

# Lecture 21: Grids and Clouds

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# Logistics

- ▶ Project 3 due Monday at midnight
  - ▶ I will be traveling Sunday – ask questions soon!
- ▶ Final project:
  - 12/1: Short presentation
  - 12/16: Final reports
- ▶ Today: Joint presentation with Tao Zao

## Project 3 comments

- ▶ Second MPI implementation should be memory scalable!
  - ▶ May want to think about how to do initialization...
- ▶ 1D ring doesn't save on communication volume
  - ▶ 2D layout would be better – see dense LA lecture
  - ▶ But this exercises what I want you to learn!
  - ▶ And you overlap communication with computation
- ▶ Be careful to communicate about termination!
  - ▶ `MPI_Allreduce` works...

# Grids



[http://en.wikipedia.org/wiki/File:  
Electric\\_transmission\\_lines.jpg](http://en.wikipedia.org/wiki/File:Electric_transmission_lines.jpg)

# Clouds



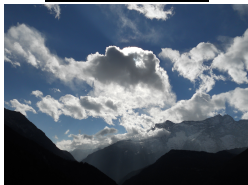
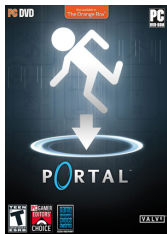
[http://en.wikipedia.org/wiki/File:Cloud\\_in\\_nepal.jpg](http://en.wikipedia.org/wiki/File:Cloud_in_nepal.jpg)

# Portals



[http://en.wikipedia.org/wiki/File:Portal\\_standalonebox.jpg](http://en.wikipedia.org/wiki/File:Portal_standalonebox.jpg)

Watch out, little guy!



# Utility computing

Names change, but the concept is attractive:

- ▶ Flexible access to compute time and data storage
- ▶ Maybe not in a single administrative domain
- ▶ Using simple, standardized interface
- ▶ Maybe with nice high-level interfaces



# Cycle scavenging

- ▶ Condor project (1988-present)
  - ▶ Idea: Use idle cycles on networked computers
  - ▶ Support for transparent checkpointing and migration
  - ▶ Now managing EC2 Spot Instances!
- ▶ Volunteer computing
  - ▶ SETI@Home (1999-present)
  - ▶ Folding@Home (2000-present)
  - ▶ BOINC (2003-present)
- ▶ Good for high throughput in embarrassingly parallel settings
- ▶ Not so good for solving PDEs...

# Globus (1996-present)

Dream: uniform access to distributed

- ▶ Compute power
- ▶ Data storage
- ▶ Data sources (satellites, instruments, etc)

Used by Teragrid / XSEDE.

Some components:

- ▶ Grid Security Interface (GSI)
- ▶ Grid Resource Allocation and Management (GRAM)
- ▶ MPIg (aka MPICH-G4)

# Gateways / portals

Remote access interfaces (often via web) to science-specific tools:

- ▶ XSEDE (NSF) lists several
- ▶ hpc2 (NYSTAR – NY state) hosts several
- ▶ Nanohub hosts several
- ▶ NERSC hosts several
- ▶ ...

# M&MEMS: A personal recollection (2000)

The screenshot shows a Netscape browser window displaying the M&MEMS website. The browser's address bar shows "http://www.mems.berkeley.edu". The website header includes the Millennium logo and a navigation menu with options like Back, Forward, Reload, Home, Search, Netscape, Print, Security, Shop, and Stop. A banner at the top right reads "Learn about the Millennium Projects' contribution to the SETI@Home project". Below the banner, the page title is "A Millennium-based MEMS Simulator".

The main content area is divided into several sections:

- Netlist:** A text input field containing "--Select Netlist", "beamgap", and "cont".
- Completed Simulations:** A list box containing "--DC Analysis", "beam2", "cont", "--Steady State Analysis", and "(none)".
- Running Simulations:** A list box containing "--DC Analysis", "beamgapprerun", "--Steady State Analysis", "(none)", and "--Transient Analysis".

At the bottom of the main content area, there are several buttons: "Upload Netlist", "View Netlist", "Delete Netlist", "Submit New Simulation", "View Simulation", "Delete Simulation", "Return to Main Menu", and "Turn Help On".

On the right side of the page, there are three vertical sections:

- Quick Links:** A list of links including \*Account, \*Requests, \*Cluster View, \*Tutorial, \*MPI, \*REXEC, \*FAQ, \*Rootstock, and \*Vineyard.
- Need Support?:** A section with the text "If you need assistance or have any bugs to report, send an e-mail to technical support".
- Related Projects:** A list of links including \*The Ninja Project, \*ISTORE Project, and \*Endeavour.

At the bottom right, there is a **Latest News** section with two entries:

- May 6<sup>th</sup>, 2000:** Matt Welsh has created a FHP front-end tool, ClusterView, which presents the local state of the Millennium cluster.
- April 24<sup>th</sup>, 2000:** The Berkeley ISTORE Project will be moving over a hundred istore machines to the Millennium network.

The browser's status bar at the bottom shows the system tray with various icons and the system clock.

# Cloudy prospects

Why not run lots of HPC on EC2?

- ▶ Have to start worrying about individual node failures
  - ▶ Will be a worry for anyone if we succeed at exascale...
- ▶ Communication costs are a killer

Partial solutions:

- ▶ Better algorithms (communication avoiding)
- ▶ New programming frameworks?

## “Mid-range” computing on clouds

`http://www.nersc.gov/assets/StaffPresentations/2011/  
MoabCon-Canon-Cloud-presented.pdf`

Paper: `www.lbl.gov/cs/CSnews/cloudcomBP.pdf`