Grid WRF Portal: On Demand Weather Forecast Visualization via Efficient Resource Utilization in Grid Computing

Presenter: Khalid Saleem
Florida International University

Team: Khalid Saleem, Shu-Ching Chen, S. Masoud Sadjadi, Javier Munoz, Diego Lopez, Selim Kalayci, David Villegas, Juan Carlos Martinez

SuperComputing 2007

Overview

- Motivation
- Proposed Research
- Major Research Issues
- System Overview
- Q & A

Motivation(1-2)

- Current Weather Forecast Models and Systems
  - Provide local and regional weather forecasts
  - Assist General Public and Emergency Management officials
- Examples
  - NOAA Weather Forecast and Advisories (http://www.noaa.org)
  - Weather Channel (http://www.weather.com)
  - IBM's Deep Thunder (http://www.research.ibm.com/weather/DT.html)
- Concerns
  - Meteorologists' time spent on unnecessary tasks
    - Installation, Setup of WRF Model

Motivation(2-2)

- Concerns continued....
  - Unavailability of on demand higher resolution forecasts for end users
    - Business Owners and Emergency Management Officials
    - Lack of familiarity or expertise with WRF Model
  - Multiple Forecast simulation requests under impending weather hazards
    - Size of data & Scalability demands for high performance computing
  - Lack of necessary system level control
    - Efficient processing
    - Allocation of computational loads

Proposed Research (1-2)

- On-Demand Resource Ingenious Grid enabled Weather Forecast Visualizations
  - Utilizing High resolution Weather Forecast Models
    - Weather Research Forecast Model (WRF)
      - Ensembles for hurricanes
  - Refining Weather Visualization Algorithms
  - Designing and Utilizing Effective Grid Resource Utilization algorithms

Proposed Research (2-2)

- Goal:
  - An Easily Accessible Interface over highly scaleable infrastructure
  - Ensure separation of concerns
    - Emphasizing upon the weather forecasts rather than model installation and setup (Meteorologists)
  - Assist Emergency Management Officials, Meteorologists, Business Owners and the general public
  - Support on demand domain/asset specific high resolution weather forecast visualizations

Major Research Issues

- Weather Forecast Data Processing and Visualization
- On-demand Allocation of Grid Resources

Weather Forecast Data Processing & Visualization (1-2)

- Easily accessible Interface over highly scaleable infrastructure
- Research, Design and Development
  - Grid-enabled Weather Forecast Simulations and Visualizations
    - User-driven Visualization of weather and GIS data sets
  - Methodologies for on demand allocation of grid resources
    - Domain driven allocation
- Visualization techniques/methodologies
  - Colors
  - Shapes

Weather Forecast Data Processing & Visualization (2-2)

- Grid WRF Portal
  - Web based portal
  - Allows ensemble parameter configurations for hurricanes
    - Utilization of ensembles assists in resolving the uncertainty concerns
      - If - then scenarios
  - Interactive (Zoom In/Out) and Non-interactive (MPEG/GIFs) visualizations customized according to user profile and needs
    - Facilitates Domain/Assets Definition

On Demand Allocation of Grid Resources (1-3)

- Key Issue:
  - On Demand Distribution and processing of Computation Loads based on user request
- Multiple weather forecast simulation requests along with ensemble generation and simulation for rendering 2-D visualizations requires
  - Cluster/Grid-computing infrastructure
  - Simultaneous forecast simulation runs over grid nodes for different domains
    - Differentiating between domains of interest and non-interest
  - Near real time Acquisition of weather forecast data
    - Addressing Latency concerns by restricting data transfer to a minimum

On Demand Allocation of Grid Resources (2-3)

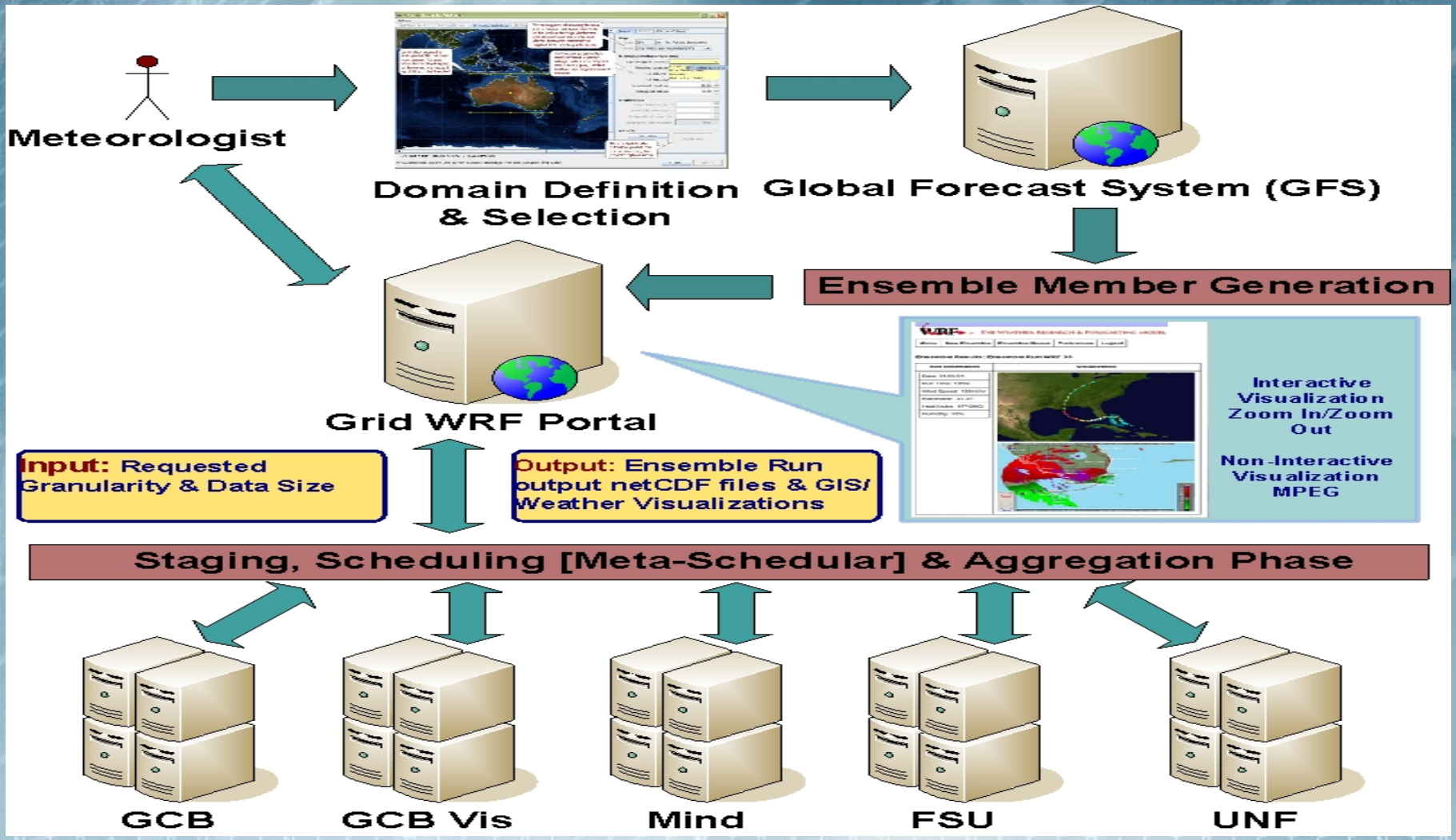
- On demand Scheduling, Simulation and Visualization of Weather Forecast data associated with GIS domains
  - Invoked via portal
  - Meta-scheduler for efficient dynamic allocation of Grid resources
- Employs VisAD for visualization purposes
- Google Maps used as base for GIS data
- Latency issue for visualization data
  - Addressed via the use of KML files

On Demand Allocation of Grid Resources (3-3)

- Grid WRF Portal Test Case (Hurricane Floyd)
  - Extraction of Atmospheric conditions from Global Forecast System (GFS) for three level nested Domain (15 km, 5 km and 1km)
  - 6 Member Ensembles script generation
  - Perturbation of WRF Parameters
    - Initial fields only
      - Geo-potential height
      - Wind velocity
      - Atmospheric pressure,
      - Temperature

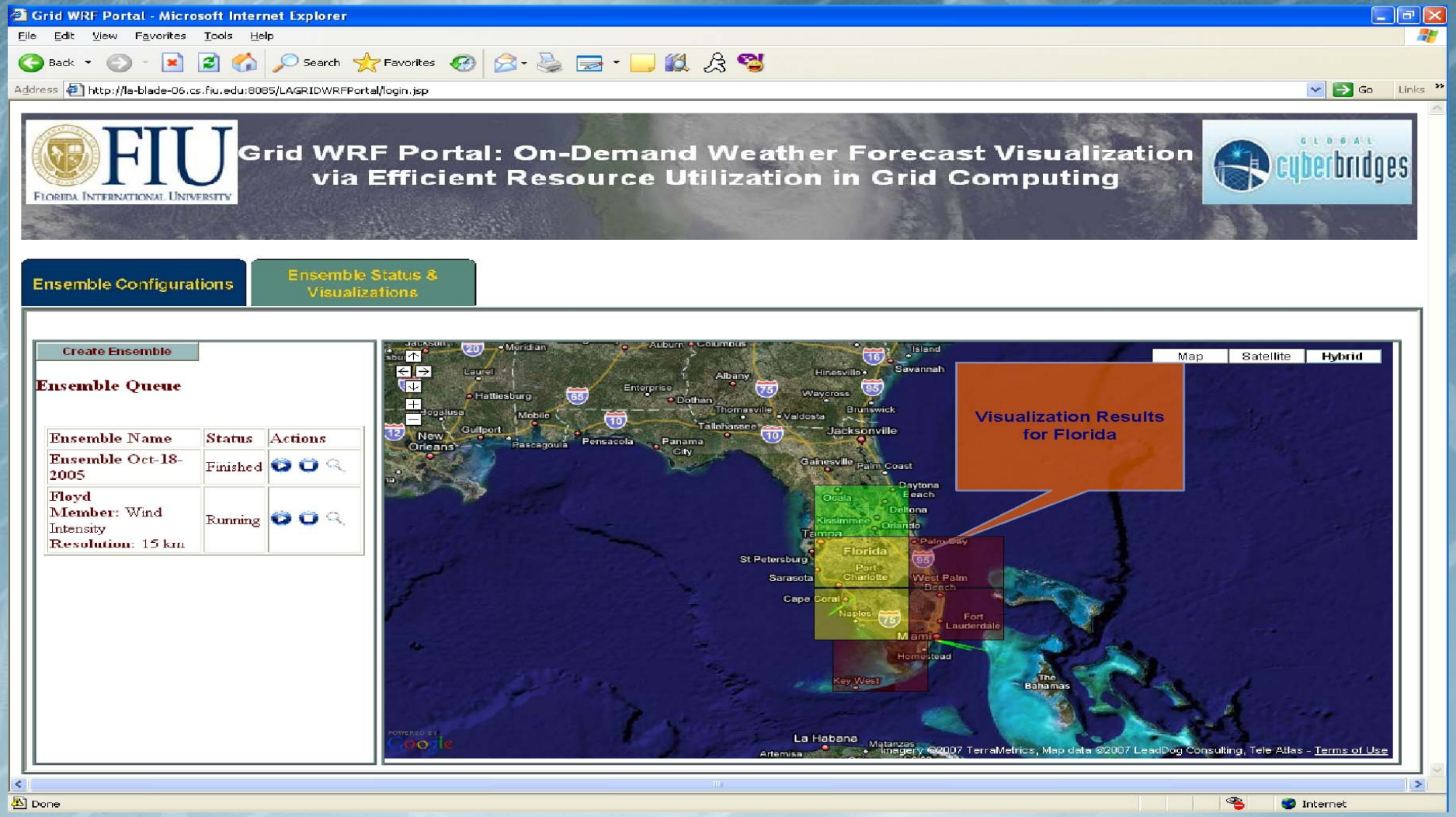
System Overview (1-3)

Portal Architecture



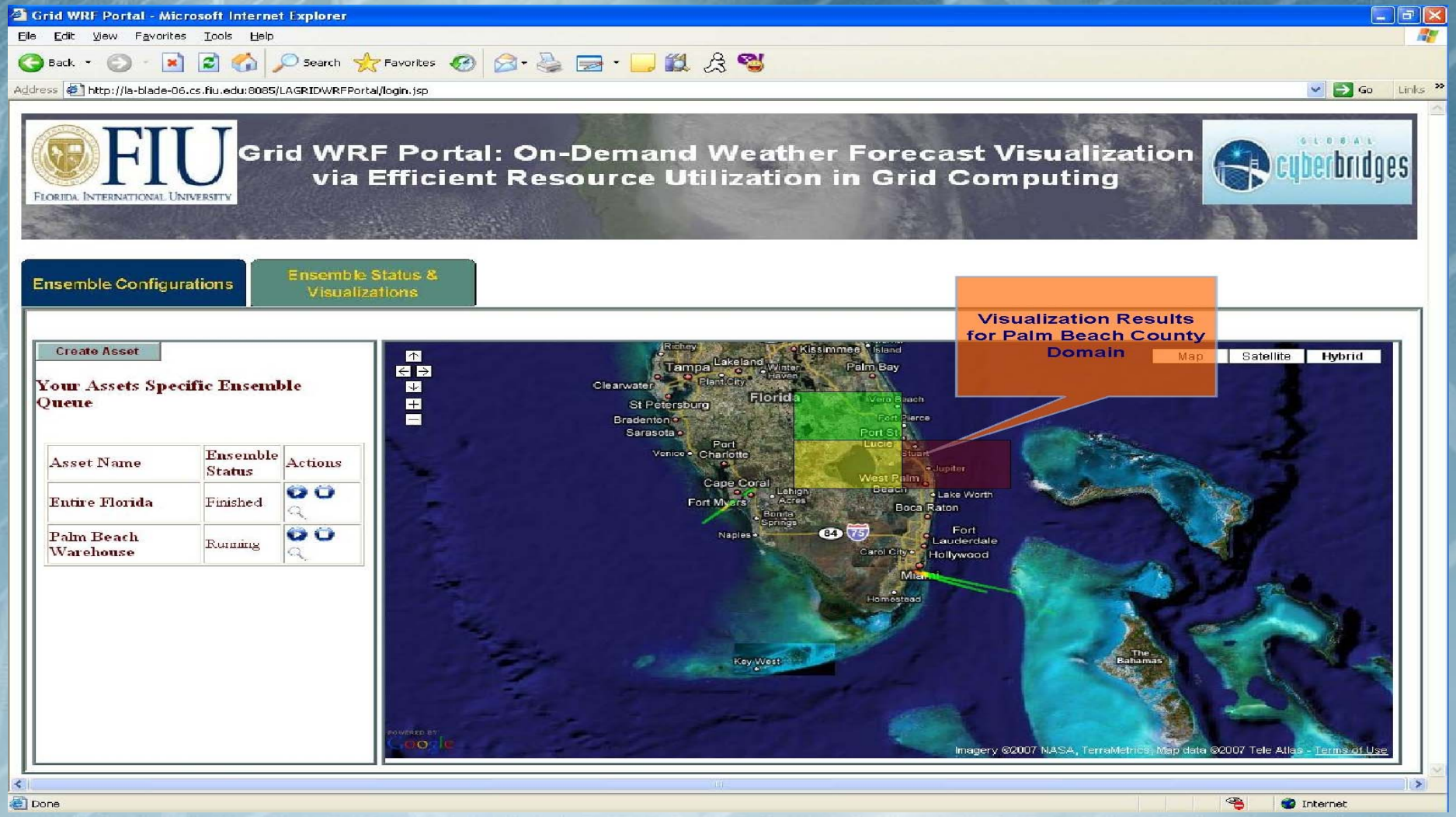
System Overview (2-3)

Meteorologist Login Interface



System Overview (3-3)

Business Owners/Emergency Official's Login Interface



Summary

- Web based portal
  - Facilitates Research over and Configuration of Weather Forecast Models
  - Generates On Demand simulations and visualizations over computing Grids
    - Dynamic Allocation of Grid Resources
      - In response to user requests

Future Work

- Facilitate representation of errors and uncertainty
- Deploying the Grid WRF Portal Test case
  - Execution of different ensemble members over two clusters
    - Involves staging/aggregation and visualization
  - Meta-Scheduler
  - Job Flow Manager
- Colors for effective and meaningful visualizations

Acknowledgements

- This work is supported by:
  - The National Science Foundation grant OCI-0636031 and REU-0552555.
  - IBM (SUR and Student Support awards).
- We would like to thank:
  - The CIARA staff and engineers support: Heidi Alvarez, Julio Ibarra, Ernesto Rubi, Diego Obina, Ileana Gonzalez, and Omaida Hennessey.
  - The SCIS system staff support: Steve Luis, Eric Johnson, Catherine Hernandez, and Chak Leung.

Question & Answers