Accomplishments

You have the option of selecting “nothing to report” in this section.

What are the major goals of the project?

PRAGMA Experimental Network Testbed (PRAGMA-ENT): established in October 2013 with the goal of constructing a breakable international software-defined network (SDN) testbed for use by PRAGMA researchers and collaborators. PRAGMA-ENT is breakable in the sense that it offers complete freedom for researchers to access network resources to develop, experiment, and evaluate new ideas without concerns of interfering with a production network. PRAGMA-ENT long term goal is to offer the necessary networking support to the PRAGMA multi-cloud and user-defined trust envelopes. To this end, research and development on several areas of networking will be conducted, including wide-area layer 2 (L2) connectivity, software-defined networks, overlay networks, and IPv6.

PRAGMA Lake eutrophication expedition: To gain understanding and predictive ability of the impact of eutrophication on lake ecosystem services, we need to understand, for example, how phytoplankton community structure and biomass respond to drivers operating at different time scales, such as short-term weather patterns, multi-year climate cycles, and long-term climate trends, and how easily measured indicators of phytoplankton communities, such as in-situ pigment fluorescence, allow us to predict ecosystem-scale wax and wane of phytoplankton blooms. This PRAGMA expedition, led by Paul Hanson (UW), in collaboration with Renato Figueiredo (UF) and Cayelan Carey (Virginia Tech), and involving the GLEON lake modeling working group, has an over-arching goal of discovering the controls over the wax and wane of lake phytoplankton communities. By connecting the scientific community with data and model resources, this expedition enables advanced simulation of lake hydrodynamics and water quality to address research questions. The expedition focuses initially on three CI challenges: Organizing and structuring heterogeneous data from multiple data providers; tracking/managing the collection of resources so that all stakeholders can participate in some meaningful way; tracking/ managing attribution for stakeholders. One activity in the expedition is the deployment of an IPOP overlay virtual network and HTCondor across participating GLEON/PRAGMA institutions to enable aggregation and sharing of computational resources and models by a distributed group of collaborators.

PRAGMA Biodiversity Expedition: Facilitates the use of cyberinfrastructure to study the biodiversity, distribution and adaptation of organisms in extreme montane tropical environments, such as Mount Kinabalu (4095 m), in Sabah, Malaysia, a global biodiversity hot-spot and World Heritage Site. Located in the northern part of Borneo, Kinabalu is marked by numerous ultramafic (serpentine) outcrops where soil and substrates are high in iron, magnesium, nickel and other metals. These environments can be toxic to many plant and animal species, while other species are known to hyper-accumulate of nickel. An underlying goal is to understand how plants, animals, and microbes adapt to extreme environments, changing climate, and toxic conditions. The expedition also focuses on several CI challenges: PRAGMA expedition participants (A. Stewart, N. Williams) are working on portability and virtualization of clustered software (Lifemapper) where software can be moved to the data stored in participating PRAGMA nodes. Research collaborators also wish to share software and data across international boundaries in trusted, networked environments. Systems will need to provide sufficient metadata, usage tracking, and security to support distributed, collaborative environments, and Biodiversity Expedition plans to leverage PRAGMA-ENT to address specific needs. Remote sensing data capture using Unmanned Aerial Vehicles (UAVs) on Kinabalu has now been initially field-tested. Scaling up UAV data capture would present further CI challenges in data sharing and processing.

What was accomplished under these goals (you must provide information for at least one of the 4 categories below)?

**Major Activities:**

* PRAGMA-ENT involves participation of researchers in the US, Japan, China, Taiwan, Thailand, and South Korea.
* Teams in the US and Japan are collaborating with Internet2, National Institute of Information and Communications Technology (Japan), and Pacific Wave Peering Exchange to establish an international L2 circuit.
* Monthly conference calls synchronize PRAGMA-ENT activities in all involved countries.
* The Pragma Lake expedition involves participation of researchers at U. Florida, U. Wisconsin, and Virginia Tech. The major activities in the reporting period have been to design, deploy, test and document an HTCondor distributed virtual cluster where nodes are connected by the IPOP virtual network overlay for this expedition. The team has met via tele-conference on a bi-weekly basis, and has reached out to additional collaborators from the GLEON (Global Lake Ecological Observatory Network) community who we expect to be early adopters of the technology.
* Lifemapper [Nadya and Aimee]
* The Biodiversity Expedition organized a PRAGMA mini-symposium as part of the 8th International Conference on Serpentine Ecology, hosted by Sabah Parks, Malaysia, in June 2014. A set of information management needs emerged relating to the global community for aggregating data at a global scale, and PRAGMA was seen as a potential facilitator.
* Biodiversity Expedition participants collaborated with Univ. of Queensland and Sabah Parks researchers for five days of UAV data capture on Mount Kinabalu (prior to the conference above). The activity resulted in a preliminary data set of over 10,000 still images of multispectral data (4 bands) and several hours of video. The multispectral data is still being pre-processed (an emerging CI challenge) as the imagery will have a nominal ground resolution of ca. 15 cm. The processing, storage, and sharing of these data is a topic we hope to address together with PRAGMA-ENT.

**Specific Objectives:**

**Significant Results:**

**Key outcomes or other achievements:**

* An end-to-end wide-area software-defined network has been established between UF and UCSD. An Internet2 AL2S VLAN connects hardware OpenFlow switches at UF and UCSD.
* Software tunnels have been used to connect US and Japanese sites, establishing an international network of OpenFlow switches.
* Lake expedition users typically work on Windows environments; to better support Windows computers, an enhancement to the IPOP software has been implemented in the form of a service that monitors the status of the IPOP software and automatic starts/restarts IPOP.
* A prototype HTCondor pool with Windows virtual machines and running the IPOP overlay has been deployed at University of Florida resources, and documentation has been created in a GitHub repository for the expedition ([www.github.com/graple](http://www.github.com/graple)). The prototype at UF is slated to have 50 cores deployed at UF by the end of August 2014.

What opportunities for training and professional development has the project provided?

On-line seminars exposed students at PRAGMA institutions (in the US and abroad) to the technologies being integrated into PRAGMA-ENT. The seminar “Towards Software-Defined Systems”, delivered by José Fortes in February 2014, introduced to the PRAGMA community the concepts and technologies that will be integrated and exposed in PRAGMA-ENT.

The lake expedition has provided opportunities for development of students at the participating institutions in High-Throughput Computing (HTC) and overlay virtual network software.

How have the results been disseminated to communities of interest?

PRAGMA-ENT activities and results are shared with PRAGMA community during semi-annual PRAGMA meetings.

PRAGMA-ENT webpage, on the main PRAGMA website, disseminates PRAGMA-ENT to a broader community.

Lake expedition activities have been disseminated through the PRAGMA and GLEON web sites. Enhancements and documentation on the IPOP software have been disseminated through the IPOP project’s Web site.

Biodiversity Expedition activities were disseminated on the ICSE web site and through direct interaction with serpentine ecologists in the mini-PRAGMA symposium. The proceedings of the conference/symposium will be published.

What do you plan to do during the next reporting period to accomplish the goals?

PRAGMA-ENT participants will continue to interact monthly through on-line meetings. PRAGMA-ENT infrastructure will be expanded to include more sites and countries, and a second team, focused on applications, will work on the integration of PRAGMA multi-cloud and user-defined trust envelopes.

The Lake expedition participants will continue to interact bi-weekly through conference calls. The team plans to have a presentation and demonstration of the HTCondor/IPOP system at the GLEON-16 meeting in Quebec, Canada, and at the PRAGMA meetings, both in October 2014; a planned outcome of these events is to bring additional users and computing resources from the GLEON and PRAGMA communities to the distributed HTCondor/IPOP virtual cluster. The team also plans to pursue supplementary travel funds to bring computer science and limnology students to these events to catalyze interactions between the two domains.

NOTE: You may upload PDF files with images, tables, charts, or other graphics in support of the Accomplishments section. You may upload up to 4 PDF files with a maximum file size of 5 MB each.

**Products**   
You have the option of selecting “nothing to report” in this section. There are no limitations to the number of entries you submit and you can also pull information directly from Thomson Search when using the online tool on Research.gov.

Within the Products section, you can list any products resulting from your project during the specified reporting period, such as:

**Journals:**

Pierre St Juste, Kyuho Jeong, Heungsik Eom, Corey Baker, Renato Figueiredo, ‘TinCan: User-Defined P2P Virtual Network Overlays for Ad-hoc Collaboration‘, ICST Transactions on Collaborative Computing, Volume 14 Issue 2, 08/2014

**Books:**

**Book Chapters:**

Maurício Tsugawa, Andréa Matsunaga, José A. B. Fortes. Cloud Networking to Support Data Intensive Applications. Cloud Computing for Data-Intensive Applications. (to appear)

**Thesis/Dissertations:**

**Conference Papers and Presentations:**

**Other Publications:**

**Technologies or Techniques:**

**Patents:**

**Inventions:**

**Licenses:**

**Websites:**

<http://www.pragma-grid.net/expeditions.php>

<http://www.github.org/graple>

http://www.ipop-project.org

**Other Products:**

NOTE: You may upload PDF files with images, tables, charts, or other graphics in support of the Products section. You may upload up to 4 PDF files with a maximum file size of 5 MB each.

Participants

There are no limits on the number of participants you list for this section; however, you must list participants who have worked one person month or more for the project reporting period. You have the option of selecting “nothing to report” in this section. For Research Experience for Undergraduates (REU) sites and supplements, specific questions will be listed in this section. The online service will also ask for additional information on participants such as:

* What individuals have worked on the project?
* What organizations have been involved as partners?
* Have other collaborators or contacts been involved?

What individuals have worked on the project?

**Name:** José Fortes

**Nearest Person Month Worked: 1**

**Contribution to the Project:** Fortes oversees all PRAGMA activities at the University of Florida, works on aspects of the PRAGMA-ENT design, and collaborates with other PRAGMA PIs on activities aimed at promoting, expanding and disseminating PRAGMA engagements and collaborations with researchers at international sites.

**Funding Support:** This award

**Country(ies) of foreign collaborator:**

**Traveled to foreign country:** yes

**Country:** China, Taiwan and Malaysia

**Duration of stay: 10 days (China), 10 days (Taiwan) and 6 days (Malaysia)**

**Name:** Renato Figueiredo

**Nearest Person Month Worked:** 1

**Contribution to the Project:** Figueiredo has led cyber-infrastructure design and integration activities in the PRAGMA Lake expedition, including IPOP overlay networks and HTCondor

**Funding Support:** This award

**Country(ies) of foreign collaborator:** none

**Traveled to foreign country:** yes

**Country: China and Taiwan**

**Duration of stay: 5 days (China), 5 days (Taiwan)**

**Name:** Reed Beaman

**Nearest Person Month Worked:** 1

**Contribution to the Project:** Beaman organized the mini-PRAGMA symposium in Malaysia and participated in the UAV remote sensing data collection on Mount Kinabalu. He also collaborates with the Lifemapper team.

**Funding Support:** This award

**Country(ies) of foreign collaborator:** Australia, Malaysia

**Traveled to foreign country:** yes

**Country: Taiwan, Malaysia**

**Duration of stay: 5 days (Taiwan), 10 days (Malaysia)**

**Name:** Youna Jung

**Nearest Person Month Worked:** 2

**Contribution to the Project:** Jung has led software engineering and documentation activities in the PRAGMA Lake expedition

**Funding Support:** This award

**Country(ies) of foreign collaborator:** none

**Traveled to foreign country:** no

**Country:**

**Duration of stay:**

**Name:** Kensworth Subratie

**Nearest Person Month Worked:** 6

**Contribution to the Project:** Subratie has led development of Windows restart/monitoring service for IPOP and prototype development/deployment in the PRAGMA Lake expedition

**Funding Support:** This award

**Country(ies) of foreign collaborator:** none

**Traveled to foreign country:** no

**Country:**

**Duration of stay:**

**Name:** Pierre St. Juste

**Nearest Person Month Worked:** 5

**Contribution to the Project:** St. Juste has contributed to development, documentation and testing of IPOP overlay software

**Funding Support: This award**

**Country(ies) of foreign collaborator:** none

**Traveled to foreign country:** no

**Country:**

**Duration of stay:**

**Name:** Maurício Tsugawa

**Nearest Person Month Worked:** 1

**Contribution to the Project:** Research and development of virtual network technologies and co-leader of PRAGMA Experimental Network Testbed expedition.

**Funding Support:** University of Florida

**Country(ies) of foreign collaborator:** Japan, China, Taiwan, Thailand, South Korea

**Traveled to foreign country:** yes

**Country:** China and Taiwan

**Duration of stay:** 5 days (China), 5 days (Taiwan)

**What other organizations have been involved as partners?**

The online service will also ask you for additional information such as:

* Type of Partner Organization
* Name
* Location
* Partner’s contribution to the project

**Type of Partner Organization:** Collaborative research (e.g., partner's staff work with project staff on the project)

**Name:** University of Florida

**Location:** Florida, USA

**More detail on partner contribution (optional):**

**Type of Partner Organization:** Collaborative research (e.g., partner's staff work with project staff on the project)

**Name:** University of Queensland

**Location:** Brisbane, Queensland, Australia

**More detail on partner contribution (optional):** Partners at U. Queensland provided the Unmanned Aerial Vehicles (UAVs) and expertise. Three Univ. Queensland participants were involved.

**Type of Partner Organization:** Collaborative research (e.g., partner's staff work with project staff on the project)

**Name:** Sabah Parks

**Location:** Kota Kinabalu, Sabah, Malaysia

**More detail on partner contribution (optional):** Provided logistical support, coordination, permits, etc. for data collection and hosted the mini-PRAGMA symposium on Serpentine Ecology.

**Type of Partner Organization:** Collaborative research (e.g., partner's staff work with project staff on the project)

**Name:** University of Wisconsin

**Location:** Madison, Wisconsin, USA

**More detail on partner contribution (optional):** Partners at U. Wisconsin collaborated in formulation of usage scenarios, documentation, and testing of the lake expedition prototype.

**Type of Partner Organization:** Collaborative research (e.g., partner's staff work with project staff on the project)

**Name:** Virginia Tech University

**Location:** Blacksburg, Virginia, USA

**More detail on partner contribution (optional):** Partners at Virginia Tech collaborated in formulation of usage scenarios, documentation, and testing of the lake expedition prototype.

**Have other collaborators or contacts been involved?** No

Impacts   
You have the option of selecting “nothing to report” in this section.

**What is the impact on the development of the principal discipline(s) of the project?**

PRAGMA-ENT conducts research and development on the establishment of an international end-to-end software-defined networking testbed. Challenges, experience, and solutions found by PRAGMA-ENT activities will be valuable to the networking community.

The Lake expedition is deploying distributed virtual clusters that are interconnected by a new design of the IPOP overlay that uses standard protocols for peer discovery, notification, and traversal of network address translators (NATs), and where virtual network endpoints run on user devices (servers, laptops). Results and user feedback collected from this deployment will provide valuable information for the P2P and overlay network community.

**What is the impact on other disciplines?**

PRAGMA-ENT will give the necessary networking support to PRAGMA multi-cloud activities and user-defined trust envelopes . These systems, in turn, offer the necessary information technology support to multidisciplinary teams of PRAGMA researchers.

The PRAGMA Biodiversity Expedition involves sharing data across international borders. The Nagoya Protocol covering genetic resources under the Convention on Biological Diversity was recently ratified by the threshold 50th country and becomes international law on Oct 12, 2014 (90 days after the 50th signatory). It becomes ever more important that computational applications and data resources are responsive to both permitting data access and restrictions for use and distribution. The concept of trust envelopes was discussed as a method for addressing international data sharing concerns, and the idea has gained some initial traction for international partners such as Sabah Parks.

The PRAGMA Lake expedition is deploying a high-throughput computing cyber-infrastructure tailored to address computational needs of lake ecology modelers. By lowering the barrier to users to access and effectively use HTC resources, the expedition has the potential impact of enabling limnologists to refine their models, and to improve their analysis by considering larger number of simulation parameters, finer-resolution models, and/or additional dimensions.

**What is the impact on the development of human resources?**

PRAGMA-ENT enables privileged access to advanced network equipment and tools (e.g., hardware OpenFlow switches), in an international multi-site setup – a great opportunity to gain experience in advanced and software-defined networking.

The lake expedition collaboration has a potential impact on the development of human resources in both lake ecology and computer science domains: lake ecology students are able to develop skills on the use of High-Throughput Computing (HTC) and overlay virtual network in their research workflows, and computer systems students are able to develop skills in modeling of physical phenomena, in particular in lake ecology processes.

**What is the impact on physical resources that form infrastructure?**

**What is the impact on institutional resources that form infrastructure?**

**What is the impact on information resources that form infrastructure?**

**What is the impact on technology transfer?**

**What is the impact on society beyond science and technology?**

Cultural eutrophication, which is defined as excessive plant, algal, and bacterial growth due to nutrient enrichment, is particularly salient example of how human decisions impact lake ecosystem services. Eutrophication, perhaps the greatest water quality challenge facing freshwater ecosystems throughout the world, can lead to formation of harmful, or even deadly, algal blooms, fish kills, species losses, and shifts in lake food webs and biogeochemical cycling. By connecting the scientific community with data and model resources, the PRAGMA Lake expedition has the potential impact of enabling advanced simulation of lake hydrodynamics and water quality to address eutrophication research questions.

Changes / Problems  
  
If not previously reported in writing to the agency through other mechanisms, provide the following additional information or state, "Nothing to Report", if applicable.

Changes in approach and reason for change:

Actual or Anticipated problems or delays and actions or plans to resolve them:

Changes that have a significant impact on expenditures:

Significant changes in use or care of human subjects:

Significant changes in use or care of vertebrate animals:

Significant changes in use or care of biohazards:

Special Requirements

This report section is only available when Special Requirements are specifically noted in the solicitation and approved by the Office of Management and Budget.

NOTE: You may upload PDF files in support of the Special Requirements section. You may upload PDF files with a maximum file size of 10 MB each. There is no limit to the number of files uploaded.