

Computational Science Portals: Grid Portal Toolkit (GridPort)

Mary Thomas

Computational Science Portals Group

San Diego Supercomputer Center

University of California at San Diego

Presented at

CERN

Geneva, Switzerland

Outline

- Introduction/Background/Motivation
- The GridPort Toolkit
- GridPort-Based Portals
 - HotPage
 - Other application Portals
- Web Services based portals
- Future Work

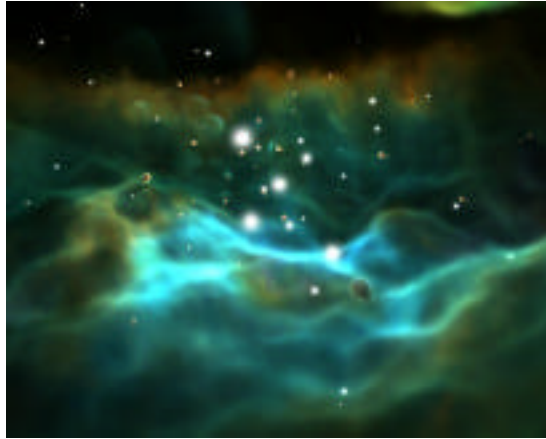
A National Laboratory for Computational Science and Engineering

Leading-Edge Site for NSF/NPACI

GRIDPORT

NPACI

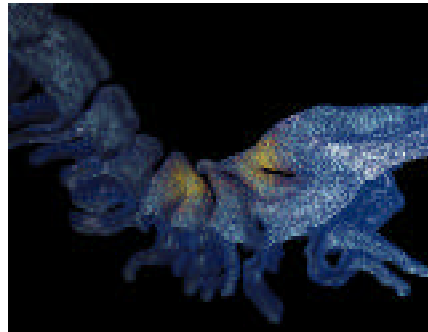
Broad-based Impact



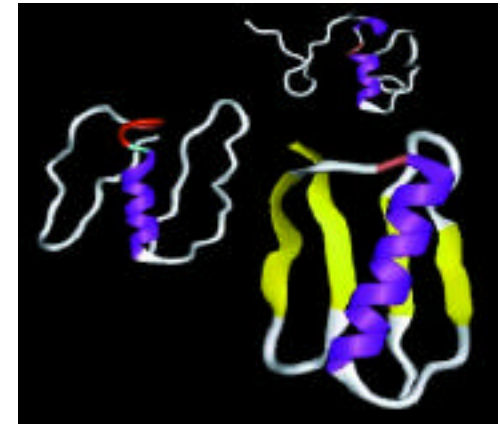
Viewing the Orion Nebula
Developed for Hayden Planetarium
American Museum of Natural History
using NPACI Scalable Volume
Visualization Tools



Distributing
Large-scale
calculations of
CHARMM
Using Legion



Developing scalable
simulation
infrastructure to
enable breakthrough
science



| Job Name | Status | Queue | Start | End | Elapsed | Exit Code |
|----------|-----------|-------|------------------|------------------|---------|-----------|
| job001 | Completed | batch | 2008-01-15 11:00 | 2008-01-15 11:00 | 00:00 | 0 |
| job002 | Completed | batch | 2008-01-15 11:00 | 2008-01-15 11:00 | 00:00 | 0 |
| job003 | Completed | batch | 2008-01-15 11:00 | 2008-01-15 11:00 | 00:00 | 0 |
| job004 | Completed | batch | 2008-01-15 11:00 | 2008-01-15 11:00 | 00:00 | 0 |
| job005 | Completed | batch | 2008-01-15 11:00 | 2008-01-15 11:00 | 00:00 | 0 |
| job006 | Completed | batch | 2008-01-15 11:00 | 2008-01-15 11:00 | 00:00 | 0 |
| job007 | Completed | batch | 2008-01-15 11:00 | 2008-01-15 11:00 | 00:00 | 0 |
| job008 | Completed | batch | 2008-01-15 11:00 | 2008-01-15 11:00 | 00:00 | 0 |
| job009 | Completed | batch | 2008-01-15 11:00 | 2008-01-15 11:00 | 00:00 | 0 |
| job010 | Completed | batch | 2008-01-15 11:00 | 2008-01-15 11:00 | 00:00 | 0 |

Increasing access through
the GridPort Toolkit and
Genie Portal

SAN DIEGO SUPERCOMPUTER CENTER COMPUTATIONAL RESOURCES

SUPERCOMPUTERS



BLUE HORIZON
10M SP POWER*
24 processors, 16 GB memory
1.5M GB peak speed

CRAY T3E
1M processor, 2 GB memory
1 GB optical peak speed

SUN SP6000
16 processors, 16 GB memory
3.2M optical peak speed

CRAY T3E
16 processors, 2 GB memory
1.2M optical peak speed

CRAY T3E
24 processors, 2 GB memory
1.2M optical peak speed

RESEARCH SYSTEMS

3 SUN SP6000
16 processors, 2 GB memory
1.2M GB

200 SP
1.2M GB

SUN SP6000
16 processors, 2 GB memory
2M GB

SUN SP6000
24 processors, 2 GB memory
2M GB

SUN SP6000
24 processors, 2 GB memory
2M GB

SUN SP6000
24 processors, 2 GB memory
2M GB

SUN SP6000
24 processors, 2 GB memory
2M GB

NPACI RESOURCE PARTNERS

PRODUCTION SYSTEMS

CRAY T3E
16 processors, 2 GB memory
1.2M optical peak speed
University of Texas

10M SP POWER*
24 processors, 16 GB memory
1.5M optical peak speed
University of Texas

10M SP POWER*
24 processors, 16 GB memory
1.5M optical peak speed
University of Illinois

10M SP POWER*
24 processors, 16 GB memory
1.5M optical peak speed
University of Michigan

RESEARCH CLUSTERS

CRAY T3E
16 processors, 2 GB memory
1.2M optical peak speed
UC Berkeley

CRAY T3E
16 processors, 2 GB memory
1.2M optical peak speed
UC Berkeley

CRAY T3E
16 processors, 2 GB memory
1.2M optical peak speed
UC Berkeley

CRAY T3E
16 processors, 2 GB memory
1.2M optical peak speed
UC Berkeley

VISUALIZATION

INFORMATION REPOSITORY

360 DESIGN 2000
2 processors

360 DESK 1000
4 processors

360 DESK 1000
4 processors

360 DESK 1000
4 processors

HPSS
(High Performance Storage System)

10M SP*
24 processors
16 GB memory
1.5M optical peak speed

2-CRIP 3000
3 processors

360 DESK 1000
4 processors

360 DESK 1000
4 processors

360 DESK 1000
4 processors

360 DESK 1000
4 processors

360 DESK 1000
4 processors

360 DESK 1000
4 processors

3 STORAGE FOR 5000 TAPES
1000 tapes
1000 tapes
1000 tapes

360 MPPA SERVER 4500
4 processors, 16 GB memory
1.5M optical peak speed

SUN SP6000
16 processors, 2 GB memory
1.2M optical peak speed

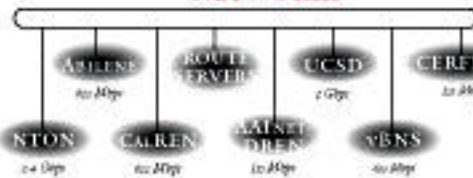
AASPACE
16 processors, 2 GB memory
1.2M optical peak speed

CRAY T3E
16 processors, 2 GB memory
1.2M optical peak speed

SUN SP6000
16 processors, 2 GB memory
1.2M optical peak speed

10M SP POWER*
24 processors, 16 GB memory
1.5M optical peak speed

NETWORKS



ALTERNATE ARCHITECTURE SYSTEMS

HP 2200
16 processors, 2 GB memory
1.2M optical peak speed
Caltech

HP 2200*
24 processors, 16 GB memory
1.5M optical peak speed
Caltech

MASS STORAGE SYSTEMS

HPSS
16 processors, 2 GB memory
1.2M optical peak speed
Caltech

DNF
16 processors, 2 GB memory
1.2M optical peak speed
University of Texas

ADAM
16 processors, 2 GB memory
1.2M optical peak speed
University of Michigan

Abbreviations:

SP6K: very high performance EndBox Network Service
Mbps: megabits (billions of bits) per second
Gbps: gigabits (billions of bits) per second
GB: gigabytes
GOPS: billions of floating point operations per second
TB: terabytes (2,000 gigabytes)

NOTES:
* WHEN FULLY CONFIGURED IN 2000
* TB PERKINET NET IN 2000

Portals for Computational Science

- Computational science environment is complex:
 - Users now have access to a variety of distributed resources (compute, storage, etc.).
 - Interfaces to these resources vary and change often
 - Policies at sites sometimes differ
 - Using multiple resources can be cumbersome
- Portals can provide simple interfaces
 - Portals are web based and that has advantages -
 - Users know & understand the web
 - Interface to middle-tier infrastructure of the Grid
 - Users can be isolated from resource specific details
 - Uniform interface isolates system changes/differences
 - Not an end-all solution
 - But good for community models, small projects, etc.

The GridPort Toolkit

- Based on the architecture developed for the NPACI HotPage
- Focus on computational scientists and application developers
- Comprised of a set of simple, modular services and tools
- Support application level, customized science portals development
- Facilitate seamless web-based access to distributed compute resources and grid services
- Built with commodity technologies
- Sits on top of the middle-tier of the Grid -
 - *An interface to these services for web*

GridPort Toolkit Design Concepts

- Key design idea:
 - Any site should be able to host a portal
 - Any user should be able to create their own portal if they have accounts and certificate
- Key Requirements:
 - Base software design on infrastructure provided by World Wide Web:
 - use commodity technologies wherever possible
 - avoid shell programs/applications/applets
 - GridPort Toolkit should not require that additional services be run on the HPC Systems
 - reduce complexity -- there are enough of these already
 - so, leverage existing grid research & development
 - GSI security (considering Kerberos, secure ID)

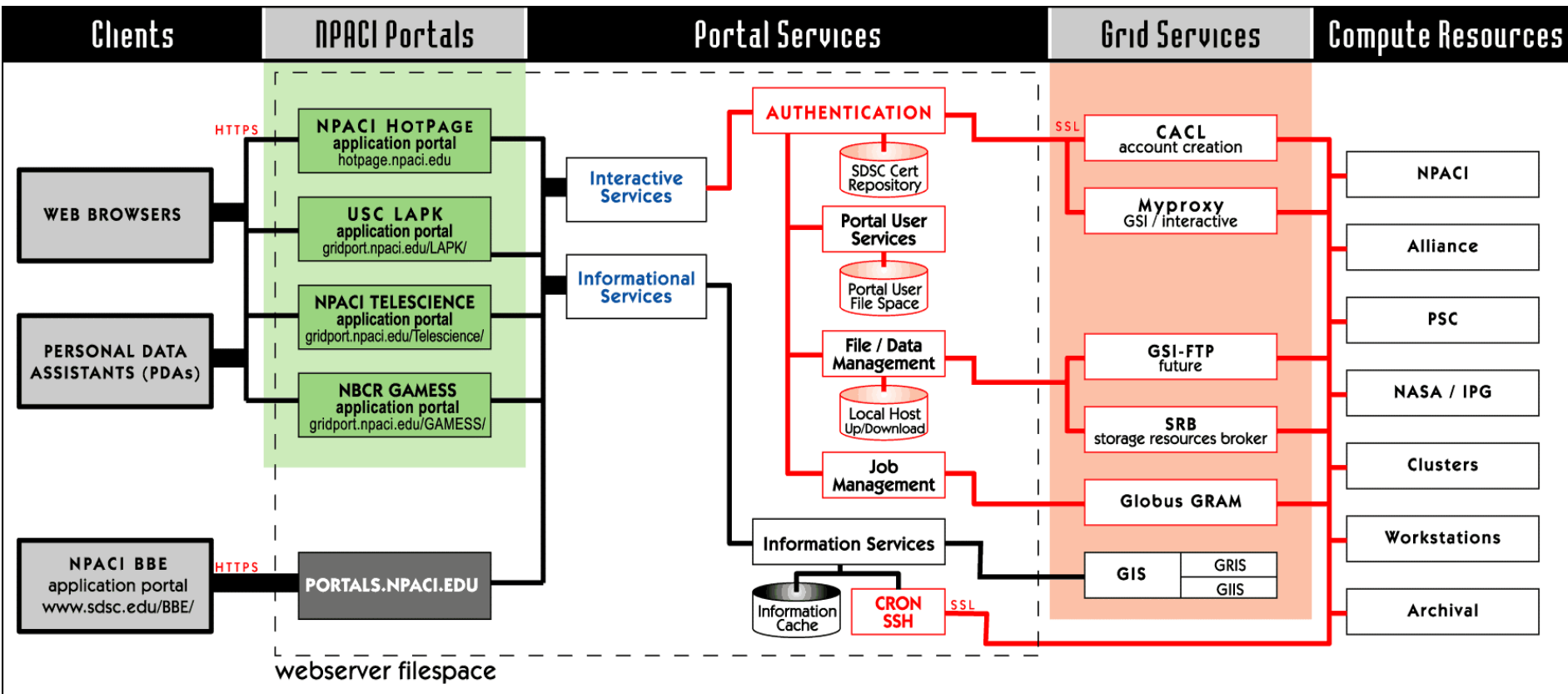
Technologies Used

- Uses 'commodity' technologies -> Portability
 - contributes to 'plug-n-play' grid
 - Software is easily ported to, and used by other sites.
 - Perl makes it easy to modify and adapt to local site policies, requirements, servers
- Requirements:
 - Communicator and IE (4.0 or greater),
 - HTTP, HTTPS, SSL, HTML/JavaScript, Perl/CGI, SSH
 - Netscape or Apache servers
 - Grid:
 - Globus, GSI, SRB, CACL (SDSC)
- Goal is to design a toolkit that is simple to implement, support, and develop
 - Technology transfer

Current Portal Services

- Current features (always adding more)
 - login/logout to grid services (single sign-on)
 - jobs:
 - Submit/cancel jobs to queues
 - monitor jobs and track them
 - web-based batch script builders
 - files:
 - dir listing, file transfer/archival
 - file upload & download
 - SRB integration, default collections for users
 - command execution
 - any UNIX commands
 - accounts:
 - Personalization
 - Webnewu, reslist

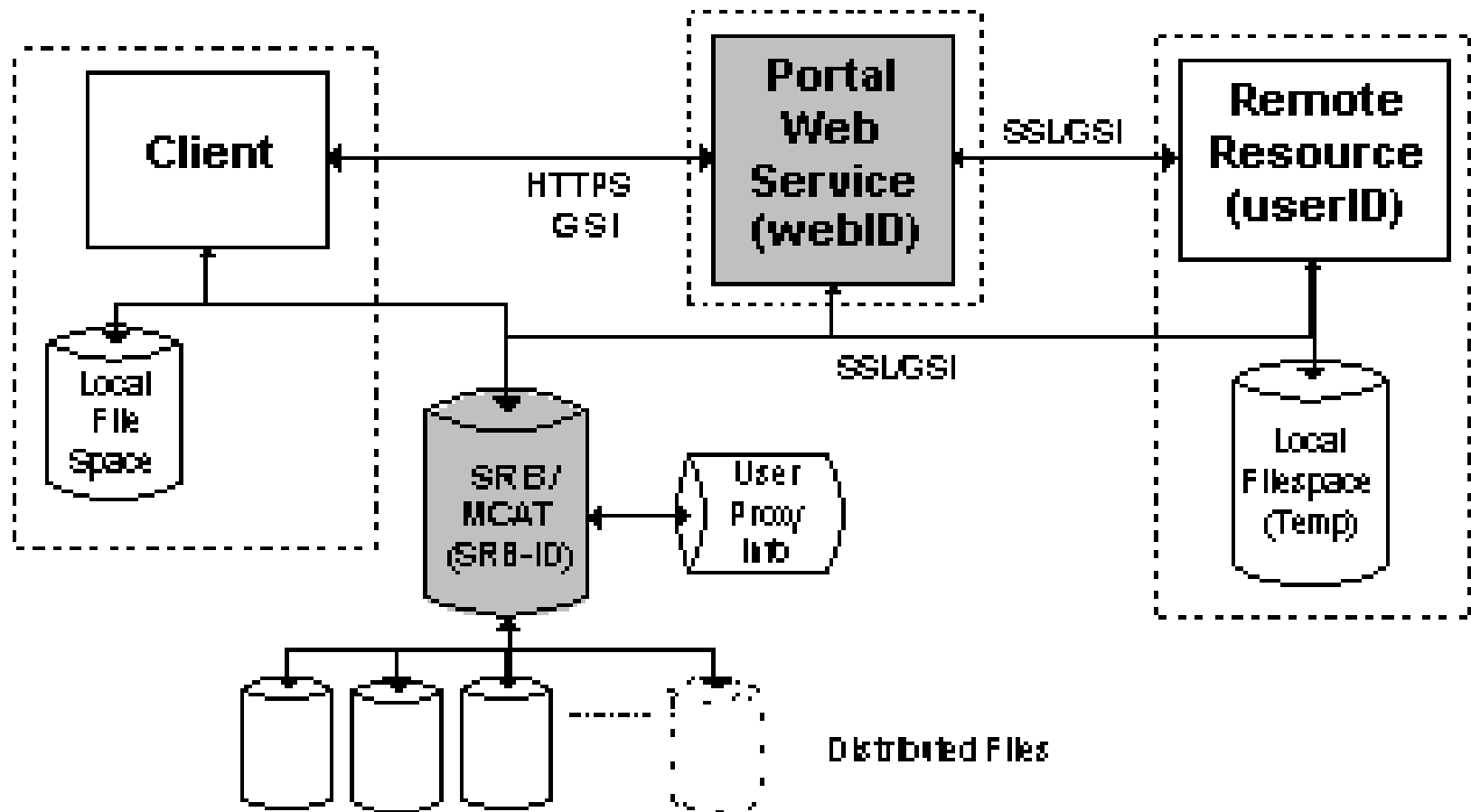
GridPort Architecture



Grid Security at all Layers

- *GSI* authentication for all portal services
 - transparent access to the grid via *GSI* infrastructure
 - Security between the client -> web server -> grid:
 - SSL/RC4-40 128 bit key/ SSL RSA X509 certificate
 - authentication tracked with cookies coupled to server data base/session tracking
- Single login environment (another key goal)
 - provides access to all NPACI Resources where *GSI* available
 - with full account access privileges for specific host
 - use cookies to track state
- Globus used for client requests on resources, but latencies are an issue:
 - Gatekeeper not designed for simple tasks (e.g. "ls")
 - Perl invocation of Globus may be heavyweight (will eval)

GridPort Use of SRB



Applications running on GridPort

- Current applications in production:
 - NPACI HotPage (also @PACI/NCSA)
 - <https://hotpage.npaci.edu>
 - LAPK Portal: Pharmacokinetic Modeling (live demo of Pharmacokinetic Modeling Portal)
 - <https://gridport.npaci.edu/LAPK>
 - GAMESS (General Atomic and Molecular electronic Structure System)
 - <https://gridport.npaci.edu/GAMESS>
 - Bays to Estuaries Project (Don Sutton)
- Application portals under development:
 - Telescience (Ellisman)
 - <https://gridport.npaci.edu/Telescience>
 - PDB

HotPage View: Job Submission

NFACI HotPage
 GRID ENABLED INTERACTIVE ENVIRONMENT
 Home News Allocations User Guides Consulting Training Systems

IBM Blue Horizon
[Machine Info](#)
[Message of the Day](#)
[Scheduled Downtime](#)
[Current Usage](#)
[Queue Status](#)
[Node Map](#)

[List Home Dir](#)
[List Work Dir](#)
[List Current Dir](#)
[List Archival Dir](#)
[List All Jobs](#)
[List My Portal Jobs](#)

| | | | | |
|-----------|-------------|---------|-------------|----------|
| Display | Edit | Delete | Permissions | Move |
| Rename | Copy | Make | Upload | Download |
| Tar/Untar | Gzip/Gunzip | Restore | Submit Job | Kill Job |

Listing for Blue Horizon :/rmount/paci/sdsc/mthomas/Examples/mpi
 Current HPSS Directory: /users/sdsc/mthomas

[Up One Directory](#)

| | | | | | | | |
|-------------------------------------|-----------|---------|--------|-------|--------|-------|---------------------------|
| <input checked="" type="checkbox"/> | -rwx----- | mthomas | use300 | 884 | Aug 31 | 04:37 | c_dl.c* |
| <input type="checkbox"/> | -rwx----- | mthomas | use300 | 6803 | Aug 31 | 04:37 | c_ex00* |
| <input type="checkbox"/> | -rwx----- | mthomas | use300 | 666 | Aug 31 | 04:36 | c_ex00.c* |
| <input type="checkbox"/> | -rwx----- | mthomas | use300 | 7527 | Aug 31 | 04:37 | c_ex01* |
| <input type="checkbox"/> | -rwx----- | mthomas | use300 | 906 | Aug 31 | 04:36 | c_ex01.c* |
| <input type="checkbox"/> | -rwx----- | mthomas | use300 | 8233 | Aug 31 | 04:37 | c_ex02* |
| <input type="checkbox"/> | -rwx----- | mthomas | use300 | 1071 | Aug 31 | 04:36 | c_ex02.c* |
| <input type="checkbox"/> | -rwx----- | mthomas | use300 | 7911 | Aug 31 | 04:37 | c_ex03* |
| <input type="checkbox"/> | -rwx----- | mthomas | use300 | 1071 | Aug 31 | 04:36 | c_ex03.c* |
| <input type="checkbox"/> | -rwx----- | mthomas | use300 | 7252 | Aug 31 | 04:37 | c_ex04* |
| <input type="checkbox"/> | -rwx----- | mthomas | use300 | 760 | Aug 31 | 04:36 | c_ex04.c* |
| <input type="checkbox"/> | -rwx----- | mthomas | use300 | 8731 | Aug 31 | 04:37 | c_ex05* |
| <input type="checkbox"/> | -rwx----- | mthomas | use300 | 1911 | Aug 31 | 04:36 | c_ex05.c* |
| <input type="checkbox"/> | -rwx----- | mthomas | use300 | 8615 | Aug 31 | 04:37 | c_ex06* |
| <input type="checkbox"/> | -rwx----- | mthomas | use300 | 1844 | Aug 31 | 04:36 | c_ex06.c* |
| <input type="checkbox"/> | -rwx----- | mthomas | use300 | 10282 | Aug 31 | 04:37 | c_ex07* |
| <input type="checkbox"/> | -rwx----- | mthomas | use300 | 1585 | Aug 31 | 04:36 | c_ex07.c* |
| <input type="checkbox"/> | -rwx----- | mthomas | use300 | 8655 | Aug 31 | 04:37 | c_ex08* |

Order Machines By: [Location](#) | [Architecture](#) | [Model](#)

| | | | | | | | | | | | | |
|--|-----------------------------------|------------------------------------|------------------------------|-----------------------------|-------------------------------------|----------------------------------|-------------------------------------|------------------------------|--------------------------------------|----------------------|------------------|-------------------|
| SDSC 81% Blue Horizon (horizon) | SDSC 96% T3E272 (golden) | SDSC 62% HPC10K64 (ultra) | SDSC 100% T90 (t90) | SDSC UP SDSC (t90) | UTexas 0% T3E68 (lonestar) | UTexas 81% SP64 (azusa) | UTexas 51% SV1/10 (aurora) | UTexas ? TACC (dmf) | UMich 94% SP1/12 (sp-umich) | UMich UI (adm) | V2500 (mvlid) | V2500 (scully) |
|--|-----------------------------------|------------------------------------|------------------------------|-----------------------------|-------------------------------------|----------------------------------|-------------------------------------|------------------------------|--------------------------------------|----------------------|------------------|-------------------|

GENIE TEXT EDITOR

```
#include <stdio.h>
#include "mpi.h"
#include <math.h>

int main(argc,argv)
int argc;
char *argv[];
{
    int myid, numprocs;
    int tag1,tag2,count;
    int buffer_send,buffer_rec;
    MPI_Status status;

    MPI_Init(&argc,&argv);
    MPI_Comm_size(MPI_COMM_WORLD,&numprocs);
    MPI_Comm_rank(MPI_COMM_WORLD,&myid);
    tag1 = 1234;
    tag2 = 4321;
    count=1;
    if(myid == 0){
        buffer_send=5678;
        MPI_Recv(&buffer_rec,co
        MPI_Send(&buffer_send,c
        printf("processor %d sent
```

Job Submit - Netscape

To submit c_dl.c, please fill out this form.

Arguments:

Select Queue:

Number of Cpus:

Max Time (min):

Informational Services

- Vertical portal to NPACI Resources and Services:
 - News/events within NPACI
 - Documentation, training , news, consulting
 - Simple tools:
 - application search systems information
 - generation of batch scripts for all compute resources
 - Network Weather System
- Provides dynamic information -
 - real-time information for each machine (or summaries) such as:
 - Status Bar: live updates/operational status/utilization
 - Machine Usage: summary of machine status, load, queues
 - Queues Summaries: displays currently executing and queued jobs
 - Node Maps: graphical map of running applications mapped to nodes
 - Network Weathering System: connectivity information between a user's local host and grid resources

Interactive Services

- Users have direct access to accounts on resources
 - single entry point to all NPACI resources on which a user has accounts/allocations
- Requires portal account, and authentication
 - secure access to compute and storage resources (GSI)
- Standard menus for each machine
 - allows user to perform common Unix tasks:
 - create, submit, monitor, cancel or delete jobs
 - view output
 - compile and execute code
 - manipulate and view files, navigate through file systems
 - use system commands: `chmod`, `mv`, `ls`, `cat`, `mkdir`, `cp`, `rm`
 - perform file transfer:
 - upload/download/archive files
 - archiving and retrieving data between local host and HPC system
 - managing accounts and allocations (via Webnewu)

Laboratory for Applied Pharmacokinetics (LAPK) Portal

- Users are Doctors, so need extremely simple interface
- Must be portable - run from many countries
- Need to hide details such as
 - Type of resources (T3E), file storage, batch script details, compilation, UNIX command line
- Uses gridport.npaci.edu portal services/capabilities:
 - File upload/download between local host/portal/HPC systems
 - Job Submit:
 - submission (builds batch script, moves files to resource, submit jobs)
 - Job tracking: in the background portal tracks jobs on system and moves results back over to portal storage when done
 - Job cancel/delete
 - Job History: maintains relevant job information
- **Major Success:**
 - LAPK users can now run multiple jobs at one time using portal.
 - Not possible before because developers had to keep codes & scripts simple enough for doctors to use on T3E

LAPK Job Submit and Job History

Laboratory of Applied Pharmacokinetics Web Portal

Friday, July 21, 2000 Current Web Portal Status: **Up**

Batch Job Builder

| | | | |
|-------------------------|-----------------------|-----------------------|---|
| Job Name: | lapk_100 | Email Address: | <input type="checkbox"/> Email Results? |
| Model File: | junk.html | Input File: | <input type="text"/> |
| Routine: | Big NPEM | #CPU's: | 8 |
| Wall Clock Time: | 2 (hours) : 00 (mins) | Comments: | |

Laboratory of Applied Pharmacokinetics Web Portal

Current Web Portal Status: **Up**

LAPK Job History

Last Updated: Jul-21-2000, -7:38 PST

Please wait while your job history is being accessed...

| Date | Job Name | Job ID | Status | Action | Model File | Data File | #CPU | Wall Clock Time | Comme |
|-------------|----------|--------|--------|------------------------------|-----------------|-------------------|------|-----------------|-------|
| Jul-20-2000 | lapk_149 | 82004 | Done | View Results | npemdriv_run1.f | npembig2.inp | 8 | 2 hrs. 8 min. | |
| Jul-20-2000 | lapk_116 | 82495 | Done | View Results | npemdriv_run3.f | npembig2_run3.inp | 2 | 0 hrs. 2 min. | |
| Jul-20-2000 | lapk_116 | 82496 | Done | View Results | npemdriv_run3.f | npembig2_run3.inp | 2 | 0 hrs. 2 min. | |
| Jul-20-2000 | lapk_159 | 82508 | Done | View Results | npemdriv_run1.f | npembig2.inp | 8 | 2 hrs. 8 min. | |
| Jul-20-2000 | lapk_161 | 82509 | Done | View Results | npemdriv_run1.f | npembig2.inp | 8 | 2 hrs. 8 min. | |

GridPort and Web Services

- New architecture for Grid portals is emerging:
 - Workshop held at SDSC (May '01) to discuss this.
 - Grid Portals Markup Language/XML
- Similar to 'web services' model that is currently evolving in commercial world:
 - Sun Jxta, IBM WebSphere Microsoft .NET
 - XML/SOAP/UDDI/WSDL
 - Client may be a web page/portal or another application or portal
- Allows separation of the function of hosting client from the service or application being used
- **Key project goal:**
 - Allow scientist to write local portals

Web Services Expt: GridPort Client Toolkit

- Focus on medium/small applications and researchers
- Choose simple protocol (HTTP/CGI/Perl)
- Application website can be located on **any** server.
- Connection to portal services is through the GCT:
 - <https://portals.npaci.edu/client/tools/FUNCTIONS>
 - Inherits all existing portal services running on portal
- Ease of use:
 - Do not have to install complex code to get started:
 - webservers, no Globus, no SSH, no SSL, no PKI, etc.
 - Do not have to write complex interface scripts to access these services (we've done that already)
 - Do not have to fund advanced web development teams
- Client has local control over project, including filespace, etc.
- Integration to existing portals can be done:
 - Bays to Estuaries project

GridPort Client Toolkit: DemoApp

GridPort Demo Application Web Portal - Microsoft Internet Explorer

File Edit View Favorites Tools Help

Back Forward Stop Refresh Home Search Favorites History Print Copy Paste

Address <https://portals.npaci.edu/client/examples/demoApp/> Go

Links Customize Links Free Hotmail Windows Media Windows

GRIDPORT

SDSC

Upload Login Status

GridPort Application Demo Portal

Sunday, February 25, 2001

LOGIN

FILES:

- List Files
- Upload Files
- List File Contents

JOBS:

- Submit Batch Job
- Submit Executable Job
- Submit Executable Job

ACCOUNTS:

Listing for Golden :/paci/us/mthomas

[Up One Directory](#)

| | | | | | | |
|------------|---------|--------|-------|--------|-------|----------------------------------|
| drwxr-xr-x | mthomas | use300 | 4096 | Oct 7 | 18:23 | Mail/ |
| drwxr-xr-x | mthomas | use300 | 4096 | Oct 8 | 1999 | dev/ |
| -rwxr-xr-x | mthomas | use300 | 14769 | Oct 23 | 23:29 | it2bbig2.ing* |
| -rwxr-xr-x | mthomas | use300 | 4715 | Jan 3 | 22:03 | it2bdrv.f* |
| -rwxr-xr-x | mthomas | use300 | 1027 | Oct 7 | 18:36 | lapk_202.batch2* |
| -rwxr-xr-x | mthomas | use300 | 1066 | Jan 3 | 22:06 | lapk_203.batch2* |

Batchscript Job Submission Page

To submit a job to the batch queue on a compute resource via a batchscript, enter the full path to the batchscript below.

T3E/272

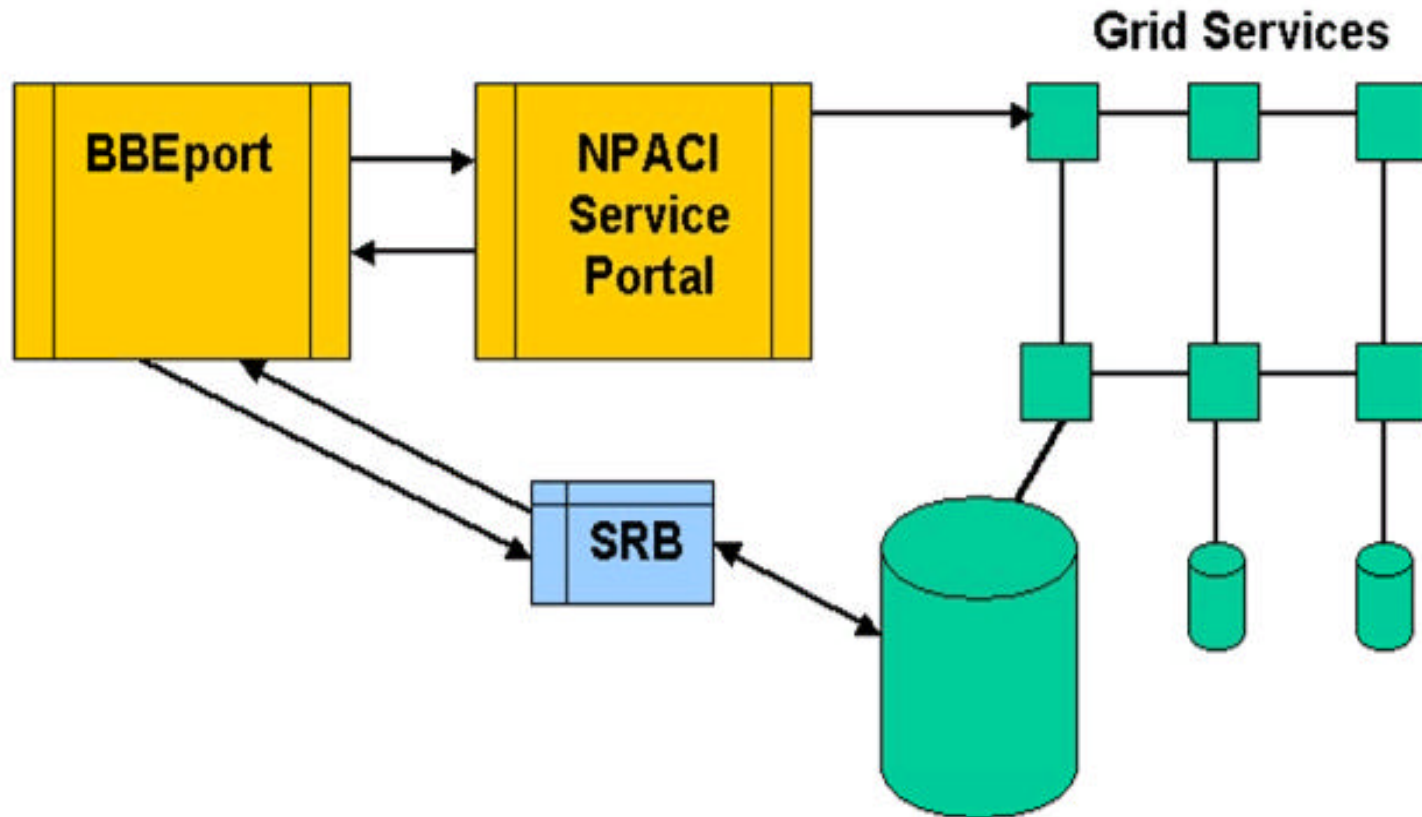
Batchscript Full Path

Submit Batchscript

Basin, Bays to Estuaries (BBE) Portal

- Community model: scientific portal for conducting multi-model Earth System Science (ESS):
 - Simulations are run to forecast the transport of sediments within the San Diego Bay area during a storm.
- Technology developed for the BBE project:
 - Website located on BBE webserver/machine
 - Uses SRB for file management (GSI)
 - Perl/CGI
- Uses GCT for all interactive functions:
 - minimal effort required to modify code
 - roughly 14 tests needed to integrate GCT
 - four new perl scripts required

Basin, Bays to Estuaries (BBE) Portal



Services Implemented in GCT

- Authentication:
 - Login
 - Logout
 - Check authentication state
- Jobs:
 - Submit jobs to queues
 - Cancel jobs
 - Execute commands
(command like interface)
- Files:
 - Upload from local host
 - Download to local host
 - FTP - move FILE
 - View Portal FILEspace (?)
- Commands:
 - Pwd
 - Cd
 - Whoami
 - Etc.

Future Work

- Evaluate Servlet technologies: why?
 - Faster than Perl process invocation
 - Rapid integration to databases, schemas, etc.
 - Integrate with JINI and new broker
 - Collaboration with Sun & CAL(IT)2 project
- Implement portal broker in Java
 - Choose services based on conditions such as user, resource, security methods, etc.
- Develop data portal capabilities:
 - Integrate SRB for file management
 - All portal accounts get collection
 - Java and Perl libraries
 - Use for maintaining state/status information

Future Work (cont.)

- Continue to develop Web services
 - Develop XML schemas
 - Evaluate using SOAP/WSDL, etc.
 - architectures
 - Collaborate with GGF/GCE:
 - GCE Testbed plan underway between
 - USA: PACI, Alliance, NASA, Jefferson lab, PNNL, others
 - Europe: Daresbury, Cactus, others?
- Continue to develop personalization features
- Develop Advanced Tools:
 - JobBuilder, JobTracker, JobCompiler, FileStager
- Collaborations:
 - User portal collaboration: NSF (PACI, NASA, PSC, Argonne), PNNL, Globus, others)
 - Global Grid Forum/Grid Computing Environments (GCE)
 - metascheduling projects
 - Grid accounts

GridPort Team

- *A Collective Effort*
- SDSC Staff:
 - Mary Thomas
 - Steve Mock
 - Kurt Mueller
 - Maytal Dahan (former intern)
 - Cathie Mills (former intern)
- Student Interns:
 - Ray Regno
 - Chris Garsha
 - Kathy Seyama
- Cadre of other SDSC services and people
- Collaborators: User Portal Collaboration
 - Globus/Argonne
 - SRB
 - NCSA/Alliance
 - NASA/IPG
 - LBL
 - Univ. of Texas
 - Univ. of Indiana (Gannon)
 - Don Sutton (UCSD)
 - Daresbury (UK)

References

- GridPort Toolkit Website
 - <https://gridport.npaci.edu>
- NPACI HotPage User Portal
 - HotPage: <https://hotpage.npaci.edu>
 - Accounts: <http://hotpage.npaci.edu/accounts>
- Downloads
 - GridPort Toolkit
 - NPACI HotPage
 - GCT Portal (frames based)
 - <http://gridport.npaci.edu/download>
- Contact:
 - Use comment form located on HotPage