InterACTWEL Science Gateway for Adaptation Planning in Food-Energy-Water Sectors of Local Communities

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ABSTRACT

Since their inception in mid 2000s, adoption of Science Gateways as interfaces and conduits for digital infrastructure needed in science and engineering research and education has significantly increased. This trend has also driven changes in the types of services and resources that are now being expected from the Science Gateways by a growing group of diverse end users. In this poster, we present a novel Science Gateway, InterACTWEL (Interactive Adaptation and Collaboration Tool for managing Water, Energy and Land), which serves as a research cyberinfrastructure as well as an applied decision support system for adaptive natural resources management in interdependent food, energy, and water sectors. End users of this gateway include not only interdisciplinary technical and social science researchers, but also public and private sectoral stakeholders. The gateway is a collaboration between Oregon State University and Science Gateways Research Center, Pervasive Technology Institute at Indiana University, and is addressing challenges and solutions related to computational services, visualization techniques, advanced software applications, collaboration capabilities, cyber security and privacy, and data repositories unique to food-energy-water sectors and their stakeholders.

KEYWORDS

Apache Airavata, SciGaP, InterACTWEL, Food-Energy-Water Nexus, Adaptation Planning

1. INTRODUCTION

InterACTWEL (Interactive Adaptation and Collaboration Tool for managing Water, Energy and Land) is envisioned to be transformational decision support ecosystem with state-of-the-art analytics and visualization capabilities that, once launched and adopted, will empower land, water, energy managers and food producers to conceptualize and co-plan towards a resilient future for their local communities. InterACTWEL is aimed to help communities identify natural resources management decisions over time, and for long-term adaptation to drastic changes that they do not have control of, such as severe water restriction, changing state laws, and changing climatic patterns. Creating such capabilities for large communities to prepare for an evolving future of changes requires creation of, access to, and use of complex and multi-sectoral datasets of varying sizes, advanced simulation models, large-scale optimization algorithms, visualization techniques for rendering of complex decision and goal spaces, as well as interfaces that facilitate end-user engagement and cognitive learning. Since public and private sectoral stakeholders (e.g., farmers, energy producers, municipalities, food processors, regulatory and non-regulatory governmental agencies, non-governmental organizations, tribes) in local communities are all direct and life-long beneficiaries of resource management tools generated by the research community, the Science Gateway [1-7] must support needs and activities of a diverse personas of end-user. This poster will describe the user base, functionalities, and services in the novel Science Gateway (ScG) InterACTWEL designed to enable research and practitioner community to sustain translational research goals and long-lasting collaboration between researchers and citizens.

2. InterACTWEL USERS AND WORKFLOWS

In InterACTWEL Science Gateway, we envision three types of end users, each with their own unique scenarios of use cases and types of relevant tasks/functions performed by them within the InterACTWEL cyberinfrastructure. These user types include:

1. **Global Administrator (GA):** The main role of Global Administrator is to set up InterACTWEL Project for a river basin or community, as well as identify and invite Local Administrators (described below) from Food, Energy, and Water (FEW) Sectors of the study region. The GA is expected to also manage all security, access, and privacy settings in user accounts, hence they have complete control of the project, the data and models, and the members of the project. The GA could be either a researcher, agency personnel, or an engineering consultant, and often most closely related to government, academic or NGO agencies that are driving the creation of new collaborations among decision makers in food-energy-water sectors. In other words, these are the people that would lead the

ScG project and, would, therefore be responsible for engaging all stakeholders, collecting the data & models, setting up the experiments and disseminating the findings of the study. A key attribute of Global admins is that they would have to gain the trust of all stakeholders given that the information and data provided by them will be handled as requested by the data provider. This is seen as a major challenge within the FEW sectors since distrust amongst stakeholders often prevents a more rigorous and scientific analysis of potential action plans and future policy changes. The GA is also expected to set up relevant parameters that describe the perturbation type (e.g., decreased water availability in a region) that the community wants to plan for, as well as submit appropriate simulation and optimization runs, once the local administrators have set up their data, models, decision strategies, and cost-benefit goals and constraints.

2. **Local Administrators (LA):** These are sector leads or managers that represent stakeholders (or, actors) in one or more individual food, energy, and water sectors of a local community. LAs are technical leads and provide relevant data, models, decision strategies, and cost-benefit goals and constraints that represent their sector within the

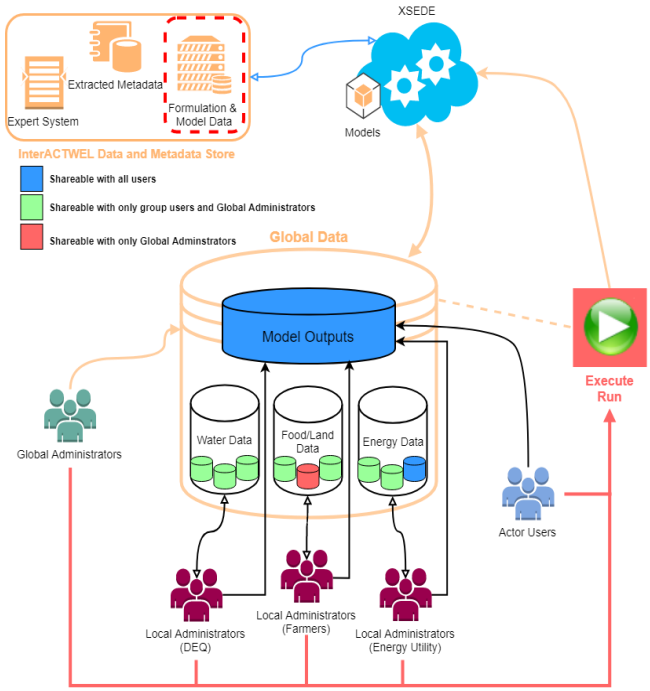

Figure 1. End users of InterACTWEL and their Roles

InterACTWEL's planning environment. As such, LAs have complete control over their data (e.g, sharing privileges, visibility and use restrictions, etc.), and have the ability to run "pre-setup" experiments using a different parameter if desired.

3. **Actor Users (AU):** These end users are most closely related to the impacted community members (e.g., residents of the watershed, tribal communities), actors in each of the FEW sectors (i.e., farmers, water utilities) and other interested actors from the public (e.g., researchers, students). The interaction of these users with the ScG is limited to the visualization and evaluation of the model results from the experiments through a visualization GUI. Users in this category will be able to request the evaluation of different action plans, but may or may not have access to the input data, models or have the ability to set up new experiments. Nevertheless, these end users will have the capacity to evaluate and provide feedback on adaptation plans being proposed. As such, the ScG should present a GUI that is clear, easy to use and navigate, and engaging since the feedback from the end users will ultimately drive the implementation of plans that will ensure the resiliency and sustainability of these communities.

It is important to highlight that the role of these different ScG users is not trivial as user privileges are constrained by data privacy issues. Intersectoral (and even intra-sectoral) data sharing is not allowed/encouraged due to existing mistrust amongst FEW actors. Thus, the main functionality that the ScG supports is the ability to READ/WRITE and SHARE data within and between specific users (i.e., groups) and, more importantly, allow users to run an experiment that uses all data, even though they might not have READ/WRITE privileges to it.

3. InterACTWEL GATEWAY WITH SCIGAP SERVICES

Figure 2 presents an overview of the preliminary architecture of the ScG with all the needed components and associated technologies. The three different types of end users, each with different roles and privileges, are expected to interact with the ScG through different graphical user interfaces (GUIs). Regardless of the GUI presented to the different users, the back-end of the system is based on the standard Apache Airavata (red box in Fig. 2). Airavata proved to be the most feasible options as the back-end software to be used given its robustness, longevity, continued development and support (e.g., APIs). Additionally, the future development plans of this software will allow integrating needed services by the InterACTWEL ScG. As such, Airavata will be used to manage:

- Users roles and privileges (see section use cases below for more details)
- Project and associated workflows (e.g., input and setup of models and data)
- Communication between the data storage services and computing resources (e.g., setup work-flows, run experiments, add/modify data parsers, etc.)

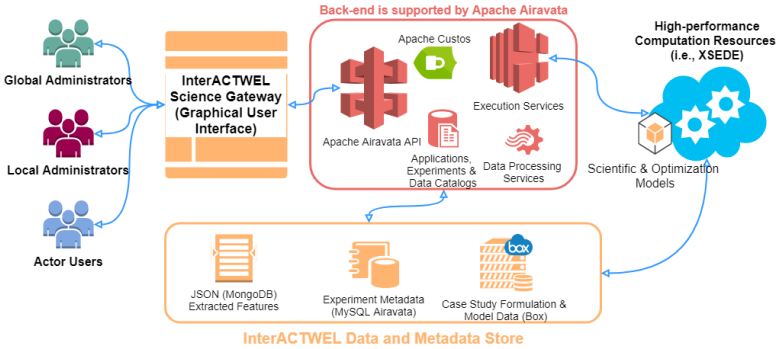

Figure 2: Overview of technology components and computational resources

User data, application/model configuration, experiments setup, and workflows are stored in the Airavata databases. However, data, models and outputs of projects created through the InterACTWEL ScG are managed by using Box's cloud storage services. Finally, depending on the user's account and the funding resources the InterACTWEL ScG allows the use of various high-performance computing resources (e.g., Jetstream, TACC, etc.) during project setup, and run different experiments given the user's input (i.e., an instance of the model with different values for the input parameters). The flexibility of the ScG to allow different data management and cloud computing resources was highlighted to be critical in the sustainability and longevity of InterACTWEL.

Current efforts of the ScG are focused on 1) testing the usability of the different GUIs used for visualization and evaluation of adaptation plans, 2) the development of more use cases for the GUIs used by project managers (global admins) and sectoral leads (local admins) in the ScG to manage different types of users, and data and models of case study region which will help finalize the development of additional functionalities provided by Apache Airavata (e.g., management of groups of users), and 3) development and testing of workflows that support the seamless setup and deployment of the simulation-optimization approach given the case study data (i.e., referred to as "Experiments" in the ScG).

4. FUTURE WORK

To date, most of the work associated with the InterACTWEL ScG development has been concentrated on the planning and design of the cyberinfrastructure's back-end (i.e., integration of scientific models, the development of new functionalities in Airavata, choices of database types and associated schemas, etc.). As we continue to develop the InterACTWEL ScG, it is crucial to start thinking about the best practices used to engage users, the sustainability and long-term vision plan for the ScG, in particular, what business strategies we could use to ensure its longevity. When used as decision support system (DSS), developed specifically to empower communities to propose, analyze and discuss community driven adaptation plans, it is important that we know how to:

- anticipate the needs of different stakeholders (i.e., identified in InterACTWEL as global administrators, local administrators, and actor users)
- understand the available marketing strategies that could be used to increase adoption and use by different groups of stakeholders
- design a ScG back-end that supports the continuous improvement of the scientific models, the usability and flexibility of the user interfaces, and its social networking functionalities

ıermore, it is essential for us to understand what are the most appropriate and feasible business plans to maintain the ScG. Having a vision for the types of agencies and organizations that are most likely to use the ScG, what funding models could be used to benefit both the users and the overall sustainability of the ScG.

5. CONCLUSIONS

The InterACTWEL ScG project is pushing boundaries in Science Gateway community on the types of services and resources that are now being expected by a growing group of diverse end users. This poster presented how end user expectations and roles in Food-Energy-Water sectors can advance ScG capabilities and capacities, especially when ScG serves dual purpose – interdisciplinary research as well as decision support. A long-term goal for InterACTWEL is to have the scientific community improve and expand the ScG's scientific models and analytical capabilities. The use of scientific models and analytical tools are often case study dependent, thus allowing users to integrate their own tools and software into the DSS is critical as we examine use cases for the InterACTWEL ScG.

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REFERENCES

[1] Lawrence, K.A., Zentner, M., Wilkins-Diehr, N., Wernert, J.A., Pierce, M., Marru, S. and Michael, S., 2015. Science gateways today and tomorrow: positive perspectives of nearly 5000 members of the research community. Concurrency and Computation: Practice and Experience, 27(16), pp.4252-4268.

[2] Marlon Pierce, Suresh Marru, Mark A Miller, Amit Majumdar, and Borries Demeler. 2013. Science Gateway Operational Sustainability: Adopting a PlatformasaService Approach. (2013).

[3] Suresh Marru, Lahiru Gunathilake, Chathura Herath, PatanachaiTangchaisin, Marlon Pierce, Chris Mattmann, Raminder Singh, Thilina Gunarathne, Eran Chinthaka, Ross Gardler, et al. 2011. Apache airavata: a framework for distributed applications and computational workflows. In Proceedings of the 2011 ACM workshop on Gateway computing environments. ACM, 21–28.

[4] Christie, M. A., Bhandar, A., Nakandala, S., Marru, S., Abeysinghe, E., Pamidighantam, S., & Pierce, M. E. (2017). Using Keycloak for Gateway Authentication and Authorization.

[5] Basney, J., Fleury, T. and Gaynor, J., 2014. CILogon: A federated X. 509 certification authority for cyberinfrastructure logon. Concurrency and Computation: Practice and Experience, 26(13), pp.2225-2239.

[6] Kanewala, T. A., Marru, S., Basney, J., & Pierce, M. (2014, May). A credential store for multi-tenant science gateways. In *Cluster, Cloud and Grid Computing (CCGrid), 2014 14th IEEE/ACM International Symposium on* (pp. 445-454). IEEE.

[7] Nakandala, S., Marru, S., Piece, M., Pamidighantam, S., Yoshimoto, K., Schwartz, T., Sivagnanam, S., Majumdar, A. and Miller, M.A., 2017, July. Apache Airavata Sharing Service: A Tool for Enabling User Collaboration in Science Gateways. In Proceedings of the Practice and Experience in Advanced Research Computing 2017 on Sustainability, Success and Impact (p. 20). ACM.