent with educational requirements, specifications, and standards. During this phase, the six LEAD education testbeds (Millersville, Howard, Oklahoma, Alabama-Huntsville, Indiana, and Unidata) will engage successful national science and technology education initiatives to build on best practices that will help steer the development of an intuitive user environment.

The *second phase* commences with the flow of proto-tools and proto-technologies from the IT developers for evaluation and refinement. User groups will evaluate prototypes and provide critical feedback to LEAD developers resulting in progressive refinements to the tools and technologies to ensure compatibility with the needs of each respective community.

The *third phase* focuses on the deployment and integration of LEAD applications into the learning environment to incite curricular change and to drive innovation in meteorology and computer science education, and to draw connections to other disciplines through its inherent extensibility (e.g., oceanography, ecology). The hallmark of the third and final phase will be the distribution of interactive tutorials and learning materials.

In order for this plan to be successful, user communities must play a vital role in the development of LEAD. Toward this end, LEAD education and outreach has established so-called ***LEAD Learning Communities (LLC)***. The LEAD Learning Communities comprise a collaborative network of teachers, researchers, and students who interact to address a variety of issues related to LEAD that are common to their community. The principal driver in the development of LEAD Learning Communities is to enable and foster a two-way interaction between the LEAD developers and users to maximize the overall effectiveness of this new capability. Each learning community will 1) Integrate LEAD applications into their domain of activity, 2) develop new applications, 3) create performance outcomes for both education and research, 4) provide feedback to LEAD developers so that user needs drive the design and development process, and 5) determine potential relevance of LEAD technologies to other related fields and initiatives.

In light of the many ways in which students, teachers, and researchers might be clustered together, we have chosen to develop two LEAD Learning Communities: 1) the *Teaching and Learning Community* and 2) the *Research and Applications Community*. The Teaching and Learning Community will focus on activities related to teaching and learning that are important to all levels of the education enterprise ranging from middle school to graduate school. The idea for the LEAD Teaching and Learning Community leverages on the new paradigm of teaching and learning where students are engaged in the learning process by constructing their own knowledge. The activities of this community include but are not limited to the deployment and integration of LEAD applications as they are developed into the various learning environments, and to the evaluation and assessment of these applications. The assessment and evaluation process will be used to generate recommendations that will be communicated to the developers to drive further modification and refinement.

The goals of the Teaching and Learning Community are: 1) Provide a service to the geosciences' education community in areas

of new learning environments, ***dynamically adaptive learning*** capabilities, authentic learning experiences, data access, data visualization, new modeling environments, and professional training and development for educators; 2) Facilitate and engage in ongoing communication and consultation based on implementation results in order to meet the needs and capabilities of the users at all education levels; 3) Create LEAD enabling environments that identify appropriate and related initiatives to ensure a collaborative effort for improved access to scientific and educational information.

The purpose of the LEAD Research and Applications community is to focus on issues related to meteorology and computer science research and applications, particularly those requiring advanced cyberinfrastructure capabilities that are not presently available. This learning community will foster an interaction between the basic and applied research communities utilizing LEAD capabilities and LEAD developers.

The goals of the Research and Applications community are: 1) Provide service to the operations research community in terms of access to data, complex tools, workflow capabilities, and a complete information technology infrastructure; 2) Facilitate and engage in ongoing communication and consultation based on implementation results in order to meet the needs of meteorology research and operations; 3) Create LEAD enabling environments that identify appropriate and related initiatives to ensure a collaborative effort to improve access to an information technology infrastructure.

The LEAD education and outreach initiative is challenged to create new paradigms in virtual learning environments. Leveraging best practices (e.g., DLESE and others), LEAD will spearhead the development of a dynamically adaptive [virtual] learning environment with multiple and diverse pathways for discovery. While still an emerging concept, dynamically adaptive learning will provide users the ability to conduct a “find” in virtual concept space, where guided inquiry is directed by intelligent tutoring.

3. A LEAD DEMONSTRATION

To help visualize the capabilities of LEAD for the community of educators and students, a demonstration is planned, which will include the visualization of data using Unidata’s Integrated Data Viewer within a learning module. The module includes inquiry-based activities for students and supporting materials for teachers.

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