

Dealing with real resources

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Igor Sfiligoi, isfiligoi@ucsd.edu

OSG Scalability Area coordinator and
OSG glideinWMS factory manager

University of California San Diego

Real resources

- They have limits
- They break!
 - Sometimes in very strange ways
- Don't always know what they are
- You need to share them

What resources you use?

- Compute resources
- Storage resources
- Network resources

Real resources

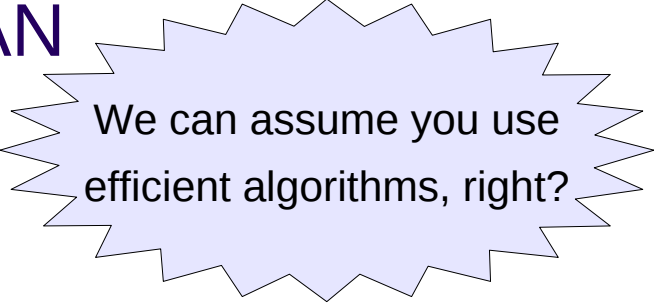
Compute resources

Use them or loose them

- CPU cycles cannot be stored
 - They are either used or wasted
- Batch processing tries to minimize the waste
 - But it cannot do miracles
 - User jobs still need to be efficient

CPU inefficiencies

- Disk operations
 - Disk is orders of magnitude slower than CPU
 - Reading many files in parallel a killer
- Network operations
 - If you wait for data over the network, you are likely wasting CPU
 - WAN much slower than LAN



We can assume you use efficient algorithms, right?

Sharing

- Most of the time you will be sharing a compute box with other people
 - Accessing the same physical disk
 - Competing for the same network link
- Memory (RAM) may become a limit
 - Most OS hide it from you through virtual memory
 - But that can be very slow!
(disk access)

Job requirements

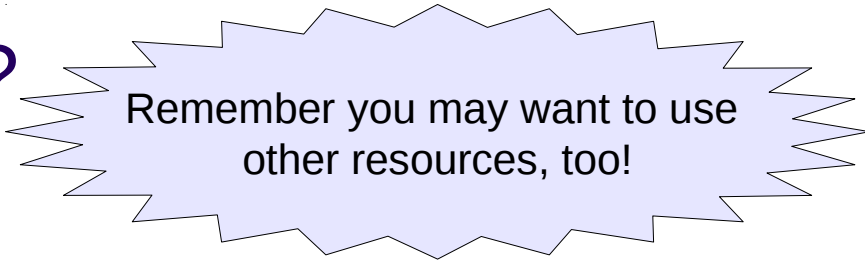
- CPU type
 - Operating system (flavor)
 - Installed libraries
 - Memory needs
-
- Do you know them?
 - Can you minimize them?

Where do you get the resources?

- Your desktop/laptop?
- Local cluster?
- The Grid?
 - Which one?
(OSG, TeraGrid, NYGrid, EGEE, ...)
- The Cloud?
 - Which one?
(Amazon, Magellan, Microsoft, Google,...)

On OSG

- Which sites support me?
- What tools will I use?
- How do I request the right resources?
 - I know what I need, right?
- How do I partition my work?
 - Cannot be a single serial job
 - Then you need to split it across sites (OSG MM and pilots can help here)



Remember you may want to use other resources, too!

Site selection

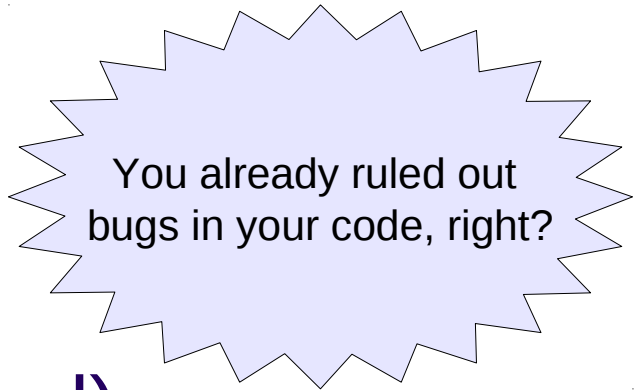
- Can I trust the information system?
 - Who the site supports?
 - Are resource attributes correct?
- Do I get all the information needed?
 - What about sites with different resources?
- How do I express my requirements?
 - Globus uses RSL
 - **But the semantics is site specific!**

My job is not working

- Is the problem 1/1000 or 1000/1000
 - I hope you tested with a single one first!
- Do you know how to debug it?
 - Interactive access is usually not an option (although pilots can partially help)
 - Does it work on your laptop?
- What do the logs say?
 - You do write to them, right? (could be just stderr)

What can go wrong?

- You don't understand your requirements
- The batch system did not honor your requirements
 - Or you expressed them in a wrong way
- Corrupted software
- Corrupted data
- Hardware problems
(lots of components involved)



You already ruled out
bugs in your code, right?

My jobs don't finish

- Have they ever started?
- Nope
 - Too restrictive requirements?
 - Permissions?
 - Batch system bug?
 - Just need to wait a little more?
- Yes
 - Your job has a bug?
 - Hung connection?
 - Have they been restarted several times?
(preemption)

Grid related problems

- Permissions!
"Globus error 7!"
- Gatekeeper problems
"Globus error 3: an I/O operation failed"
"Globus error 4: jobmanager unable to set default to the directory requested"
"Globus error 17: the job failed when the job manager attempted to run it"
"Globus error 22: the job manager failed to create an internal script argument file"
"Globus error 47: the gatekeeper failed to run the job manager"
"Globus error 121: the job state file doesn't exist"

Grid related problems ⁽²⁾

- Black holes
 - Worker nodes that “eat” your jobs
- Worker node problems
 - Misconfigured OS
 - Missing OSG software
 - Missing VO software
 - Disk full
 - Preemption

How you fix Grid problems?

Help me, please!



- Very little you can do by yourself
- Most problems can only be solved by administrators at the Grid site
 - GOC can act as an intermediary

Real resources

Storage resources

A two dimensional problem

- Storage is used for extended periods of time
 - Not instantaneous like CPU
 - People like to cling to it as long as possible
- Two dimensions
 - Space (nr. bytes)
 - Time (from-to)

Uniform yet heterogeneous

- Storage is much more uniform than CPU
 - Everyone stores bytes
- But the interface can be heterogeneous
 - What protocol does it talk?
 - How do I access it?
 - Do I need to request explicit permission before I can write?
 - How long will my data stay there?

What storage is available?

- OSG has a few standard areas
 - Local dir
 - \$OSG_APP, \$OSG_DATA
- May have local storage element
 - But not guaranteed
- Additional site specific areas
 - Ask!

Storage selection

- Several storage areas
 - Which one should I use?
- Sometimes little choice
 - Where is the needed data
 - Which one has enough free space
- Careful about performance; depends on
 - Locality
 - Architecture
 - API

Access pattern

- Just read from the original source?
 - Or should I make a local copy?
- Just write to the target area?
 - Or should I first create a local copy?
- How do I move the data?
 - In your job or externally scheduled?
 - How do I handle errors?

Tools to use

- POSIX interface
- System command line tools
(possibly overloaded)
- Storage specific tools
(dccp)
- Grid tools
(srm-cp)

Error types

- Cannot reach storage area
- Wrong permissions
- Data is corrupted
- Access is painfully slow
- Disk full

Access problems

- Local disks
 - NFS stale mount?
 - Disk failure?
- Remote storage area
 - Authentication failure?
 - Networking issue?
 - Server overload?
 - Server down?
(different administrative domain)

Wrong permissions

- **Authentication != Authorization**
- Can read but not write?
- Were able to write through one interface, but cannot read from another?
- Can copy whole file, but not access only a piece of it?
- What about group access?

Data corruption

- Hardware does misbehave
 - Someone could have overwritten (or deleted) your files
 - Can affect both data and code
-
- Do you know how to check for corruption?
 - What do you do if either code or data gets corrupted?

Way too slow?

- How many of your jobs access the same area at the same time?
- What is your access pattern?
- Can you schedule file transfers?
- Can you use a different storage area?

Disk full

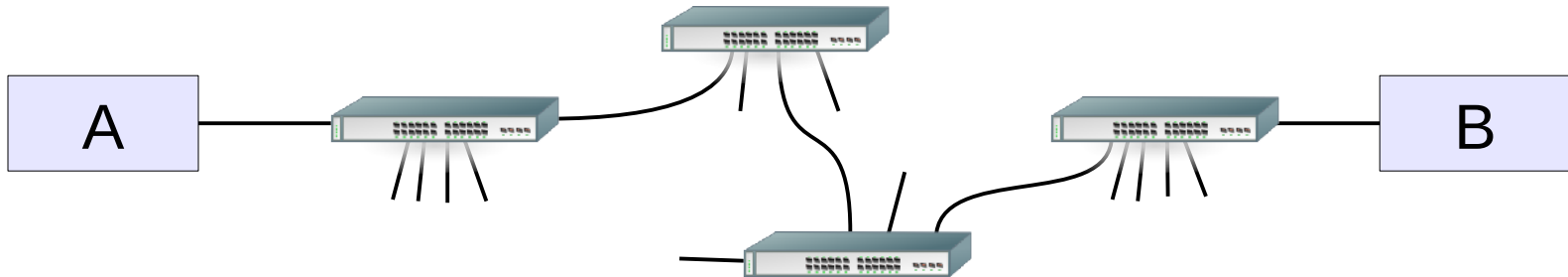
- Storage capacity is limited
 - And often shared with other users
- Can your quota be increased?
- Can you use a different area?
- Can you delete some of your old files?

Real resources

Network resources

Multi-dimensional problem

- Composed of many pieces
 - You at best see the two ends
 - But many other segments in between



- Network is always shared
 - And often you don't even know it

Use-it-or-loose-it

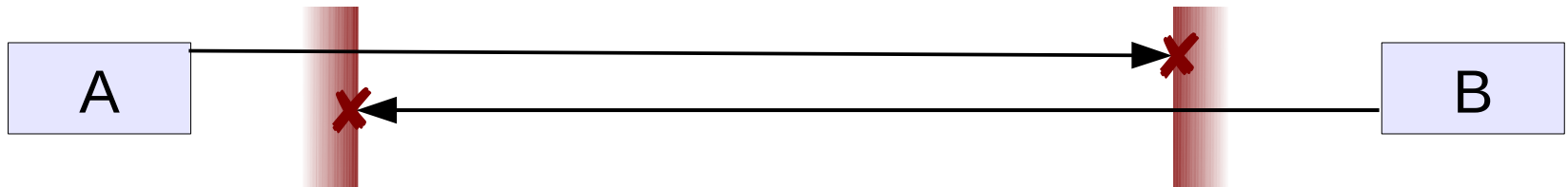
- The network is like the CPU
 - If you don't use it, it is lost
- However, most network admins are not happy if you use all the bandwidth
 - Due to the massively shared nature of it

Networking problems

- No connectivity
- Unreliable connectivity
- Slow speed

No Connectivity

- Firewalls are becoming common
 - Mostly blocking incoming connectivity
- At least one side must allow incoming connections
 - Or it is impossible to use the network



- Can your tool work with firewalls?
 - e.g. Grid submission requires incoming connections for both server and client

Unreliable connectivity

- Connection established just fine
 - But dropped after 20s
 - Did not even notify the two ends!
- Works with up to 20 clients
 - The 21 cannot connect anymore
 - The other 20 may get killed as well
- Massive UDP packet loss

Slow speed

- A bottleneck at one of the two ends?
- A bottleneck somewhere in between?
- One of the two ends needs OS tuning?
 - WAN very different from LAN
- Are you sending very small packets?
 - Using a very inefficient protocol?

Summary

- Life in distributed computing is hard
 - Many things can go wrong
- Grid computing is even harder
 - You have little control over most resources
- To keep it manageable:
 - Use debug-friendly tools whenever possible
 - Log as much as you can

OSG Users Experience

- See for yourself

[https://twiki.grid.iu.edu/bin/view/Production/
ProblemsEncounteredByVOsDuringJobSubmission](https://twiki.grid.iu.edu/bin/view/Production/ProblemsEncounteredByVOsDuringJobSubmission)

Questions?

- Questions? Comments?
- Feel free to ask me questions later:
Igor Sfiligoi, isfiligoi@ucsd.edu
- Upcoming sessions
 - **None!**
 - Enjoy the evening