SPRUCE
Special PRiority and Urgent Computing Environment

http://spruce.teragrid.org/

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Modeling and Simulation Play a Critical Role in Decision Making
I Need it Now!

- Applications with dynamic data and result deadlines are being deployed
- Late results are useless
  - Wildfire path prediction
  - Storm/Flood prediction
  - Influenza modeling
- Some jobs need priority access
  “Right-of-Way Token”
Example 1: Severe Weather Predictive Simulation from Real-Time Sensor Input

Source:
Kelvin Droegemeier, Center for Analysis and Prediction of Storms (CAPS), University of Oklahoma. Collaboration with LEAD Science Gateway project.
Example 2: Real Time Neurosurgical Imaging Using Simulation (GENIUS project – HemeLB)

Data is generated by MRA scanners at the National Hospital for Neurosurgery and Neurology.

- 512^2 pixels x 100 slices, res: 0.46875^2 mm x 0.8 mm
- 2048^2 x 682 cubic voxels, res: 0.46875 mm

Getting the Patient Specific Data

Our graphical-editing tool

Source:
Peter Coveney, GENIUS Project
University College London
Example 3: SURA Coastal Ocean Observing Program (SCOOP)

- Integrating data from regional observing systems for real-time coastal forecasts in SE
- Coastal modelers working closely with computer scientists to couple models, provide data solutions, deploy ensembles of models on the Grid, assemble realtime results with GIS technologies.
- Three scenarios: event-driven ensemble prediction, retrospective analysis, 24/7 forecasts

Source: Center for Computation and Technology, Louisiana State University
How can we get cycles?

• Build supercomputers for the application
   Pros: Resource is ALWAYS available
   Cons: Incredibly costly (99% idle)
   Example: Coast Guard rescue boats

• Share public infrastructure
   Pros: low cost
   Cons: Requires complex system for authorization, resource management, and control
   Examples: school buses for evacuation, cruise ships for temporary housing
Introducing SPRUCE

• The Vision:
  ♦ Build cohesive infrastructure that can provide urgent computing cycles for emergencies

• Technical Challenges:
  ♦ Provide high degree of reliability
  ♦ Elevated priority mechanisms
  ♦ Resource selection, data movement

• Social Challenges:
  ♦ Who? When? What?
  ♦ How will emergency use impact regular use?
  ♦ Decision–making, workflow, and interpretation
Existing “Digital Right-of-Way” Emergency Phone System

GETS is a ‘ubiquitous’ service in the Public Switched Telephone Network. If you can get a DIAL TONE, you can make a GETS call.

Calling cards are in widespread use and easily understood by the NS/EP User, simplifying GETS usage.

GETS priority is invoked “call-by-call”

Dial 1-710-NCS-GETS (627-4387)
At the tone, enter your P|N.
When prompted, dial your destination number (area code + number).
If you cannot complete a call, use a different long distance carrier:
AT&T: 1010 + 288 -or- 1-888-288-4387
MCI: 1010 + 222 +1-710-627-4387 -or- 1-800-900-4387
Sprint: 1010 + 333 -or- 1-800-257-8373

From a Wireless Priority Service enabled device:
Dial *272 before any call, including a GETS call.

US GOVERNMENT PROPERTY. If found, return to:
NCS (N3), PO Box 4502, Arlington, VA 22204-4502
WARNING: For Official Use Only by Authorized Personnel.
SPRUCE Architecture Overview (1/2)
Right-of-Way Tokens

Event

1. Automated Trigger
2. First Responder

Right-of-Way Token

SPRUCE Gateway / Web Services
SPRUCE Architecture Overview (2/2)  
Submitting Urgent Jobs

User Team

Urgent Computing Job Submission

Conventional Job Submission Parameters

Urgent Computing Parameters

Choose a Resource

SPRUCE Job Manager

Authentication

Priority Job Queue

Supercomputer Resource

Local Site Policies

3

4

5
Summary of Components

- Token & session management
  - admin, user, job manager

- Priority queue and local policies

- Authorization & management for job submission and queuing
Internal Architecture

Central SPRUCE Server

### Web Portal or Workflow Tools
- AJAX
- PHP / Perl

### Client Interfaces

### Computing Resource: Job Manager & Scripts
- Java
- Axis2
- PHP / Perl

### Client-Side Job Tools

### SPRUCE User Services || Validation Services
- Axis 2 Web Service Stack
- Tomcat Java Servlet Container
- Apache Web Server

### JDBC
- MySQL

### SOAP Request

Future work
Site–Local Response Policies: How to Handle Urgent Computing Requests?

- “Next–to–run” status for priority queue
  - wait for running jobs to complete
- Force checkpoint of existing jobs; run urgent job
- Suspend current job in memory (kill –STOP); run urgent job
- Preempt normal or lower priority jobs; run urgent job
- Provide differentiated CPU accounting
  - “Jobs that can be killed because they maintain their own checkpoints will be charged 20% less”
- Other incentives
  - One time use token
LEAD with SPRUCE Integration
Emergency Preparedness Testing: “Warm Standby”

• For urgent computation, there is no time to port code
  ✷ Applications must be in “warm standby”
  ✷ Verification and validation runs test readiness periodically (Inca, MDS)
  ✷ Reliability calculations
  ✷ Only verified apps participate in urgent computing

• Grid–wide Information Catalog
  ✷ Application was last tested & validated on <date>
  ✷ Also provides key success/failure history logs
Urgent Computing Resource Selection: Advisor

• Given a set of resources (each of which has their own urgent computing policies) and a deadline how does a user select the “best” resource?

  ✷ Advisor approach: Analyze historical and live data to determine the likelihood of meeting a deadline for each possible configuration.

    ▪ Configuration is a specification of the resource, policy and runtime parameters (e.g., application performance parameters, nodes/ppn, etc.)
Selecting a Resource

Trigger

Urgent Severe Weather Job
Deadline: 90 Min

Advisor

Historical Data
- Network bandwidth
- Queue wait times
- Warm standby validation
- Local site policies

Live Data
- Network status
- Job/Queue data

Application-Specific Data
- Performance Model
- Verified Resources
- Data Repositories

“Best” HPC Resource

Urgent Severe Weather Job
Deadline: 90 Min

Advisor

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- Network bandwidth
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“Best” HPC Resource
Probabilistic Upper Bounds on Total Turnaround Time

• The delay consists of three phases:
  - File staging (both input and output)
  - Allocation (e.g., queue delay)
  - Execution

• If phases are independent a conservative composite bound can be created by combining phase bounds
  - $C_B = F_B + A_B + E_B$
  - $C_Q \geq F_Q \times A_Q \times E_Q$
Highly Available Resource Co-allocator (HARC)

- Some scenarios have definite early notice
  - SCOOP gets hurricane warnings a few hours to days in advance
  - No need for drastic steps like killing jobs

- HARC with SPRUCE for reservations
  - Reservation made via portal will be associated to a token
  - Any user can use the reservation if added onto that active token
  - Can bypass local access control lists
Bandwidth Tokens

SPRUCE
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Fetching information...
Token: WN3E-ER7U-0UUW-FJCE

Status: Activated
Lifetime: 72:00:00
Creation date: 2007-11-01 09:51:37.0
Expiration date: 2007-12-31 00:00:00.0
Activation date: 2007-11-15 10:12:20.0
Deactivation date: 2007-11-18 10:12:20.0

Bandwidth Properties
Accessible VLANS:
- 446 activate deactivate activation log

Compute Properties
This is a test token only
Maximum Urgency: yellow

Resources on TG:
- 1a32 @ ANL
- 1a64 @ ANL

Users: there are no users assigned to this token.

(Token info fresh as of Thu Nov 15 2007 08:12:20 GMT-0600)

If you need to go back to the menu, press the User Portal link from the menu. Browser BACK button has no functionality.
Condor Integration

• Goals
  ✷ Support Condor-managed resources
    ▪ Traditional Condor pools
    ▪ Condor-G
  ✷ Support Condor applications

• Supported Policies
  ✷ Elevated priority
  ✷ Preemption

• Advantage
  ✷ Expressive and extensive configuration language enables creation of complex scheduling rules based on criteria that may not be available to other resource managers
Roadmap

• Ongoing work
  ◦ Policy mapping for resources and applications
  ◦ Notification system with triggers on token use
  ◦ INCA Q/A monitoring system for SPRUCE services

• Future Work
  ◦ Automatic restart tokens
  ◦ Aggregation, Extension of tokens, ‘start_by’ deadlines
  ◦ Encode (and probe for) local site policies
  ◦ Warm standby integration
  ◦ Failover & redundancy of SPRUCE server
Deployment Status

- Deployed and Available on TeraGrid –
  - UC/ANL
  - NCSA
  - SDSC
  - NCAR
  - Purdue
  - TACC
  - LSU
  - Indiana
- Other sites
  - Virginia Tech
  - LONI

<table>
<thead>
<tr>
<th>SITE</th>
<th>CONFIGURATION</th>
<th>POLICY</th>
<th>SCHEDULER</th>
<th>PROCESSORS</th>
<th>CONTACT</th>
</tr>
</thead>
<tbody>
<tr>
<td>UC/ANL</td>
<td>Intel IA-64, 62 nodes</td>
<td>elevated-priority next-to-run pre-emption</td>
<td>Torque/Moab</td>
<td>124/124 (Production)</td>
<td>Ti Leggett</td>
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<td>UC/ANL IA32</td>
<td>Intel IA-32, 96 nodes</td>
<td>elevated-priority next-to-run pre-emption</td>
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<td>192/192 (Production)</td>
<td>Joe Insley</td>
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<td>NCSA Mercury</td>
<td>Intel IA-64, 631 nodes</td>
<td>next-to-run</td>
<td>Torque/Moab</td>
<td>TBD/1262 (Production)</td>
<td>Peter Enstrom</td>
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<td>Purdue Lear</td>
<td>Dell EM64T Cluster, 512 nodes</td>
<td>next-to-run</td>
<td>PBS Pro</td>
<td>1024/1024 (Upgrading)</td>
<td>Preston Smith</td>
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<tr>
<td>SDSC Datastar</td>
<td>IBM P series, 272 (8-way) P655+ and 6 (32-way) P690</td>
<td>next-to-run</td>
<td>LoadLeveler/Catalina</td>
<td>2368/2368 (Production)</td>
<td>Tony Vu</td>
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<tr>
<td>SDSC OnDemand</td>
<td>Rocks cluster, 64 nodes</td>
<td>elevated-priority next-to-run pre-emption</td>
<td>SGE</td>
<td>256/256 (Pre-production)</td>
<td>DJ Choi</td>
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<tr>
<td>TACC Lonestar</td>
<td>Dell PowerEdge 1955, 1460 nodes</td>
<td>next-to-run</td>
<td>LSF</td>
<td>16/5840 (Production)</td>
<td>Bill Barth</td>
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<tr>
<td>NCAR Frost</td>
<td>Single-rack BG/L, 1024 nodes</td>
<td>next-to-run</td>
<td>Cobalt</td>
<td>2048/2048 (Production)</td>
<td>Jason Cope</td>
</tr>
</tbody>
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Imagine…

- A world-wide system for supporting urgent computing on supercomputers
- *Slow, patient* growth of large-scale urgent apps
- Expanding our notion of priority queuing, checkpoint/restart, CPU pricing, etc
- For Capability: 10 to 20 supercomputers available on demand
- For Capacity: Condor Flocks & Clouds provide availability of 250K “node instances”
Partners
SC08 Schedule

• Scheduled presentations at the Argonne National Lab booth:
  ♦ Tuesday 3:00 – 3:30: SPRUCE overview
  ♦ Wednesday 1:00 – 2:00: An hour demo session featuring:
    ▪ User interactions with SPRUCE
    ▪ How LEAD utilizes SPRUCE in their workflows
    ▪ Resource selection
    ▪ Condor with SPRUCE
Questions? Ready to Join?

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