



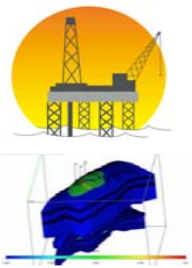
# Utilizing Grid Computing for Advanced Reservoir Studies

Z. Lei<sup>1</sup>, G. Allen<sup>1,3</sup>, P. Chakraborty<sup>1,3</sup>, D. Huang<sup>1,3</sup>, H. Kaiser<sup>1</sup>, A. Kulshresha<sup>1,3</sup>, J. Lewis<sup>1,3</sup>, X. Li<sup>1,2</sup>, J. Smith<sup>3</sup>, C. White<sup>1,2</sup>

<sup>1</sup>Center for Computation and Technology (CCT), Louisiana State University (LSU)

<sup>2</sup>Craft & Hawkins Department of Petroleum Engineering, LSU

<sup>3</sup>Department of Computer Science, LSU



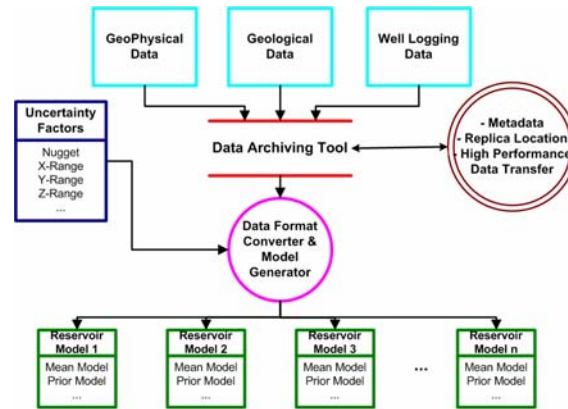
## Overview

Reservoir studies are targeted at obtaining accurate assessments and predictions of reservoir performance, for the purpose of guiding development and operational decisions. Reservoir uncertainty analysis via simulation is viewed as an effective tool to improve performance prediction. The major technical challenges in uncertainty analysis are 1) the need for massive dataset management for large-scale, geographically distributed model-related data; 2) the need to rapidly and repeatedly perform hundreds or thousands of simulations, with different reservoir models to quantify the impacts of different uncertainty factors; 3) the need for an easy-to-use problem solving toolkit to assist uncertainty analysis. The ResGrid uses Grid computing technologies to address these challenging issues.

## Usage Scenario

To conduct reservoir uncertainty analysis, a reservoir engineer only needs to interact with the Web-based Grid portal. The ResGrid services take care of security issues, data acquisition, resource management complexities, result analysis and visualization, etc.

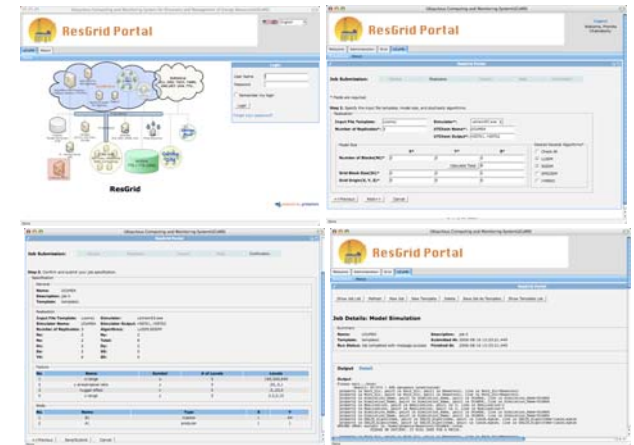
by extracting the modeling-related data. Uncertainty factors and factor levels are provided and the uncertainty parameter space is made. Based on this base model and the parameter space, massive reservoir models are constructed, each of which is associated with one combination of uncertainty factors and factor levels. These models are the inputs of massive reservoir simulation executions.



There are four modules: Resource Brokering, Staging In/Out, Invocation, and Status Monitoring. The Resource Brokering module is employed to manage Grid resources and share loads across a Grid. The Staging In/Out module uploads model datasets and executables and downloads the simulation results. The Invocation module needs to handle remote execution. The Status Monitoring module is in charge of the communication with local resources.

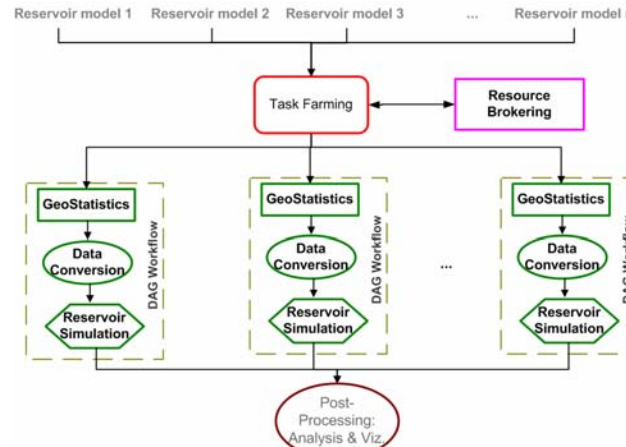
## Portal

The ResGrid portal provides the entry point to conduct advanced reservoir studies. First of all, the portal deals with security. A GSI credential is retrieved from a proxy to provide authentication to access Grid resources. Secondly, the portal provides Web pages to specify the uncertainty factors and the problem solving scales. Then, a user can submit jobs, monitor job execution status, and visualize results via this Grid portal.



## Execution Management

In execution management, task farming is used as the framework that takes reservoir models as inputs, checks a resource broker for resource allocation, and invokes massive simulations. Post processing includes result analysis and visualization.



## References

1. UCoMS website: <http://www.ucoms.org>
2. Z. Lei, D. Huang, et al. *ResGrid: A Grid-aware Toolkit For Reservoir Uncertainty Analysis*, Proceedings of CCGrid06. Singapore. May 16-19, 2006.
3. S. Pena, D. Huang, et al. *A Generic Task-farming Framework for Reservoir Analysis*. Proceedings of 2006 ICPP Workshops. Columbus, Ohio. August 14-18, 2006.

## Acknowledgements

This project is sponsored by the U.S. Department of Energy (DOE) under Award Number DE-FG02-04ER46136 and the Board of Regents, State of Louisiana, under Contract No. DOE/LEQSF(2004-07). Additional support was provided by CCT, LSU.

## Data Management

The data management acquires distributed modeling-related data, constructs reservoir models, and archives simulation results. Modeling-related data include geological & geophysical data, exploration well data, production well data, etc. These datasets are geographically distributed with the size of terabytes, even petabytes. A data replica tool is designed for data acquisition. There are three modules in this tool: metadata service, replica location service, and high performance data transfer service. A base model is generated