

Xgrid



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Student Computing Labs



What is Xgrid?

- Allows you to run tasks on many CPU's
 - Similar, but different
 - Pooch
 - AppleSeed
 - XLR8



Pro/Cons of Xgrid

- Pro
 - EASY
 - Free
- Cons
 - No MPI (for now)
 - Mac OS X only (for now)
 - Too basic for some jobs
(too simple for Michael Giddings)



“Grid” computing

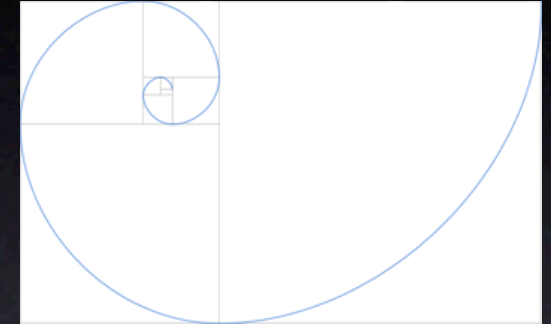
- Not serial tasks

- Fibonacci series

1, 1, 2, 3, 5, 8, 13, 21, 34...

2+3=5 13+21=34

$$F(k + 2) = F(k + 1) + F(k)$$



“Grid” computing

- Parallel tasks
 - Chunks of images

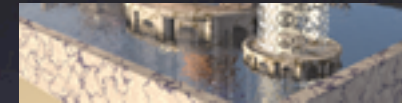
Task 1



Task 2



+ Task 3



=



“Grid” computing

- Parallel tasks
 - 3D rendering
 - Monte Carlo calculations
- Apple provides some examples
 - BLAST
 - Maelbrot
 - Customizable Plugin



Xgrid is the plumbing

- Xgrid does NOT do any math
- Xgrid can be compared to a network
 - It handles traffic
 - File transfers
 - Error handling
 - It does not deal with providing content
 - The BEEP protocol



BEEPCORE

- Open Source beepcore.org
- Standards compliant
- Supports dynamic, pluggable profiles
- P2P, client-server, or server-server
- Support for arbitrary MIME payloads
 - including XML (Xgrid uses XML)
- Java, C, Tcl (Xgrid uses Tcl)



Xgrid Security

- By default, Xgrid requires passwords
- 2 way random mutual auth sessions
 - Includes MD5 hashes
- Jobs run as “nobody”
 - Can write to /tmp
 - Can read/write/executable where world is allowed



Xgrid Features

- EASY to setup
- EASY to secure
- EASY to create custom jobs
 - NO C REQUIRED!
- EASY “workstation” or “grid node” setup
 - 15 minute idle or no idle



Xgrid parts

- Agent
 - The workers, one task per CPU
- Controller
 - The boss, delegates tasks
- Client
 - Submits jobs to be done



No really...

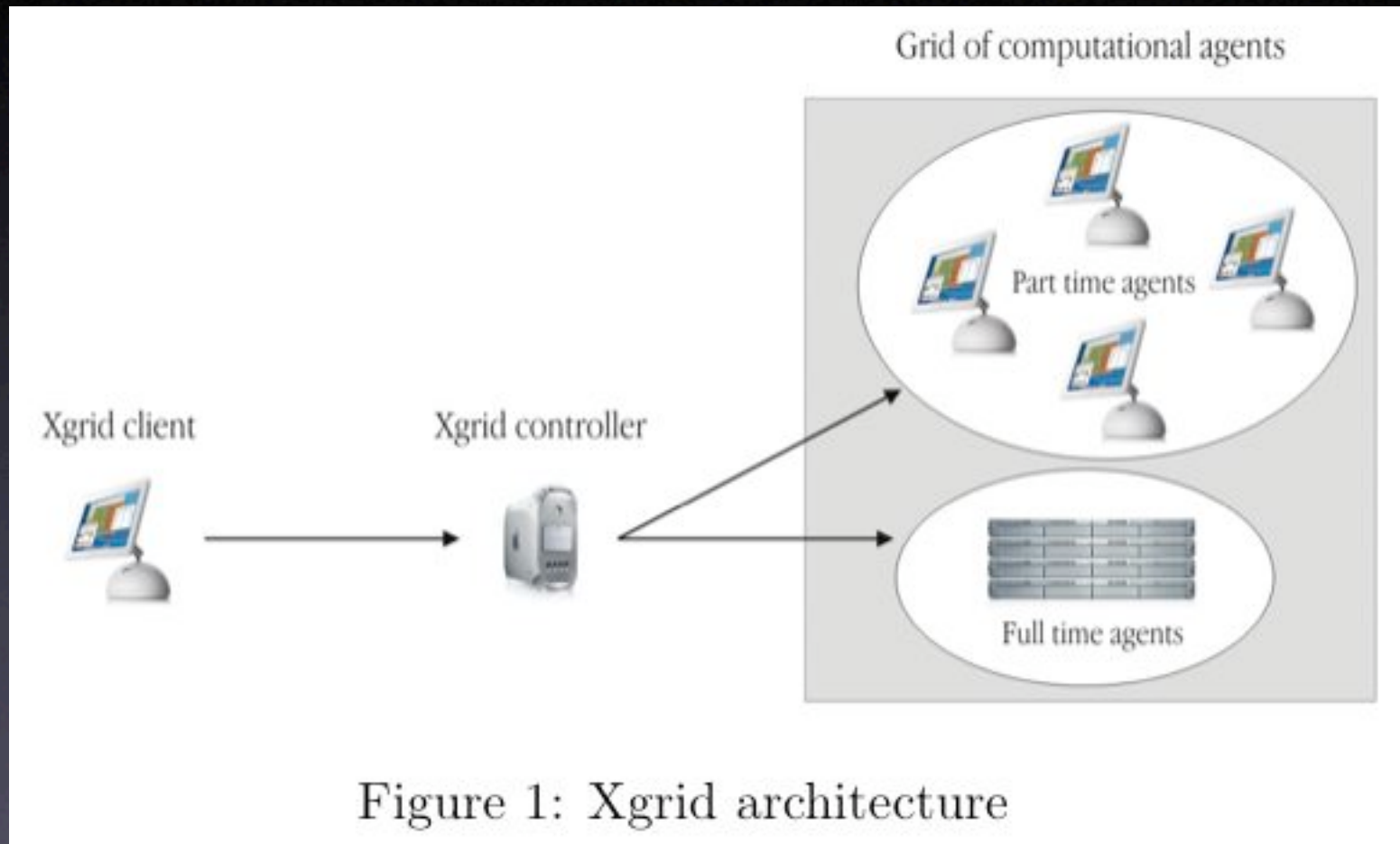


Figure 1: Xgrid architecture



GUI components

Client



Xgrid.app

Controller



System
Preferences

Agent



System
Preferences



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The Client

- /Applications/Xgrid.app
- Has local mode (for demo/testing)
- Asks user for password (for controller)
- Submits jobs
- Receives results from jobs
- Can create custom jobs called "Plugins"



The Controller

- Controller process is located at /Library/StartupItems/GridServer/GridServer
- One controller per “grid”
- As many “grids” as you want per subnet
- Listens on port 4111 & other non-privileged ports
- Broadcasts via Rendezvous
- Can give passwords to agents
- Can require password from client



The Agent

- Agent process is located at /Library/StartupItems/GridAgent/GridAgent
- Contacts controller using
 - Rendezvous
 - Static IP
- Can be many agents, located anywhere
- Requires a password from Controller
 - Does not give password to controller
- Full time, 15 minutes idle, or Xgrid screensaver



Installing Xgrid

- Run the Installer
 - GUI or command line version
- Installs these:
 - `/Applications/Xgrid BLAST.app`
 - `/Applications/Xgrid.app`
 - `/Library/Application Support/Xgrid`
 - `/Library/PreferencePanes/Xgrid.prefPane`
 - `/Library/Screen Savers/Xgrid.saver`
 - `/Library/StartupItems/GridAgent`
 - `/Library/StartupItems/GridServer`
 - `/Library/Xgrid`

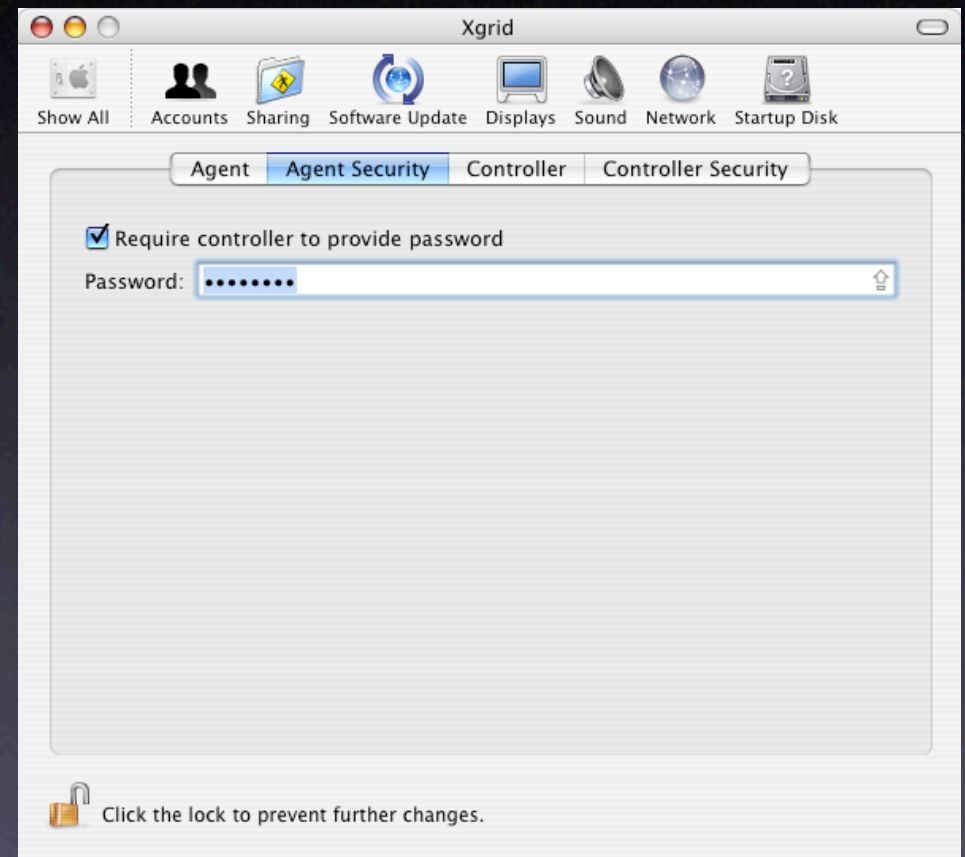
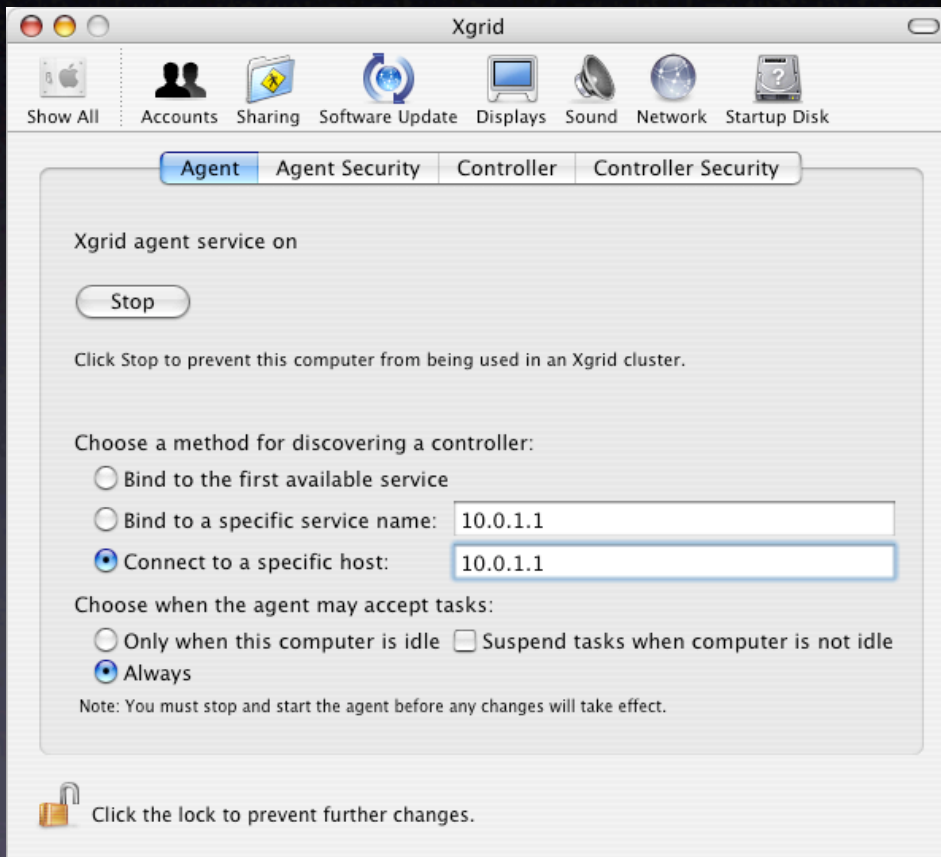


Setup Agent

- Open System Preferences
 - Xgrid prefpane, “Agent” tab
- Tell it where to find the controller
- Specify when to run
 - Always/idle (screensaver or 15 mins)
- Type password in “Agent Security”
- Click “Start” button



Setup Agent



Setup Agent

- Creates/modifies these files:

`/Library/Preferences/com.apple.xgrid.agent.plist`
`/Library/Xgrid/Agent/controller-password`
`/private/etc/hostconfig`

- These can be copied to all agents

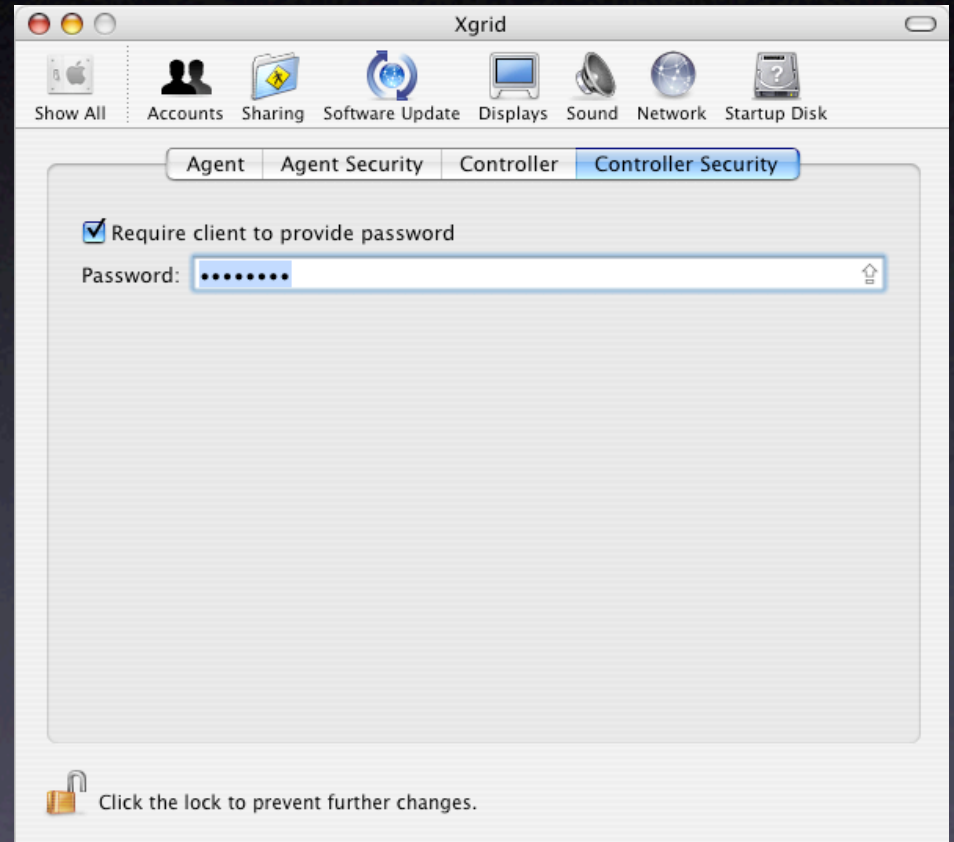
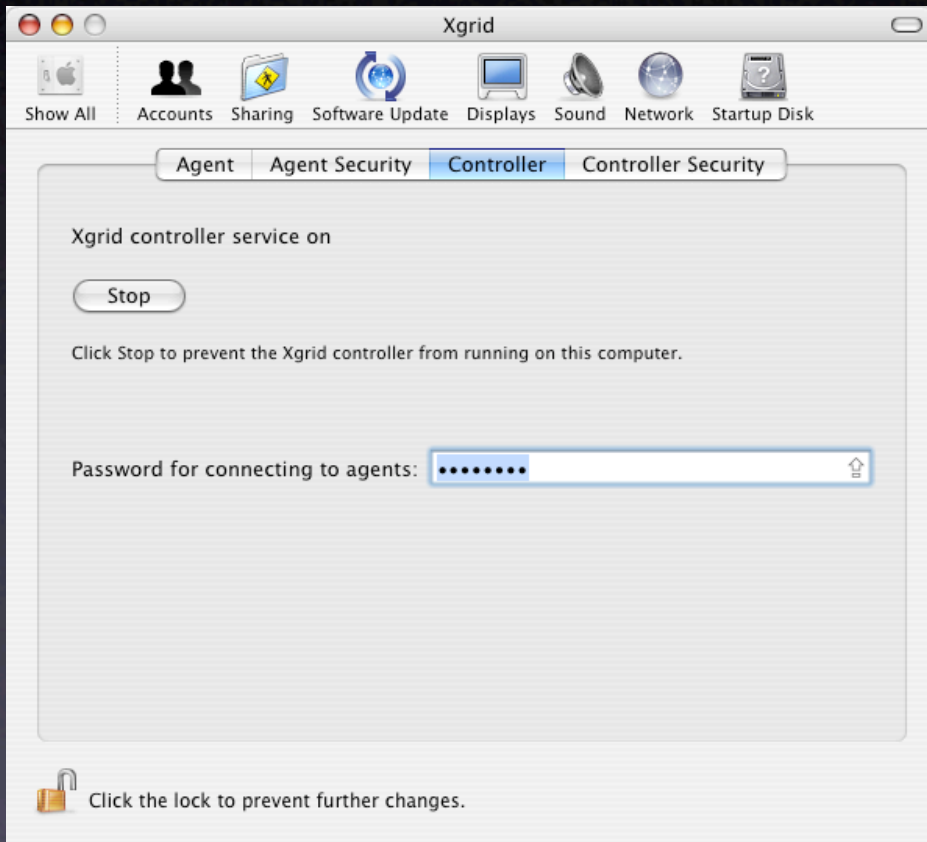


Setup Controller

- Open System Preferences
 - Xgrid prefpane, “Controller” tab
- Enter agent password
- Enter client password in “Controller Security”
- Click “Start” button

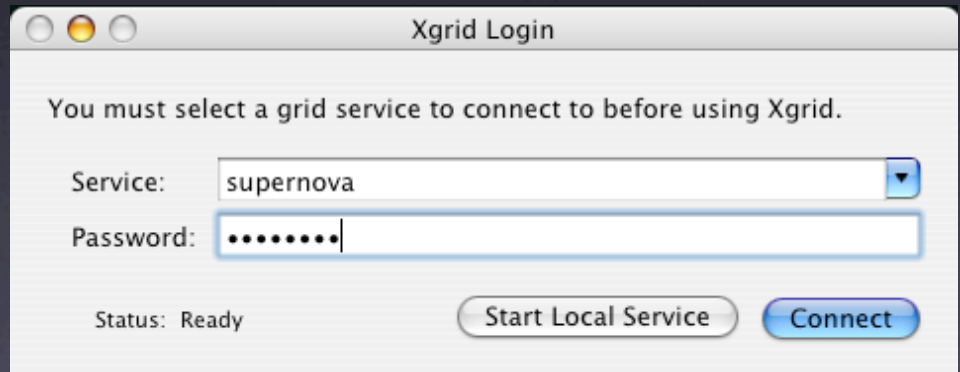


Setup Controller

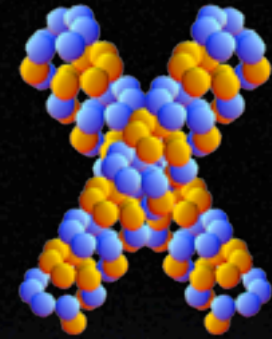


Using the Client

- Open /Applications/Xgrid.app
or /Applications/Xgrid BLAST.app
- Specify controller
 - IP
 - Rendezvous
- Enter password



Xgrid BLAST



Xgrid BLAST Jobs

0 jobs | 4 of 9 nodes available

Job name	Status	Query name	Database	Results	CPU power
----------	--------	------------	----------	---------	-----------

Node List:

- james_test_box-7 (467 MHz) Offline
- supernova (2x2.0 GHz) Offline
- james_test_box-5 (400 MHz) Available
- mscmac-3 (400 MHz) Offline
- james_test_box-3 (400 MHz) Offline
- james_test_box-1 (400 MHz) Available

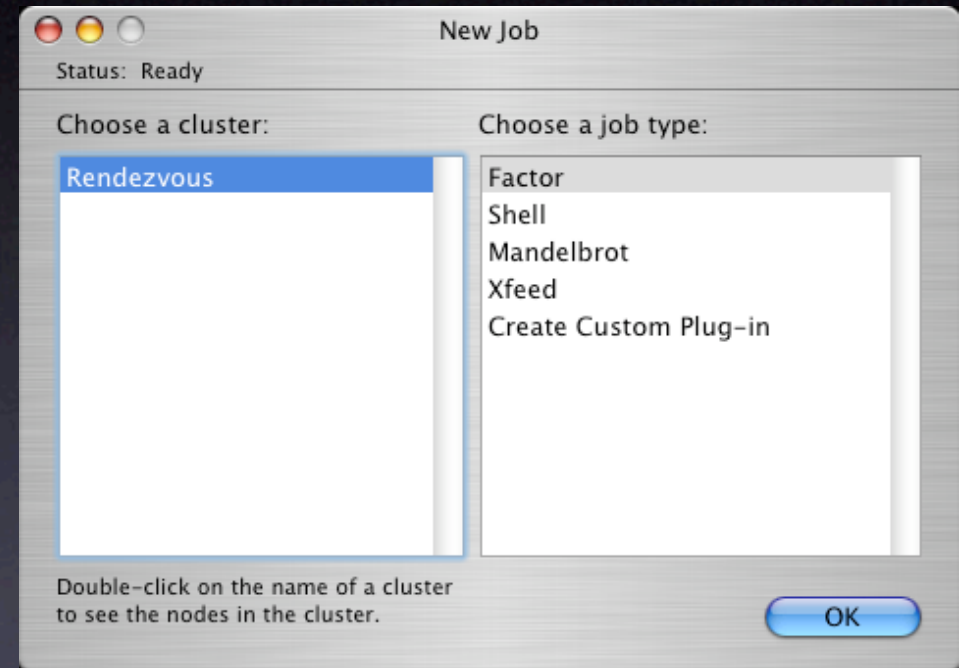
Summary:

- Total: 9 nodes (7.27 GHz)
- Working: 0 nodes (0 Hz)
- Available: 4 nodes (1.6 GHz)

Xgrid.app



- Xgrid Plugins
 - Factor
 - Shell
 - Mandelbrot
 - Xfeed
 - Create Custom Plug-in



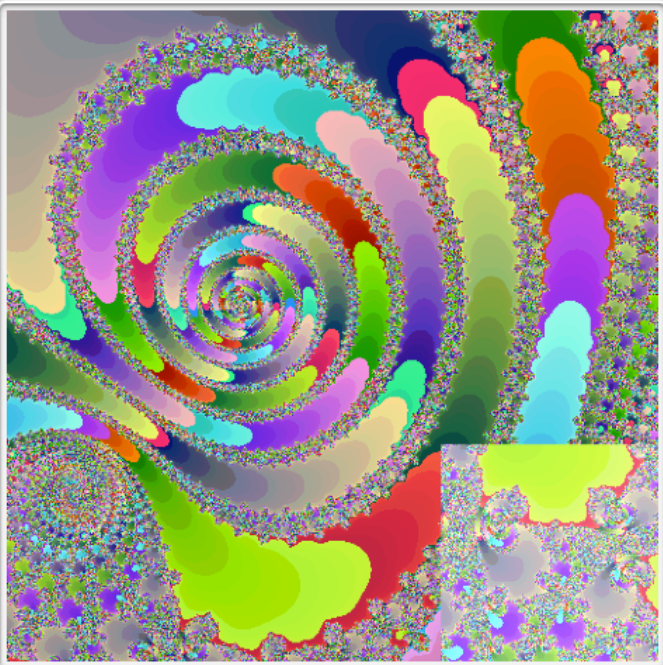
Mandelbrot

Mandelbrot - Untitled

Status: Job finishing

Current image

X: -0.7531399411113378
Y: -0.04450450548664531
Width: 1.484754897815692e-06



The Mandelbrot job type allows you to specify a region of the Mandelbrot set to plot.

Show help

Automatic tour

The automatic tour zooms the image along preset paths.

Stop

Next image

Click and drag on the image to select a portion to zoom in on.

X: -0.7531399411113378
Y: -0.04450450548664531
Width: 1.484754897815692e-06

Use Altivec if available

Show image

<<

Time to calculate image:
11.159 seconds



Shell

- `pwd`
- `scutil --get LocalHostName`
- `ping www.apple.com`



Shell

The image shows a screenshot of a macOS-style window titled "Shell - Untitled 2". The window has a title bar with three window control buttons (red, yellow, green) on the left and a close button (a small sun icon) on the right. Below the title bar, the status "Status: Job running" is displayed. The main content area is divided into two sections: "Job submission" and "Job results".

Job submission

The Shell job type allows you to enter a command to be executed by the standard system command interpreter. [Show help](#)

Command:

[Submit job](#)

Job results

```
/private/tmp/xgagent.yFd6RNZg
james_test_box-1
```

Overlaid on the bottom right of the Shell window is a "Tachometer" window. It has a title bar with three window control buttons (red, yellow, green) on the left. The tachometer is a circular gauge with a black face and a silver bezel. The needle is red and points to the number 4. The scale is marked from 0 to 8, with "MHz x100" written in the center. Below the gauge, the text "Xgrid CPU Power" is visible. Below the tachometer is a text box containing the text "(Optional) captions and technical notes here."



Custom Plugin

Create Custom Plug-in - Untitled

Status: Ready

Select the combination of command line arguments that describes the command you wish to make a new plug-in for. See the help documents for examples of use. [Show help](#)

New Plug-in Name:

Command: [Choose...](#)

Argument 1: [+](#) [-](#)

Working Dir: [Choose...](#)

Stdin File: [Choose...](#)

Destination: [Choose...](#)

[Submit job](#) [Show results](#) [Create New Plug-in](#)

Make User Editable



List of Agents

- Can't mix 10.2 & 10.3
- Workaround: use a script

Create Custom Plug-in - Untitled

Status: Ready

Select the combination of command line arguments that describes the command you wish to make a new plug-in for. See the help documents for examples of use. [Show help](#)

New Plug-in Name: Make User Editable

Command:

Argument	Type	Value	+	-	☑
Argument 1:	Literal	-c	+	-	<input type="checkbox"/>
Argument 2:	Literal	hostname	+	-	<input checked="" type="checkbox"/>
Argument 3:	Range	From: 1 to: 30 by: <input type="text"/>	+	-	<input checked="" type="checkbox"/>

Working Dir:

Stdin File:

Destination:

Agent CPU speed

Create Custom Plug-in - Untitled 4

Status: Ready

Select the combination of command line arguments that describes the command you wish to make a new plug-in for. See the help documents for examples of use. [Show help](#)

New Plug-in Name: Make User Editable

Command: [Choose...](#)

Argument 1:

Argument 2:

Working Dir: [Choose...](#)

Stdin File: [Choose...](#)

Destination: [Choose...](#)

[Submit job](#) [Show results](#) [Create New Plug-in](#)



Script workaround

```
#!/usr/bin/perl  
  
system "date";  
system "hostname";  
system "system_profiler SPHardwareDataType";  
print "@ARGV\n";  
print "$0\n";  
system "pwd";  
system "ps -awwx | grep perl";  
system "ls -RI";
```



Agent jobs

- What is copied to agents?
 - The “Command”
`/tmp/xgagent.GSI0Z6o4/bin/sh`
 - The “Working Dir”
`/tmp/xgagent.bUDiNL4g`



Client Results

- What is copied back to client?
 - Output streamed to “Destination”
 - ~/Desktop/sh_-c_hostname_1.txt
 - ~/Desktop/sh_-c_hostname_2.txt
 - ~/Desktop/sh_-c_hostname_3.txt
 - ...
 - ~/Desktop/sh_-c_hostname_30.txt
 - “Working Dir” is copied to “Destination”



Getting list of Agents

```
Terminal — tcsh — 82x26
[msmac-9:~/out] james% ls
sh_-c_hostname_1.txt  sh_-c_hostname_14.txt  sh_-c_hostname_5.txt
sh_-c_hostname_10.txt sh_-c_hostname_15.txt  sh_-c_hostname_6.txt
sh_-c_hostname_11.txt sh_-c_hostname_2.txt   sh_-c_hostname_7.txt
sh_-c_hostname_12.txt sh_-c_hostname_3.txt   sh_-c_hostname_8.txt
sh_-c_hostname_13.txt sh_-c_hostname_4.txt   sh_-c_hostname_9.txt
[msmac-9:~/out] james% ../count_agents sh_-c_hostname_
Total Jobs
    15
testbox1.domain.utah.edu
testbox2.domain.utah.edu
testbox4.domain.utah.edu
testbox5.domain.utah.edu
Total Agents
    4
[msmac-9:~/out] james%
```



Getting list of Agents

```
#!/bin/sh
```

```
cat $1*.txt > all_list           # combine all files
sort all_list > sorted_list     # sort the list
uniq sorted_list > small_list   # get rid of duplicates
echo Total Jobs
cat all_list | wc -l
cat small_list
echo Total Agents
cat small_list | wc -l
rm all_list sorted_list small_list
```



Plugin Source code

- On Xgrid.dmg
- Shell.pbproj
 - Executes /bin/sh on agent
 - Client gives /bin/sh an argument
 - 1 job
- Shell Template
 - For Xcode



Plugin Source code

- submitJobWithParameters

```
<dict>
  <key>CommandLineDictionaries</key>
  <array>
    <dict>
      <key>Command</key>
      <string>/bin/sh</string>
      <key>Inputs</key>
      <dict>
        <key>StandardInput</key>
        <data>hostname</data>
      </dict>
    </dict>
  </array>
</dict>
```

Must exist on agents

UTF 8 encoded



Plugin Source code

- /Library/Xgrid/Frameworks/GridPlugs.framework/.../
XgJobViewController.h
 - submitJobWithParameters
 - setJob
 - jobItemDidFinish
 - jobItemDidFail
 - jobItemDidCancel
 - jobItemLatestJobResultsDidArrive
 - updateStatusField



Plugin Source code

- GridPlugs.framework
 - GridPlugs.h
 - XgJobDocumentProtocol.h
 - XgJobPane.h
 - XgJobProtocol.h
 - XgJobViewController.h
 - XgTarWrapper.h



Plugin Source code

- BEEP.framework
 - BEEP.h
 - BEEPChannel.h
 - BEEPError.h
 - BEEPMessage.h
 - BEEPSession.h
 - BEEPSessionAcceptor.h
 - BEEPSessionConnector.h
 - BEEPSSLContext.h



My wishlist

- Command line client/plug-in
 - Would need to be able to authenticate
- Security to prevent a rouge agent from connecting to a controller's grid
- Better reporting of agents on grid
- Finer job control
 - Limiting jobs to a min CPU speed



Campus Resources

- <http://www.netforum.utah.edu>
 - Informal meetings are 3rd Thursday at 3 pm right after ITAC meeting at EBC
- CHPC has some grids...
- Anyone else?



Other resources

- <http://www.apple.com/acg/xgrid/>
- <http://lists.apple.com/mhonarc/xgrid-users/>
- <http://lists.apple.com/mhonarc/xgrid-users/msg00047.html>
- <http://unu.novajo.ca/simple/archives/000022.html>
- <http://www.beepcore.org/beepcore/home.jsp>



Other software

- AppleSeed
 - <http://exodus.physics.ucla.edu/appleseed>
- Pooch
 - <http://daugerresearch.com/pooch>
- Condor
 - <http://www.cs.wisc.edu/condor>
- GridIron XLR8
 - <http://www.gridironsoftware.com>



POV-Ray

- Persistence of Vision Raytracer
 - High quality
 - Free
 - Source code available
- Mac OS X GUI version
 - <http://mac.povray.org>
- Mac OS X command line version
 - DarwinPorts





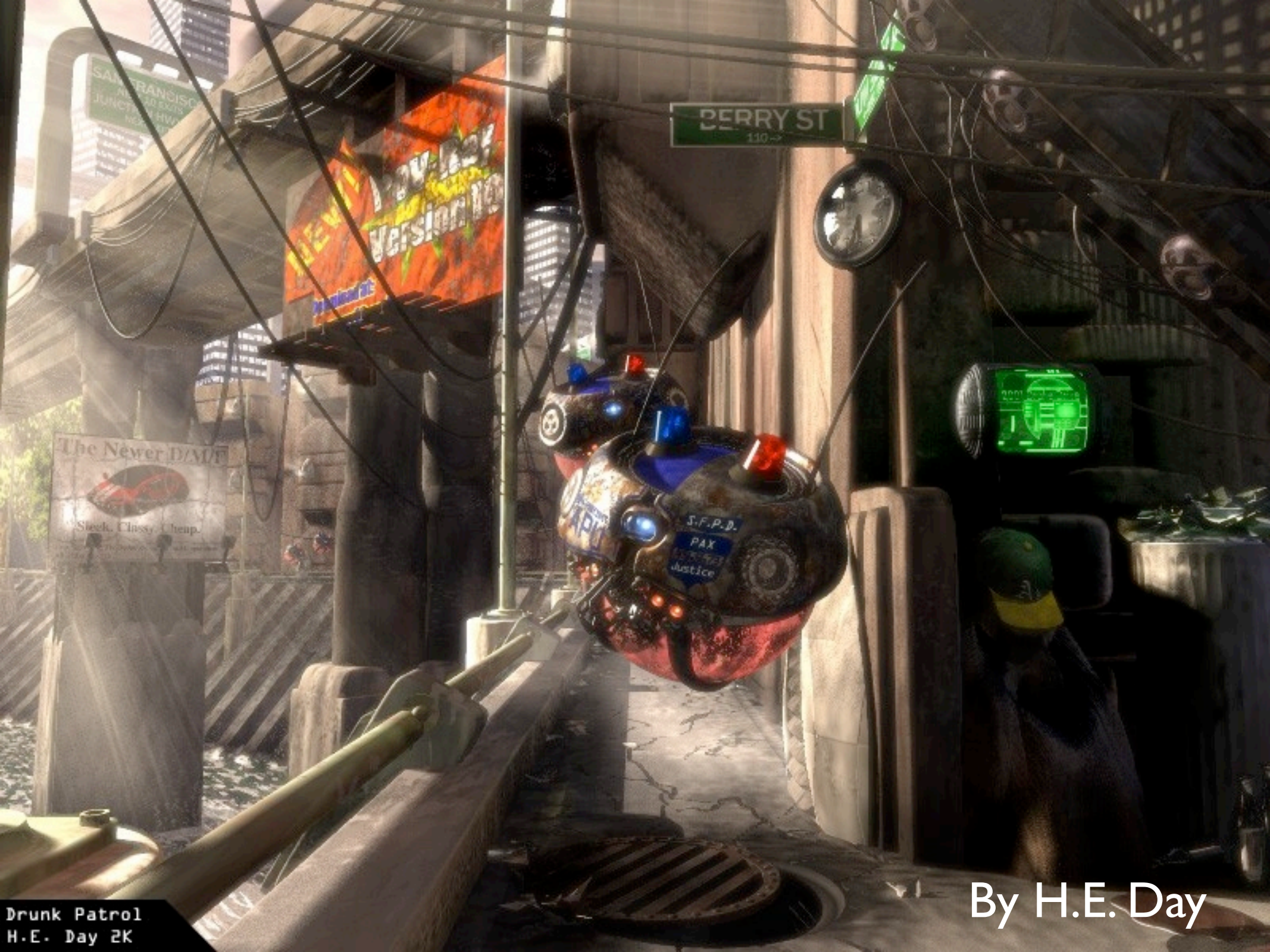
By William
Fawcett



By Norbert Kern



By Tom Aust



Installing POV-Ray

- Install Dev tools
- Install DarwinPorts

```
cvs -d :pserver:anonymous@anoncvs.opendarwin.org:/Volumes/src/cvs/od login
```

```
cvs -d :pserver:anonymous@anoncvs.opendarwin.org:/Volumes/src/cvs/od co -P darwinports
```

- Install POV-Ray

```
sudo port install povray
```



Installing POV-Ray

- Must install these libraries
 - libjpeg
 - libpng
 - libtiff
 - X11
- DarwinPorts installs them all for you



Installing POV-Ray

- These library files:
 - `/opt/local/lib/libjpeg.62.0.0.dylib`
 - `/opt/local/lib/libpng.3.1.2.5.dylig`
 - `/opt/local/lib/libtiff.3.6.1.dylib`
 - `/usr/X11R6/lib/libX11.6.2.dylib`
- These soft links
 - `/opt/local/lib/libjpeg.62.dylib`
 - `/opt/local/lib/libpng.3.dylib`
 - `/usr/X11R6/lib/libX11.6.dylib`



Installing POV-Ray

- Required POV-Ray files

`/opt/local/bin/povray`

`/opt/local/etc/povray.conf`

`/opt/local/etc/povray.ini`



Installing POV-Ray

- These files were installed on all of the agents
- Maybe possible to compile POV-Ray to look in /tmp/xgrid.... for libraries and config files?



Local Speed Test

- Benchmark sample is installed at `/opt/local/share/povray-3.5/scenes/advanced/benchmark.pov`
- Requires an “inc” file located in `/opt/local/share/povray-3.5/include`



Local Speed Test

- On my local box:
`/opt/local/bin/povray`
`-w384 -h384 +a0.3 +v -d -f -x`
`+L/path/to/povray-3.5/include/`
`+I/path/to/benchmark.pov`
- G5 dual 2.0 GHz, 1 GB RAM
- Total time: 36.5 mins (1 CPU)





Grid Speed Test

- Borrowed heavily from
 - <http://unu.novajo.ca/simple/archives/000024.html>
 - <http://astronomy.swin.edu.au/~pbourke/povray/parallel/>

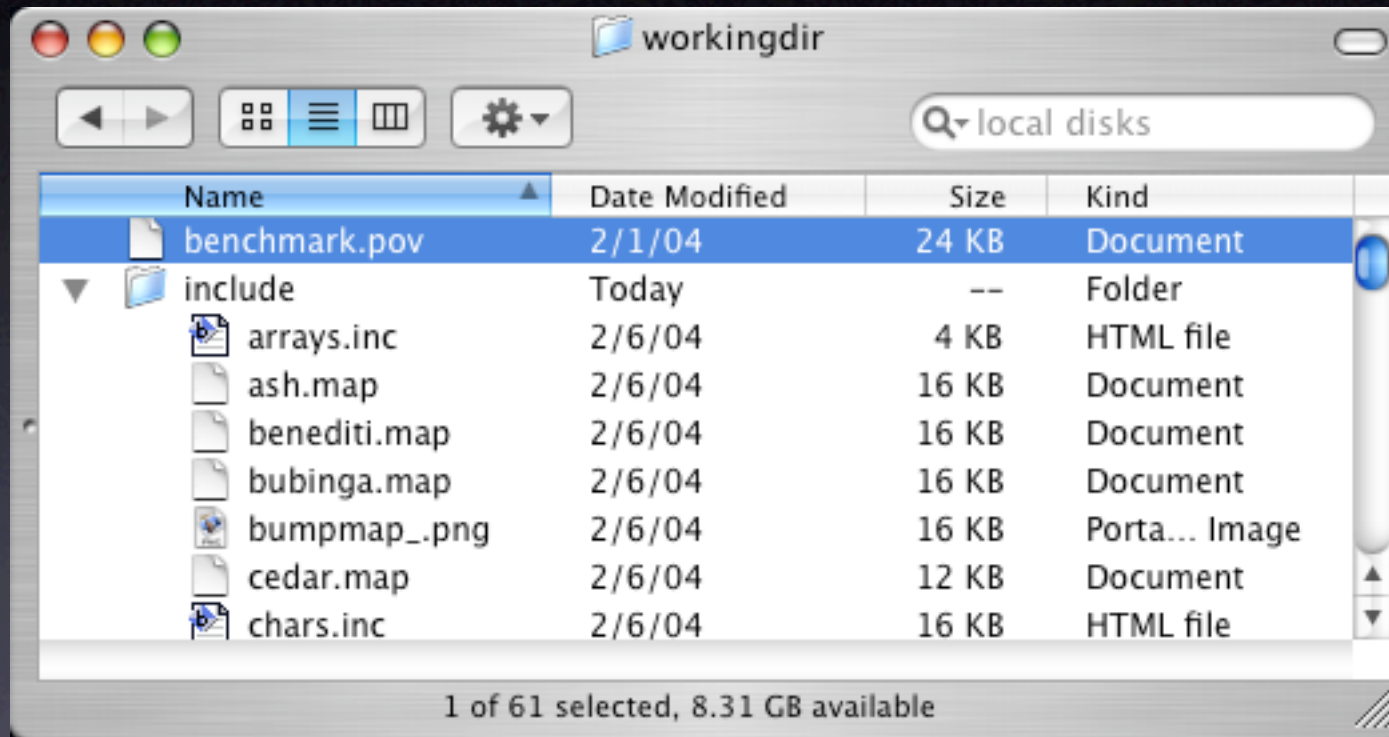


Grid Speed Test

- Create a job folder with pov and inc files
- Create ini files to give POV-Ray
 - Modified version of Daniel Côté's "generate" script
 - Use this as the arguments
- Create command to execute POV-Ray
- Create custom Xgrid plug-in



Grid Speed Test



Grid Speed Test

- Simplified “generate” script

```
#!/usr/bin/perl
```

```
$arguments = “-w384 -h384 +a0.3 +v -d -f -x +Linclude  
+lbenchmark.pov”
```

```
$slice = 384 / 48; #height/totaljobs
```

```
for ($i = 0 ; $i < 48 ; $i++) {
```

```
    $start = $i * $slice+1;
```

```
    $end = ($i +1 ) * $slice;
```

```
    $ini_file =”$arguments +SR$start +ER$end ...”;
```

```
    # save ini_file to a file
```

```
}
```



Grid Speed Test

- Custom “command” script

```
#!/usr/bin/perl
```

```
system "date";
```

```
system "/opt/local/bin/povray @ARGV";
```

```
system "date";
```



Grid Speed Test

Create Custom Plug-in - Untitled

Status: Ready

Select the combination of command line arguments that describes the command you wish to make a new plug-in for. See the help documents for examples of use. Show help

New Plug-in Name: Make User Editable

Command: Choose...

Argument 1:

Working Dir: Choose...

Stdin File: Choose...

Destination: Choose...

Submit job Show results Create New Plug-in



Grid Speed Test

- 22 agents
 - G4/400's (1 G4/466)
 - 192 - 576 MB RAM
 - 18 agents did 2 jobs
 - 4 agents did 3 jobs
 - About 26 minutes



Grid Speed Test

- 24 agents (23 computers, but 24 CPU's)
 - Dual G5 2.0 GHz w/ 1 GB RAM
 - 6 agents did 1 job
 - 16 agents did 2 jobs
 - G5 did 10 jobs, idle last 13 minutes
 - G5 jobs 1.5 to 3 minutes
 - G4 jobs 6.5 to 15 minutes
 - About 24 minutes (2x12 min jobs)



Why was the G5 idle

- Job 1 - Agent1 (g5) 1 minute
- Job 2 - Agent2 (g4) 5.5 minutes
- Job 3 - Agent1 (g5) 1 minute
- Job 4 - Agent1 (g5) 1 minute
- Job 5 - Agent1 (g5) 1 minute
- Job 6 - Agent1 (g5) 1 minute
- Job 7 - Agent1 (g5) 1 minute
- Job 8 - Agent2 (g4) 5.5 minutes (g5 idle)
- Total time: 11 minutes



Grid Speed Test

- Longest idle equals longest job
 - Long jobs bad, short jobs good
 - Each job must parse and scan, which is wasted time (long job is good here)
- How to make faster
 - Change number of jobs
 - Number ini files so that G5 gets most complex (takes longest time) slices



Grid Speed Test

- Post work
 - Paul Bourke's combineppm
 - Files: file_0001.ppm file_0002.ppm
 - combineppm file > file.ppm
 - Open file.ppm in Graphic Converter
 - Save as whatever



Other hints

- Always verify a job is going to do what you want by running one job locally
 - Use a low resolution or blockly output
 - to speed up render
- 251 max jobs because of file descriptors



Easy POV-Ray files

- MacBrickCad
 - LDraw tool
 - L3P - convert LDRAW to POV-Ray
- Quicktime
 - Movies
 - QTVR

