



VIS 2002

Managing and Using Scalable Display Walls

Grant Wallace

Princeton University Display Wall

Original and Current Display Wall



Same Room
Same Screen

1998 Display Wall
8 Projectors

2000 Display Wall
24 Projectors



Display Wall Room



- Rear Projection Jenmar screen
- Seating for audience



- Control console
- Student workstations

Display Wall Management Goals



- Automatic Projector Alignment
- Centralized Control
 - Projectors
 - Computers
 - Applications
- Centralized Data
 - Easy application upgrades
 - Rights and Privileges
 - Disaster Recovery
- Configuration
 - Interchangeable Hardware
 - Configuration files
 - Application adherence

Display Wall User Goals



- Easy to learn how to use.
- Common tasks are simple and fast to perform.
- Wide accessibility and availability.

8 Projector Display Wall (1998)



- 8 Proxima projectors
- 8 Pentium II workstations
- Intergraph graphics cards
- Myrinet & 100Mb Ethernet
- Windows NT



Workshop

Possible Management Tools



	Windows	Linux
OS Install	Drive Image	System Imager
App Install/Upgrade	Deploy Center (\$500)	System Imager
Process Management	JobcoNTrol (\$2500) NT Resource Kit	C3 (cluster command control) Smile
Keyboard/Mouse	VNC or KVM switch	VNC, x2x or KVM switch
Mapping File shares	Command line	Command line
Projectors	?	?
Common Apps	?	?

Managing 8 Node Display Wall



- Manual alignment of projectors ~1 hour per week of effort, 1-2 pixel accuracy.
- OS and driver upgrades done individually on each PC
- Process control
 - Server running on each node to Start/Stop applications.
 - NT Resource Kit commands (rsh, tlist, shutdown)
 - KVM for Hung applications and dialog boxes
- Hardware failures – order replacement parts
- Centralized fileserver – Raid 5



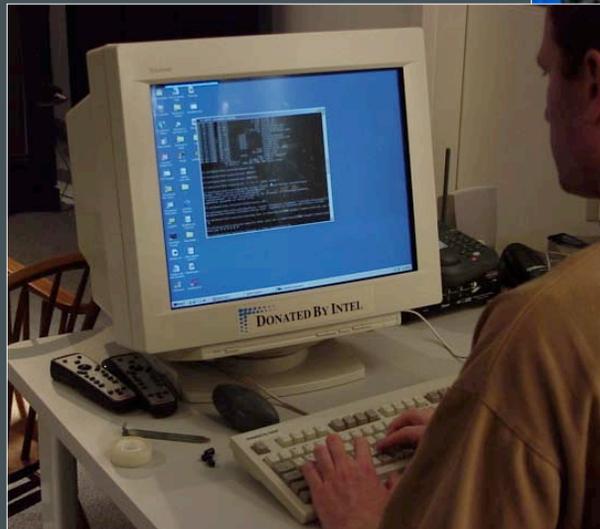
Using 8 Node Display Wall



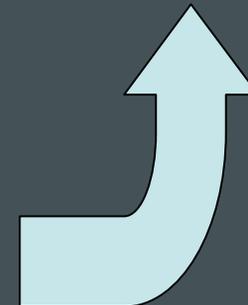
Turn on Projectors



Here is your image



Type in commands



Some Lessons



- The simpler things are, the more people can and will use them
 - Command line is harder to learn and use than GUI
 - What directory are things located in?
 - What programs do I need to run?
 - What order do I run them in?
 - What are the arguments to the scripts/apps?
 - Remote control
 - Where is it?
 - Batteries are dead
 - Inadvertently bump projectors, change settings

Some More Lessons



- Things should be configurable from a file
 - Hardware replacement
 - File system changes
 - Application upgrades
- Research systems evolve quickly
 - Continual code development/revision
 - Configurations change – keep global config files
 - Need development and release directories
- Raid hardware isn't foolproof – school of hard knocks

A New Display Wall Is Born



Complexity is increasing



Organization



Configuration



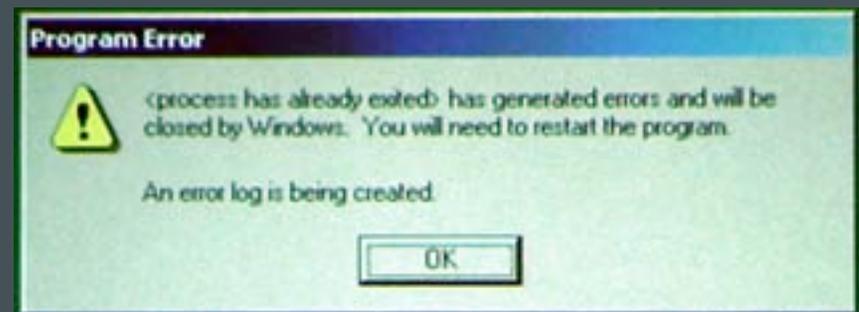
Repeating a task 24 times is tedious



Fun with “OK” Boxes



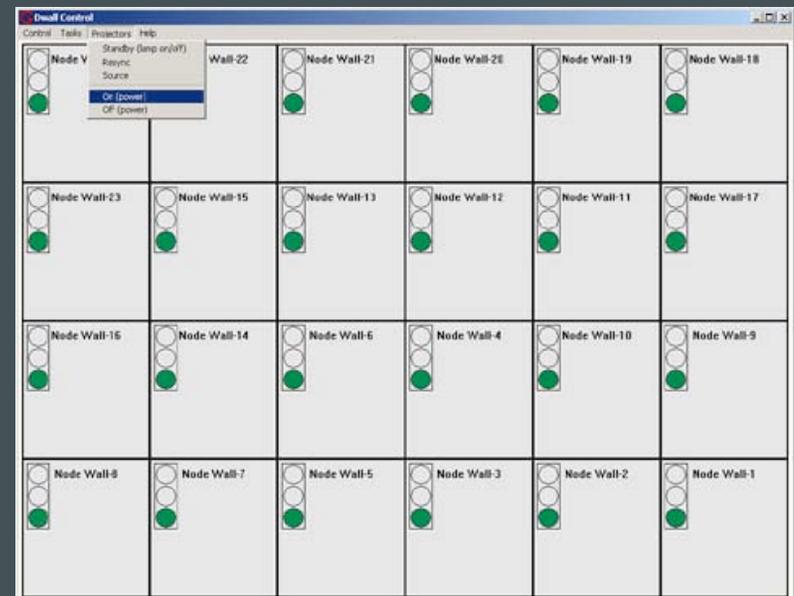
Please click “OK” 24 times



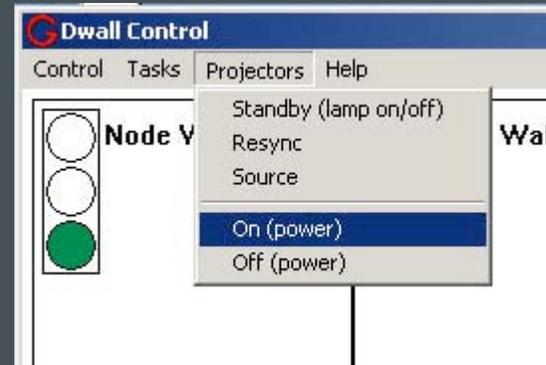
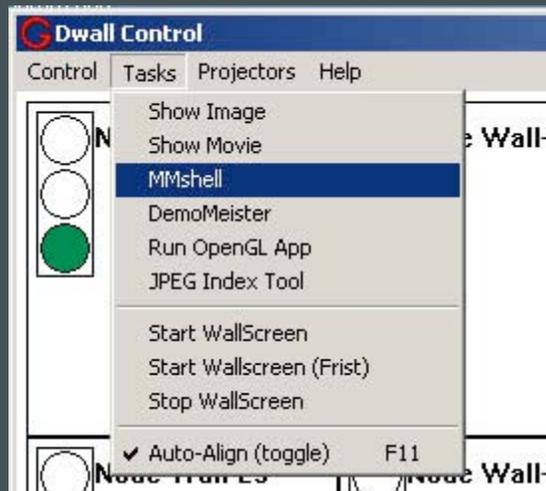
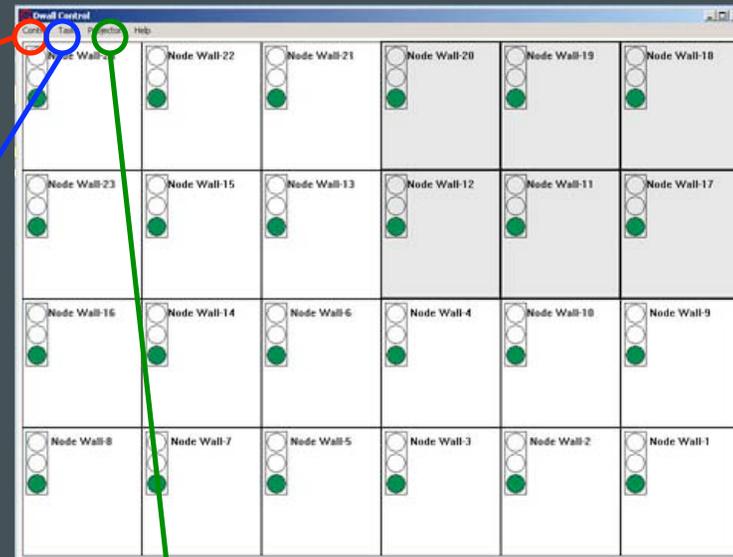
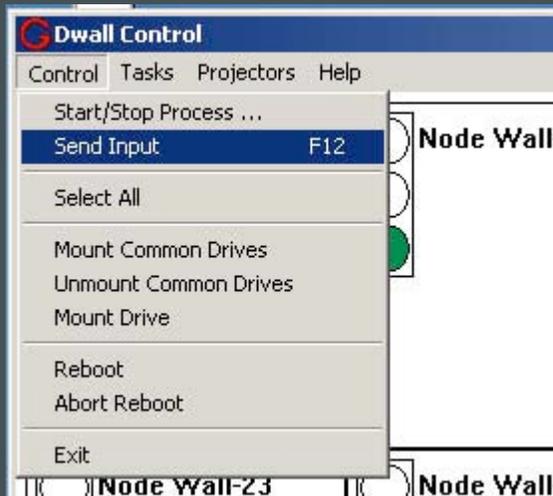
Centralized Display Wall Control



- A GUI to control the Display Wall (DwallGui)
 - Select all or subset of nodes
 - Control Projectors
 - Run Common Applications
 - Mount Network File Systems
 - Manage Processes
 - Send Mouse/Keyboard Input
 - Reboot
 - Configurable from a file



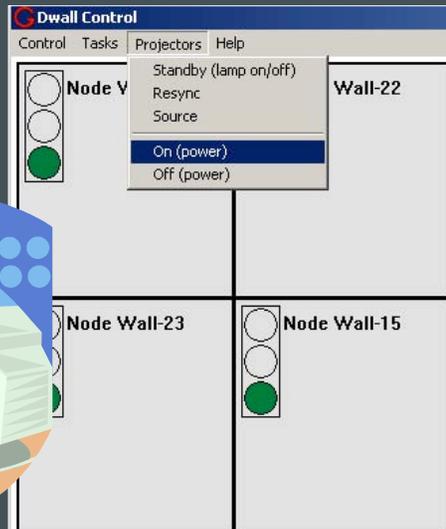
The Menus of DwallGui



Running the Display Wall using DwallGUI

Grant Wallace
Princeton University

Projector Control



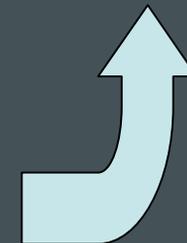
User selects projector
"on" from menu



Multiplexer
selects projector



IR emitter transmits
signal to projector



IR Linc duplicates
remote control signal

DwallGui Configuration File



[HDW_CONFIG_FILE]

\displaywall\release\config\screen24.cfg

[COMMON_MENU_TASKS]

number = 7

Show Image | \displaywall\bin\imgctrl.exe show

MMShell | \displaywall\bin\mmshell.exe

DemoMeister | \displaywall\bin\DemoMeister.exe

JPEG Tool|\displaywall\bin\imview\mmsview.exe

-

Start Wallscreen|\displaywall\bin\imview.exe

Stop Wallscreen|\displaywall\bin\imgctrl.exe kill

[HELP_DOCS]

\displaywall\doc\help\contents.html

[MOUNT_DRIVES]

number = 5

W | \\wallfs\displaywall

U | \\wallfs\cs495s02

T | \\wallfs\cs495f01

S | \\wallfs\cs495s01

R | \\wallfs\cs495f00

[COMMON_PROCESSES]

number = 2

w:\release\bin\server\align\align.exe

w:\release\bin\server\imview\imview -f -m

[SOUND_SERVER]

sound.cs.princeton.edu

Hardware Management



- Projector Alignment
- Swappable Spares
- Data Backup



Workshop on Commodity-Based Visualization Clusters

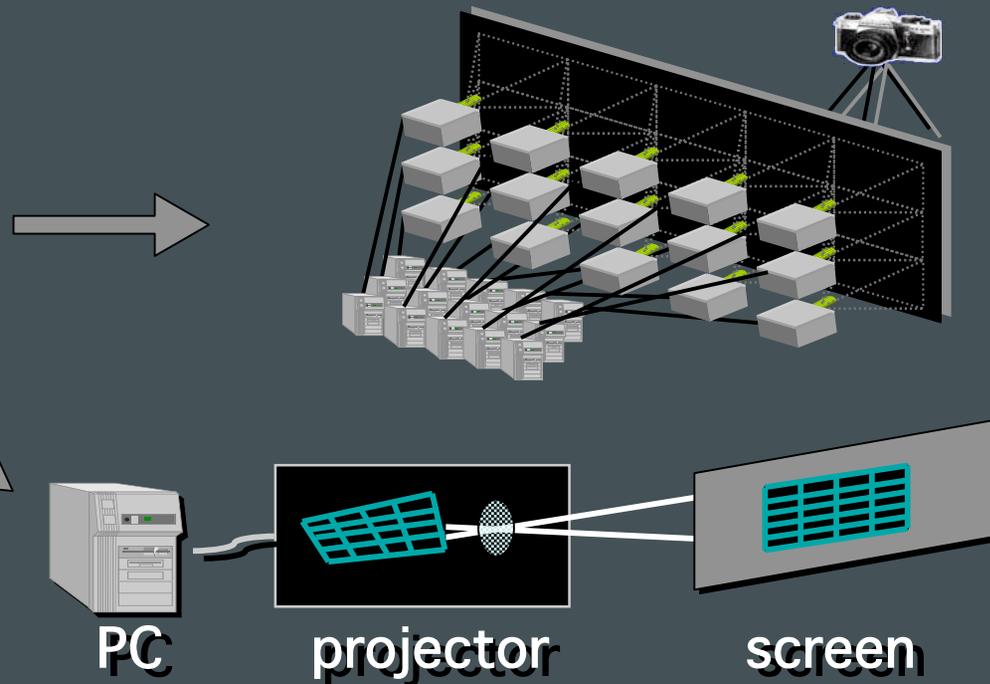
Projector Alignment



- Scalable automatic approach is needed
 - Initial alignment takes 2 people 6 hours to complete (2-3 pixel average error)
 - Periodic realignment by a single person can take over 2 hours.
- Camera Homography Tree Algorithm

Stages:

1. Capture
2. Optimization
3. Warping



Spare Hardware



- As system scales component failure more likely
 - Have components ready to swap
 - Should be easily configured into system
 - Configuration file
- ```
Projector:
HostName=[Wall-24]
Row=[0]
Col=[0]
Corners=[-26 -6 1023 13 1036 772 10 780]
```



# Data Backups



- Display Walls generate lots of data
- Too expensive for department tape storage (\$30,000)
- Backup Scheme
  - 6 Disks on a Promise Raid card  
Raid 1+0 (main data here)
  - 6 Disks on a 3ware Raid card  
2 stripe sets (backup volumes)
  - Every night backup to an alternate stripe set
  - Gives us 4 copies of data on 2 hardware platforms.
- Fileserver on UPS - Important

UPS



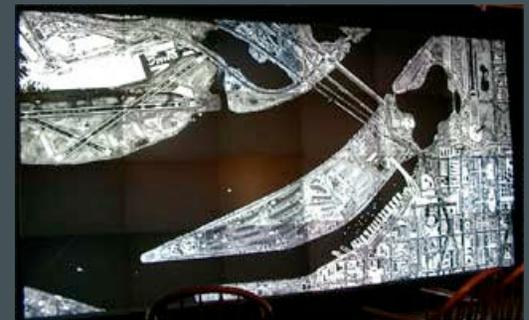
Fileserver

# Comparison of Management and Use



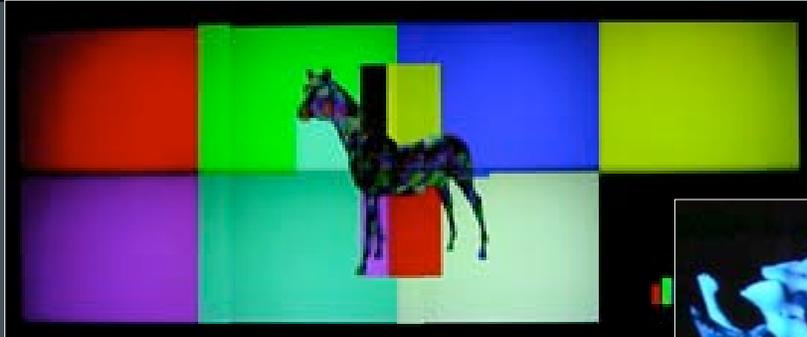
|                   | 8 Projectors                                         | 24 Projectors                                                                                   |
|-------------------|------------------------------------------------------|-------------------------------------------------------------------------------------------------|
| <b>Using</b>      | Command Line                                         | Centralized Control GUI<br>(Projector Computer Apps Data)                                       |
| <b>Projectors</b> | Manual Alignment<br>Remote Control                   | Automatic Alignment<br>Computer Control                                                         |
| <b>Software</b>   | Disk Imager<br>Individually Upgrade                  | Disk Imager<br>GUI Upgrade                                                                      |
| <b>Data</b>       | Centralized Fileserver<br>RAID 5<br>Universal access | Centralized Fileserver<br>RAID 1+0 multi-hardware<br>User Accounts<br>/dev /release directories |
| <b>Hardware</b>   | Fix as needed<br>Config distributed or hard<br>coded | Backups on hand<br>4 Projectors, 2 Computers<br>Centralized Config File                         |

# Questions?



*Workshop on Commodity-Based Visualization Clusters*

# Display Wall Serves Many Purposes



Research

Data  
Visualization



Demonstrations



Architectural Walkthrough

Teaching

