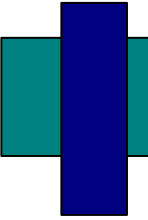# Introduction to Teaching Grid Computing

Dr. Clayton Ferner
University of North Carolina Wilmington
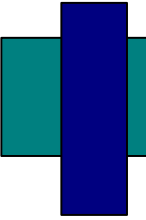
Dr. Barry Wilkinson
University of North Carolina Charlotte

OSG&C 2008
Open Source Grid & Cluster Conference 2008
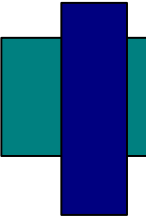
Thursday May 15, 2008

Outline

- Our Grid Computing course in North Carolina
- What we changed in 2007
- Explanation of Assignments
- Lessons Learned
- Future Improvements

Grid Computing Course

- Taught on North Carolina Research and Education Network (NCREN) that connects all 16 state campuses and also private institutions

  - Fall 2004: 8 sites
  - Fall 2005: 12 sites
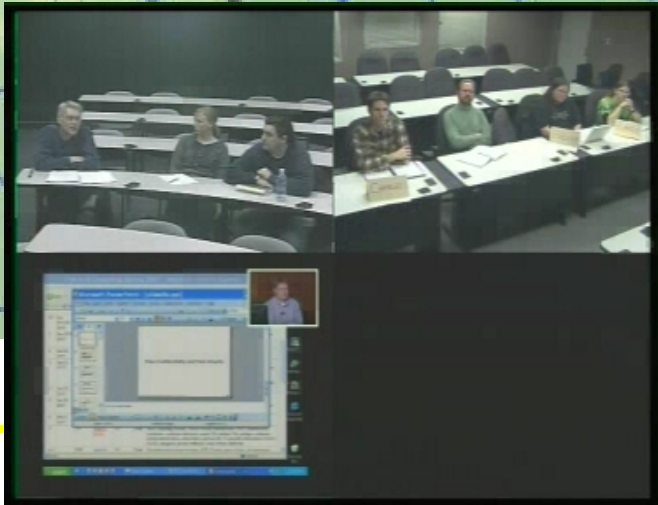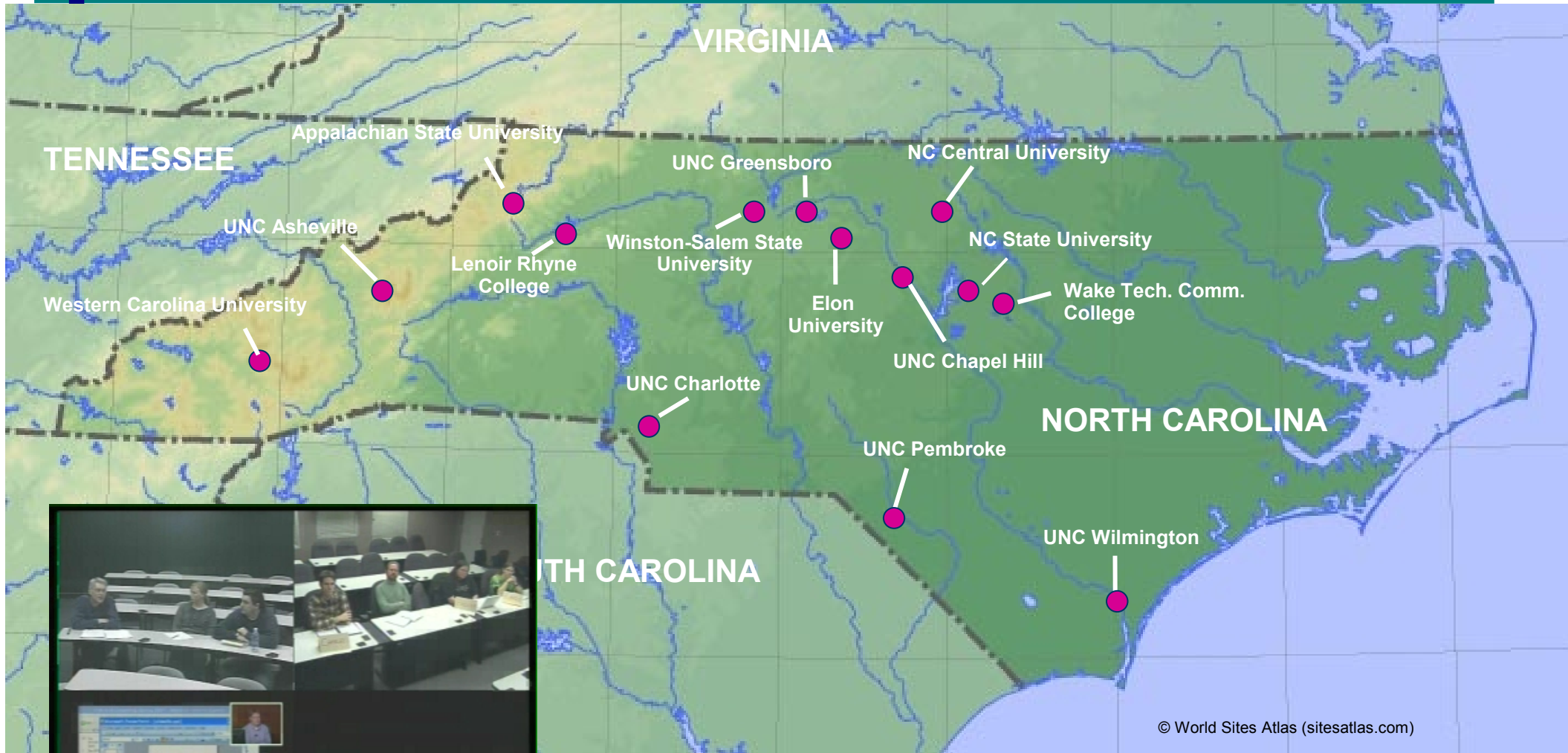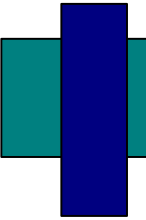 - Spring 2007: 3 sites *(Experimental re-designed course.)*
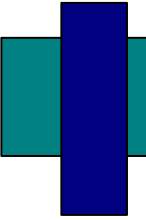
Grid Computing Course

- Undergraduate/graduate

- Hands-on with distributed grid infrastructure

- Teleconferencing facilities - students and faculty at many institutions participating

- Expert guest speakers near end of course

- Probably first such course for undergraduate students and so many distributed sites using large-scale teleconferencing facilities and a truly distributed grid infrastructure.

Grid Computing Course
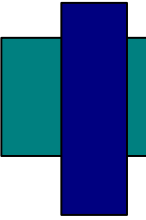

5

Problem with previous offerings

- In 2004 and 2005, the course was taught from a bottom-up perspective

  - We started with Web services then moved on the Grid services

  - Everything was command-line

  - Only toward the end of the semester did we introduce a workflow editor and schedulers (such as Condor or Sun Grid Engine)
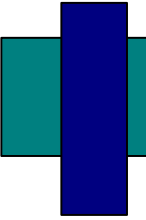
Changes to Grid Course in 2007

- In 2007 we changed the course to be a more top-down perspective

  - Although it might best be described as alternating between high-level and low-level view of Grid Computing

  - We started the course with using tools (i.e. a portal) that a typical Grid User would use
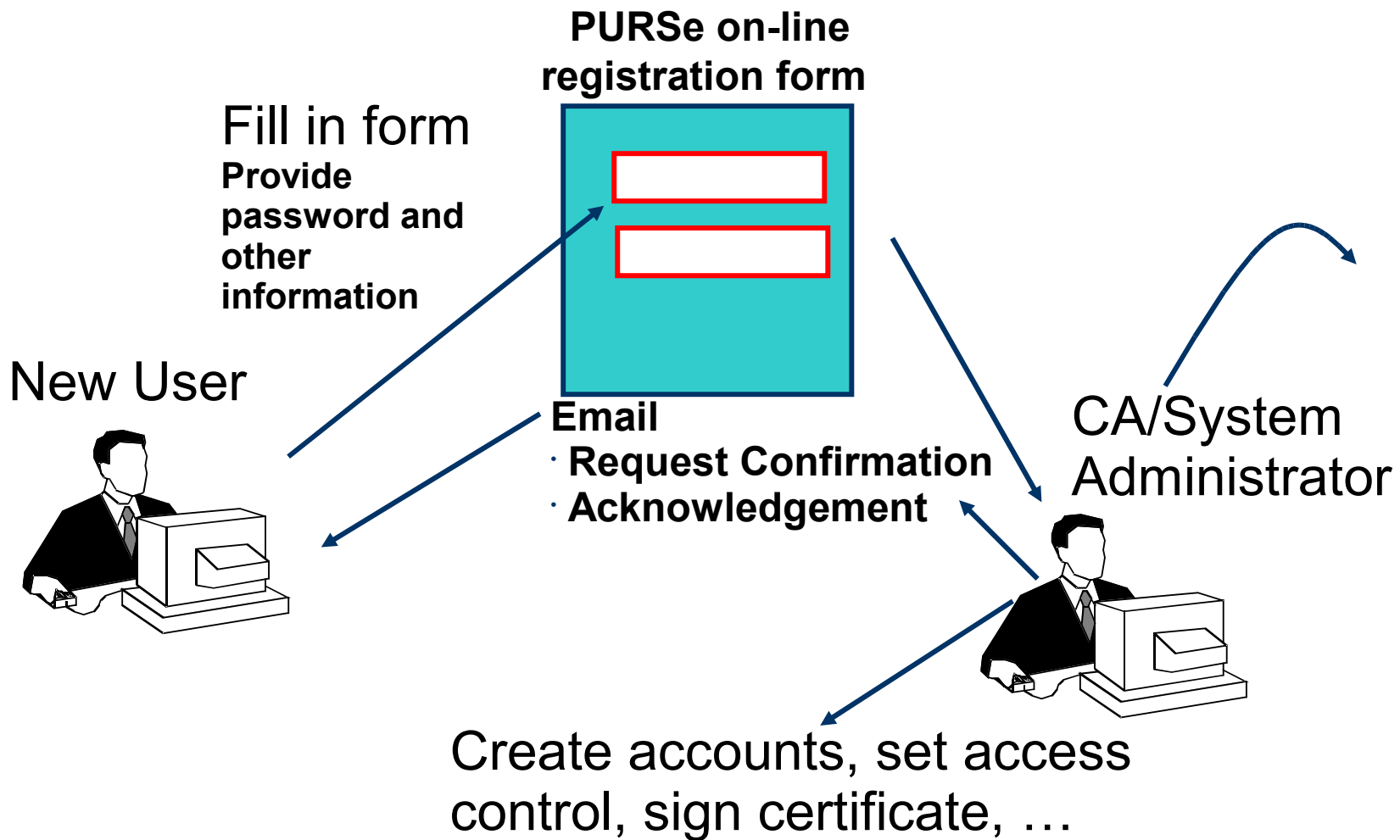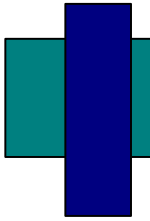
Assignments in 2007

- *Assignment 1*   Using Grid computing portal

- *Assignment 2*   Using Grid through a command line

- *Assignment 3*   Using a scheduler (Condor-G)

- *Assignment 4*   Installing GT4 core. Creating, deploying, and testing a GT4 Grid service

Assignments in 2007

- *Assignment 5* Installing and using GridNexus workflow editor to create and execute workflows

- *Assignment 6* Implementing a portlet with OGCSE2/Gridsphere portal

- *Assignment 7* MPI assignment on Grid

- *Mini-project* Developing Grid computing assignment

  - Assignments 4, 5, and 6 required students to install significant software packages on their computer
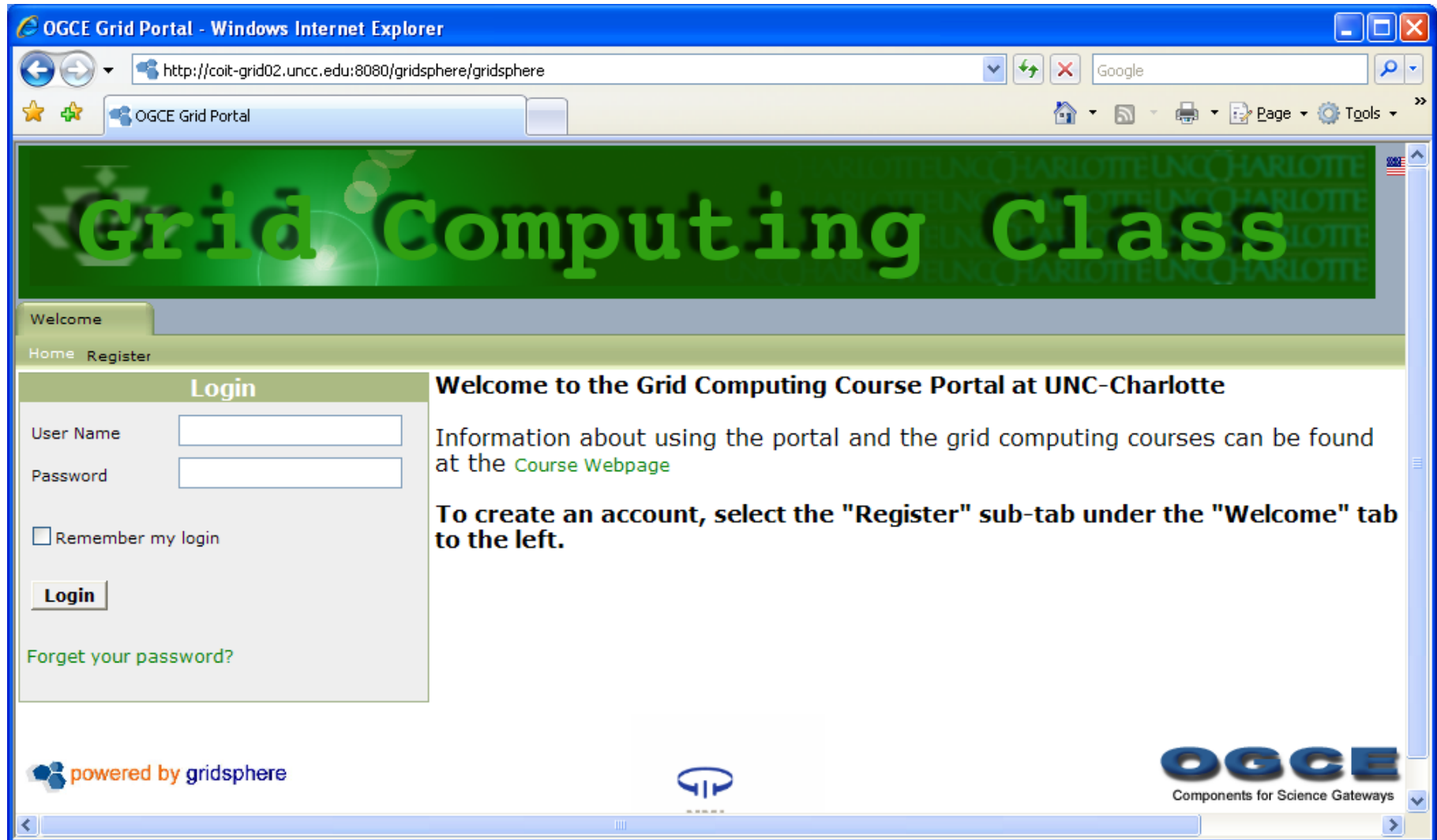
Assignment 1 (Using a Grid Portal)

PURSe on-line registration form

Fill in form
Provide password and other information

New User

Email
· **Request Confirmation**
· **Acknowledgement**

CA/System Administrator

Create accounts, set access control, sign certificate, …

Assignment 1 (Using a Grid Portal)

- Students filled out request for account

  - Certificate Request generated and sent to Certificate Authority automatically

- Certificate Authority signed certificate, installed it in the MyProxy server, emailed confirmation to student

- Student logged onto Portal, acquired a proxy, submitted a simple job, created a java program, transferred and ran that program
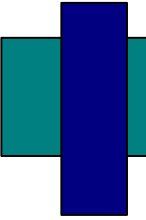
Course portal (OGCSE2/Gridsphere)

Portal provides single sign-on to all grid resources.
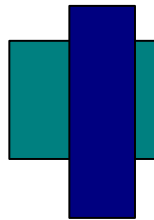
Assignment 2
(Using command-line)

- Students performed the same tasks as in Assignment 1 but used a command-line
  - Install ssh client (e.g. putty) if necessary
  - Set up your credentials (grid-cert-request)
  - Email Certificate Authority to sign certificate
  - Install certificate and create proxy
  - Submit various jobs with globusrun-ws
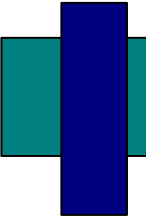 - Some jobs submitted with xml job description files
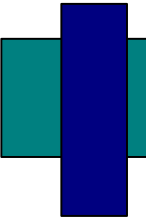
Assignment 3
(Using Condor)

- Create proxy

- Check the status of the Condor pool

- Create a test submit description text file

- Submit jobs and check status

- Using different Condor universes

- Still a command-line interface

- In 2005, we used Sun Grid Engine, which has a GUI interface

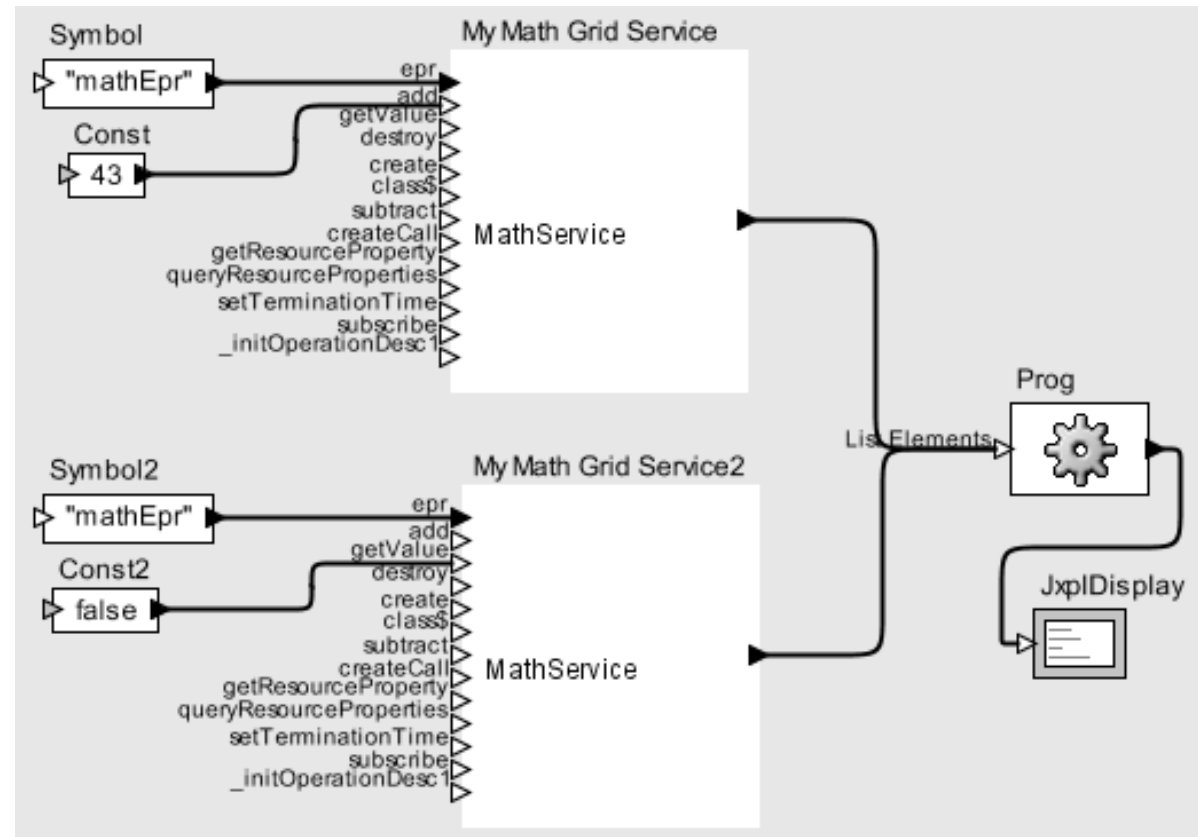# Assignment 4 (Creating and deploying a Grid Service)

- Install GT 4 core and associated software
  - JDK 1.4.2+
  - Ant 1.5.1+
  - Python 2.4+
  - Globus 4.0 core
- Testing installation
  - Start container

- Create, deploy, and test simple GT4 Grid Services
  - Deplore prewritten service and test with client
  - Add Functionality to Service
  - Need to handle WSDL (XML) and other files

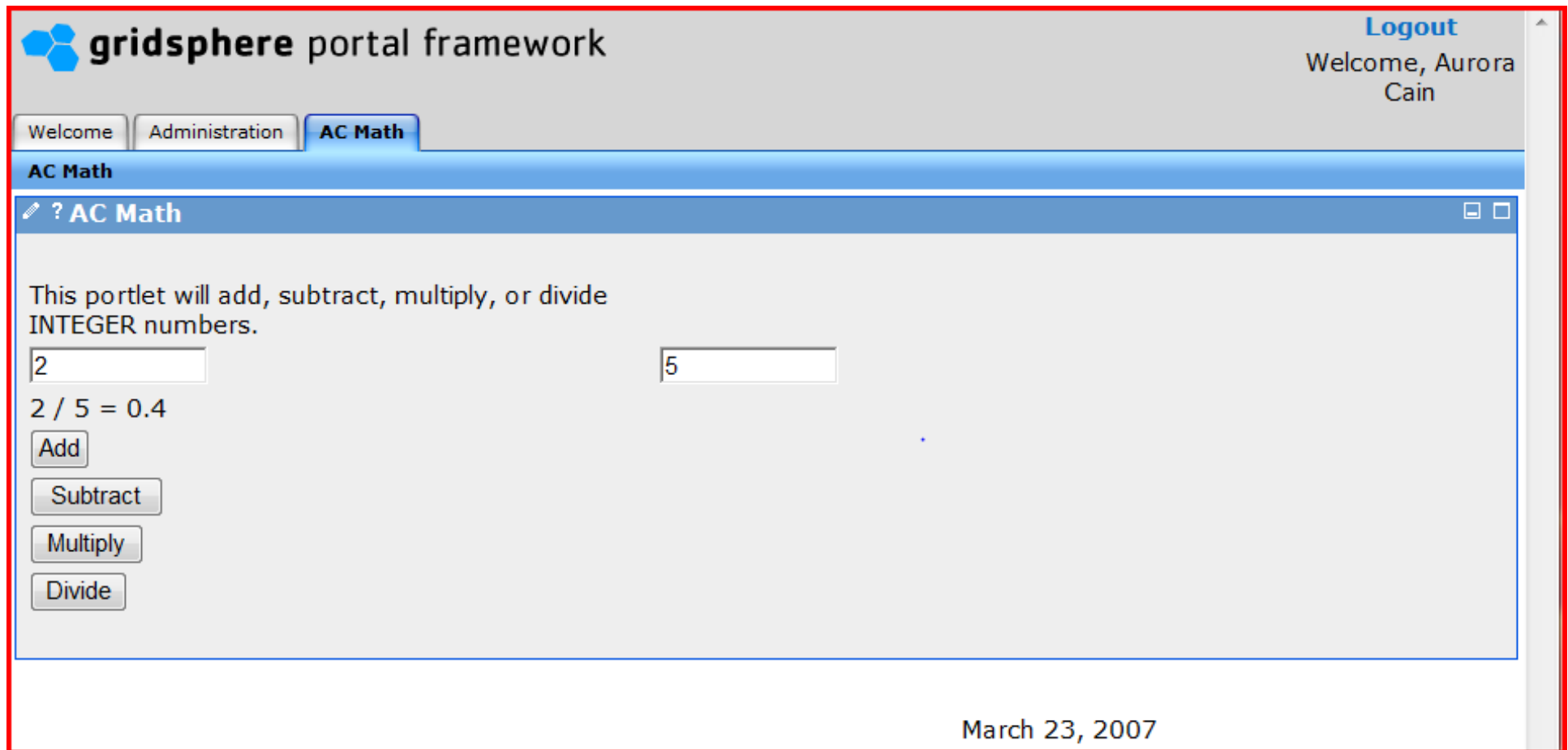# Assignment 5
(Using a GridNexus)

- Install GridNexus workflow editor

- Create Web service workflow

- Create Grid service workflow

- Submitting a job to GRAM

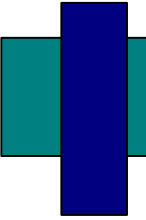# Assignment 6 (Implementing portlets with OGCSE2/Gridsphere)

- **Install Gridsphere and associated software**
  - Java 6 SDK
  - ant
  - tomcat 5.5.20
- **Install Gridsphere**
  - First start Tomcat

- **Create portlets**
  - Prewritten odd-even portlet
  - Installation involves handling deployment descriptor files etc.
  - Portlet to add, subtract, multiply and divide two numbers

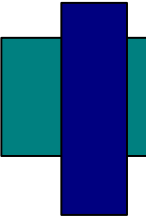# Assignment 6 (Implementing portlets with OGCSE2/Gridsphere)

gridsphere portal framework

Logout
Welcome, Aurora Cain

| Welcome | Administration | **AC Math** |

AC Math

✎ ? **AC Math**

This portlet will add, subtract, multiply, or divide INTEGER numbers.

`2`   `5`

2 / 5 = 0.4

[Add]

[Subtract]

[Multiply]

[Divide]

March 23, 2007

Assignment 7 (MPI Program)

- Write simple MPI program (Matrix Multiplication)

- We couldn't do much more than work with "embarrassingly parallel" applications since we only had a few weeks to deal with MPI.

- The students only executed their programs on one cluster (not really using the Grid).

Mini Projects

- Teams of 3 members

- Objective was to create a new Grid assignment

- Assignment had to involve created a Grid application with a GUI (such as a workflow or portal)

- Assignment had to be written up as though the student would give it to their classmates

  - Focus on dissemination

  - May create future assignments

Mini Projects

- Teams had to provide a written report (with solutions)

- Teams had to give a presentation
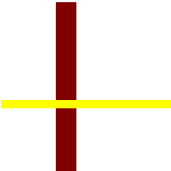
Keeping to Assignment Schedules

- Each assignment allocated 1-2 weeks to complete. Posted three dates:
  - Date assignment was set
  - Date that students had to report any system problems that were preventing them from proceeding
  - Date due

- Fall 2004 many system problems (Globus 3.2)

- Fall 2005 much fewer problems (Globus 4.0)

- Spring 2007, no system problems reported
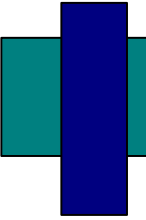
Keeping to Assignment Schedules

- In 2004 and 2005, students created and deployed their Grid services on the same machine.

- An error in a service could make the Globus container inoperable for the other students.

- In 2007, student install the Globus 4 core on an individual PC (lab machine or their own) and used their own container.

- This turned out to be a much better solution!

Lessons Learned

- Students responded positively to using their own computers that were under their direct control.

- Some minor problems with installations but nothing that could not resolved quickly

- Using personal computers where possible avoided many problems.

Avoiding Problems

- It requires immense work to prepare for a hands-on Grid computing course.

- Critical that all assignments are fully tested prior to the start of class and that all computer systems are reliable and the software maintained.

- Assignments went much smoother by requiring students to use personal computers when possible.
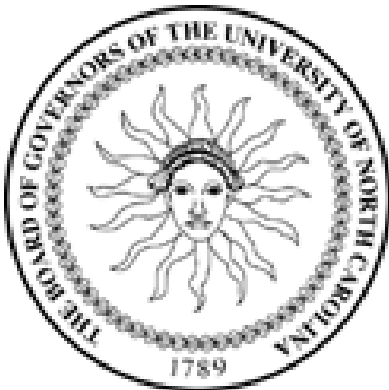
Future Improvements

- Use GridNexus to create and deploy Grid Service

- Use GUI interface to Grid Scheduling

- Maybe introduce Cloud computing and use Hadoop (MapReduce)

Acknowledgements

Questions

Dr. Clayton Ferner cferner@uncw.edu
Dr. Barry Wilkinson abw@uncc.edu

Course Webpage:

http://www.cs.uncc.edu/~abw/gridcourse