or

How e-Research will change university activities

Networking the 21st Century University

Dr. David Wallom
Oxford e-Research Centre
University of Oxford

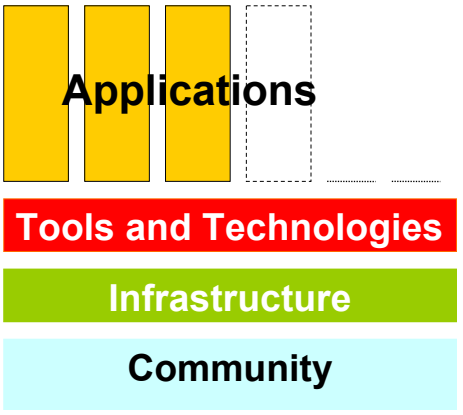
Overview

- A university centre to underpin collaborative multidisciplinary activities
- How can teaching techniques be affected?
- Creating change in research
- Examples of e-Research projects

An e-Research Centre

A "hub" to provide co-ordination of e-Research usage and activities within the university

Key to get engagement of the spokes within departments

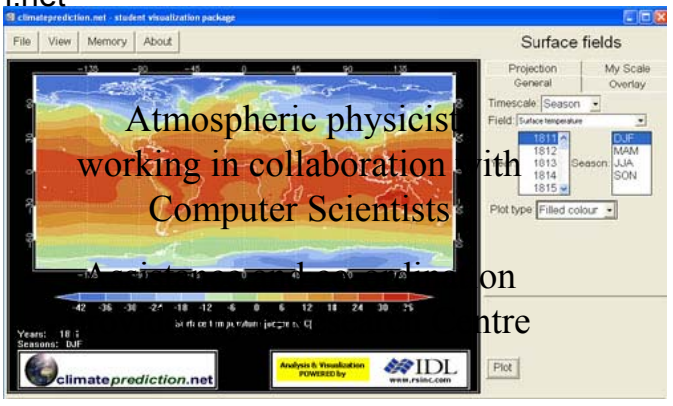


oerc

Applications

Climateprediction.net

CP.net has hit a new milestone of 13 million model-years calculated.



Atmospheric physicist working in collaboration with Computer Scientists

oerc

Tools and Technologies

Harvesting and reusing from across past and current e-Research projects

- Imaging has been a key part of earlier e-Science Projects such as eDiamond, a collaboration between engineering and computer science to develop digital mammography, creating toolkits for use with MatLab
- These toolkits have since been used within a project for the study of ancient documents by a group led within the Department of Classics

The CP net project has reused the underlying technology from the popular SETI@Home project, BOINC

Infrastructure

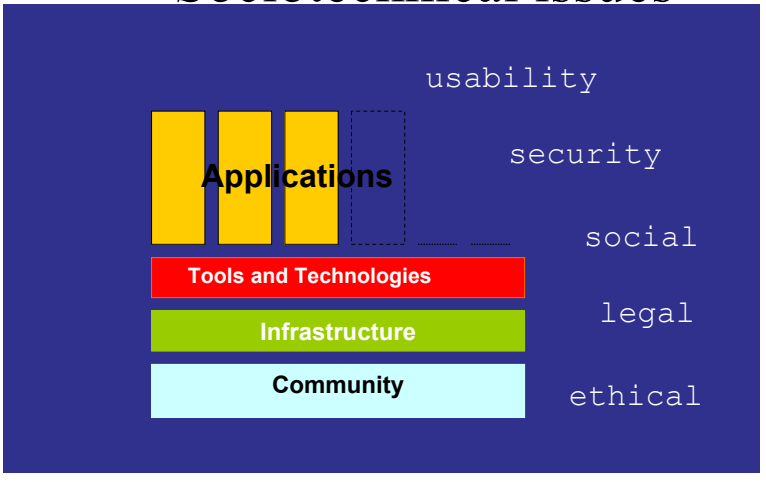
- Networks
  - UKLight
- Services
  - Campus Grid
  - HPC
- Institutional and other repositories
- Collaboration tools
  - Access Grid, VRVS

Community

- Collaborative multidisciplinary research and engagement
  - University
  - Regional
    - Local universities, colleges & schools
  - National
    - e-Science core programme, OMII
  - International
    - Open Grid Forum, EGEE
  - Industry
    - Strategic relationships with innovation companies

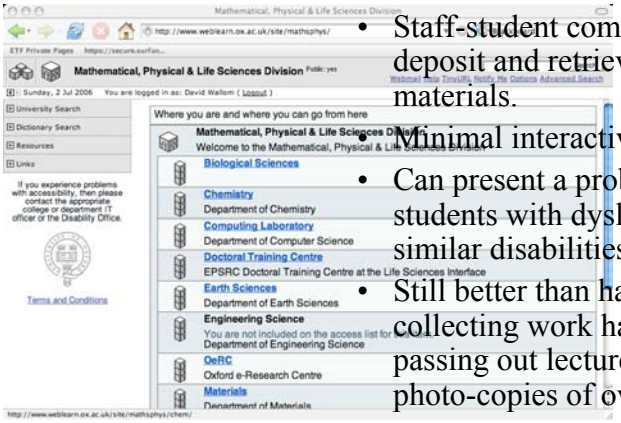
Diamond X-Ray Synchrotron, UK
State of the art facility which will use e-Science techniques to allow researchers to access research Data directly from within their home institution
(Image courtesy of Bill Pulford CCLRC)

Underlying fundamental Sociotechnical issues



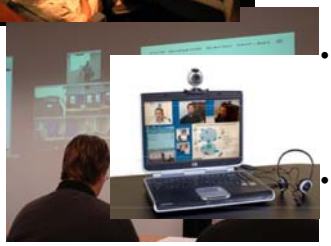
e-Research & Teaching

Current university Virtual Learning Environment



- Staff-student communication through deposit and retrieval of course materials.
- Minimal interactivity!
- Can present a problem for those students with dyslexia and other similar disabilities
- Still better than handing out and collecting work hand written or passing out lecture notes that are photo-copies of overheads!

Using e-Science collaboration technologies



- Research group meetings and seminars transmitted on Access Grid using whole room or personal systems
- Not ideal as;
  - room size node requires specialised equipment and support
  - multicast networking is required for optimal usage
- Good features though:
  - Personal nodes only require software, a standard USB web-cam and an audio headset
  - 'Very' multi-site communication a reality
- Enriching the lecture/seminar experience

Delivering a lecture in the future

- Lecturer may be physically located at an international research facility or an externally based expert
- A number of students present
  - 60% on main university campus
  - 25% on international campuses
  - 15% part-time from home
- Presented over Access Grid
  - either viewed in lecture theatres or more likely on their own laptops in their own rooms.
- Concurrently recorded into VLE as a 'podcast'
- Annotated in real time by all participants and then deposited into personal section of institutional repository

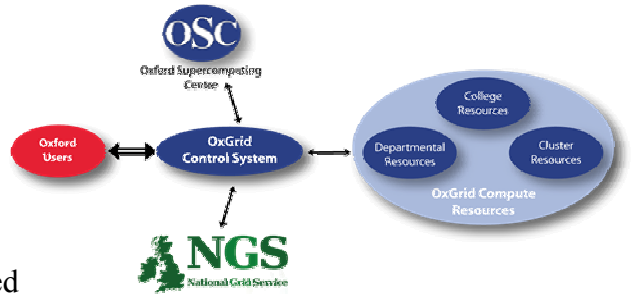
What would be necessary to make this a reality?

- High performance multicast capable networking in all university buildings including student halls
- Widespread Access Grid availability to transmit the lecture itself
  - Every new build or refurbishment of teaching spaces should include AG technology
  - Every student common room could have this installed
- Individual Wiki built into the Virtual Learning Environment for annotation of each lecture
- Institutional repository for long term storage of material for future playback.

e-Research Infrastructure

OxGrid, a campus grid for the University of Oxford

- Single submission point for Oxford users to shared and dedicated resources
- Seamless access to UK National Grid Service (NGS) and Oxford Supercomputing Centre for registered users



OxGrid Computational Resources

- Two types of systems currently connected
  - Internal systems
    - Accessible by any registered campus grid user
  - External systems
    - Prospective users must register both with the campus grid and individual system

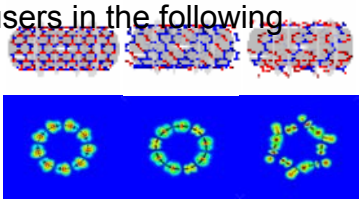
OxGrid Data Resources

- Using Storage Resource Broker to construct a single virtual disk with metadata
- Attached resources
  - Central 1TB storage system
  - 1/2TB on each system central server to give resilience
  - Future connection of other large data resources to provide up to ~100TB

OxGrid, Users

- Currently have registered users in the following groups
  - Inorganic Chemistry
  - Materials Science
  - Theoretical Chemistry
  - Statistics
  - Theoretical Physics
  - Nuclear Physics
  - Computational Biology
  - OUCS

Simulation of the quantum dynamics of correlated electrons in a laser field. OxGrid made serious computational power easily available and was crucial for making the simulating algorithm work. *Dr Dmitri Shalashilin (Theoretical Chemistry)*



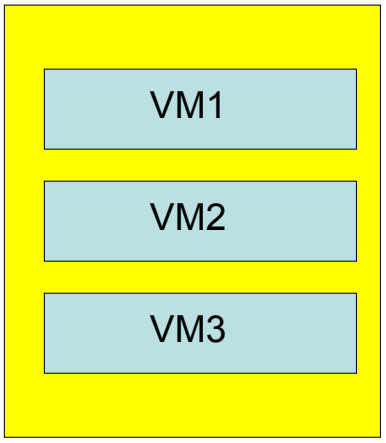
Orbitals and Electron Charge Distribution in Boron Nitride Nanostructures
Dr. Amanda Barnard, (Materials Science)

Molecular Phylogenetics of a large antigen gene family in African trypanosomes. OeRC/OxGrid has been key to my research and has allowed me to complete within a few weeks calculations which would have taken months to run on my desktop. *Dr Jay Taylor* (Statistics)

2nd Generation Campus Grid

- Individual departmental clustered systems will gradually disappear with provision of large university HPC resources
- Teaching, administration and other shared use PCs will be the only other systems available
- Therefore have work out how to best utilize these systems
  - Security: administration departments won't participate unless completely sandboxed
  - Usability: Updates etc. to clients must be seamless

Using virtualisation in university owned systems



- University defined minimal host Operating System
- Computation Campus Grid
- Data Campus Grid
- Departmentally specific environment
- All operating completely autonomously with their own network address etc.
- Assisted by the arrival of multi-core technology

Extending Campus Grid across the globe

- Utilization of 'spare' resources at multiple institutions
- Following the moon to provide 24hour 'out of hours' coverage to create Global Campus Grid
- Maximization of resource availability

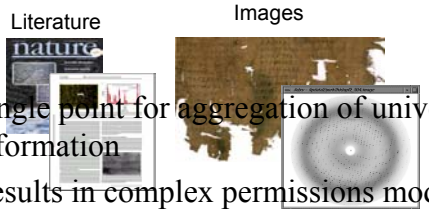
Campus Grid, longer term questions

- Support
  - Who has responsibility if system on university wide campus grid located within a single department gives problems.
    - Must ensure that there is a single point of contact for fault reporting
    - Levels of responsibility for passage of call.
  - Individual departments are able to set their own network & security setups, new setups may require custom configurations etc. Who is ultimately responsible?
    - The owners of the resources should only have to worry about their own installed software, the grid software will be managed by the campus grid staff.

Campus Grid, longer term questions

- Cost
  - Modern universities require recouping of costs of systems, how is usage of a system charged?
    - Hybrid models have been suggested where chargeable value is dependant on how vital computational resource usage is to the research project.
  - With increasing size of individual university super-computing resources, usage must be balanced between these and the grid.
    - Introduction of cost based ticketing to control usage, i.e. parallel tasks are given lower cost rating on the supercomputer to ensure usage where as serial tasks are low cost on the campus grid

Institutional repository

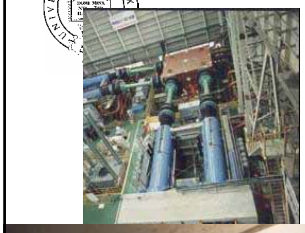


- Single point for aggregation of university generated information
- Results in complex permissions models on a per student basis as well as dynamically large number of possible access points.
- Curation not just in the short term but now heading towards 20-50 year retention, i.e. must have a strategy!

Can only be produced by a large collaboration
- Researchers
- Computer scientists
- Technologists
- Librarians
- Service providers

Enabling the complete scholarly cycle

e-Research Projects



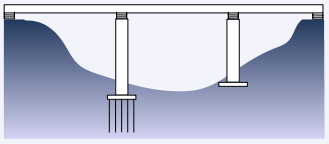
UK-NEES

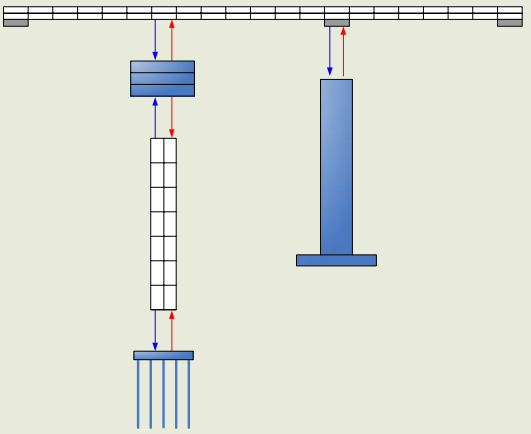
- **UK-N**etwork for **E**arthquake **E**ngineering **S**imulation
- Linking three earthquake engineering labs together
  - Oxford – general purpose dynamic testing lab, focus on hybrid physical/numerical testing
  - Bristol – large earthquake shaking table
  - Cambridge – geotechnical centrifuge
- Tele-participation using HD video conferencing
- Tele-operation of each facility

Why do earthquake engineers need e-Science?

- Need to evaluate new seismic-resistant design concepts
- Importance of testing at full or large scale
- Expense of seismic test facilities
- Potential for "sub-structuring" experiments using hybrid test techniques:
  - hybrid physical/numerical test
  - multi-site tests
- Availability of collaboration technologies and extreme computational, data and network capability

Distributed Hybrid Testing



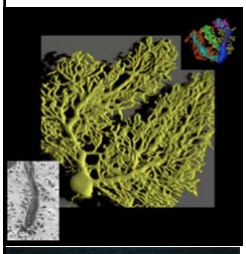


Extending the LamdaGrid

• Collaboration between biomedical scientists at UCSD and Materials Scientists at Oxford

•Real-time co-observation of samples using complementary electron microscopes

Project goals



- To enable Telemicroscopy of the San Diego electron microscope and Oxford microscope for remote access and collaboration.
- To enable a fully integrated Grid based cyberinfrastructure to conduct end-to-end imaging experiments in 3 and 4 dimensions.
- To understand, develop and prototype an OptIPuter enabled visualization system with tiled display walls at multiple sites within the US and the UK to conduct ultra-high resolution data exploration and analysis with simultaneous high definition video telecommunications for collaboration.
- Demonstrate system capabilities for biology and materials science resulting in publications of both science and infrastructure discoveries.

Specific Network Project Requirements

- High bandwidth service (10GB+)
- Extremely low latency to allow feedback into physical experiments
- Guaranteed reliability levels
- Advanced reservation

Conclusions

- e-Research has the capability to change teaching and research dramatically
  - Innovative projects pushing the boundaries of what is possible
  - Current demonstrator projects are moving into the mainstream
  - Data-Grids will become increasingly important and utilized by the wider university community
  - Physical instruments will be fully integrated into the network allowing remote exploitation
  - Future network band-width requirements will increase dramatically

Expanded collaboration and utilization of both currently available and new resources will allow both teaching and research opportunities previously unreachable to be grasped with both hands

Questions?