Open Science Grid

Dealing with real resources
Wed July 21st, 3:15pm

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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?

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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

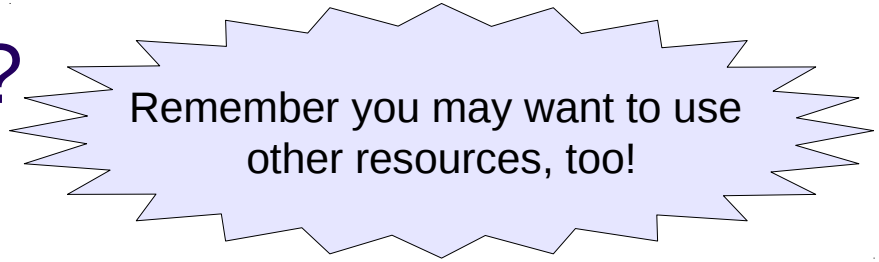
- Do you know them?
- Can you minimize them?

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)

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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!**

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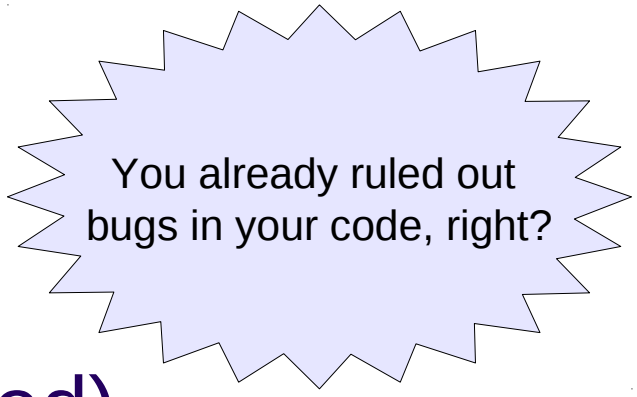
My job is not working

- 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)



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
  - You job has a bug?
  - Hung connection?
  - Have they been restarted several times? (preemption)

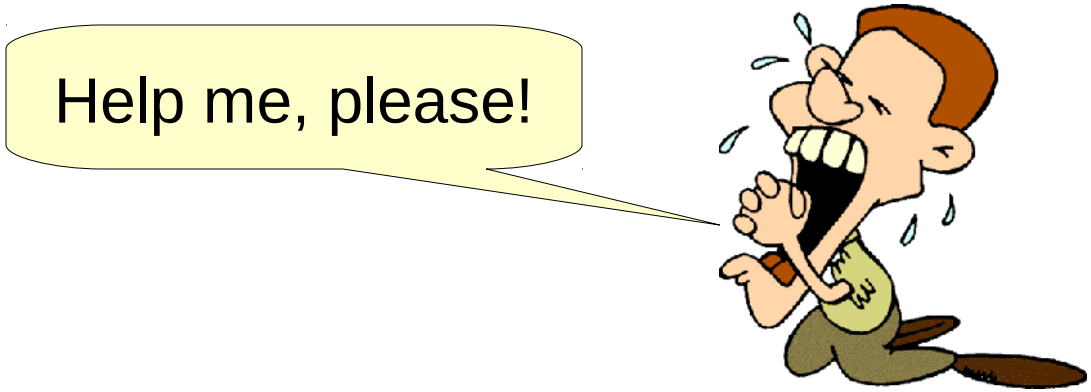
Grid related problems

- 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?



- 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

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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 store 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!

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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

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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?

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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 you 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

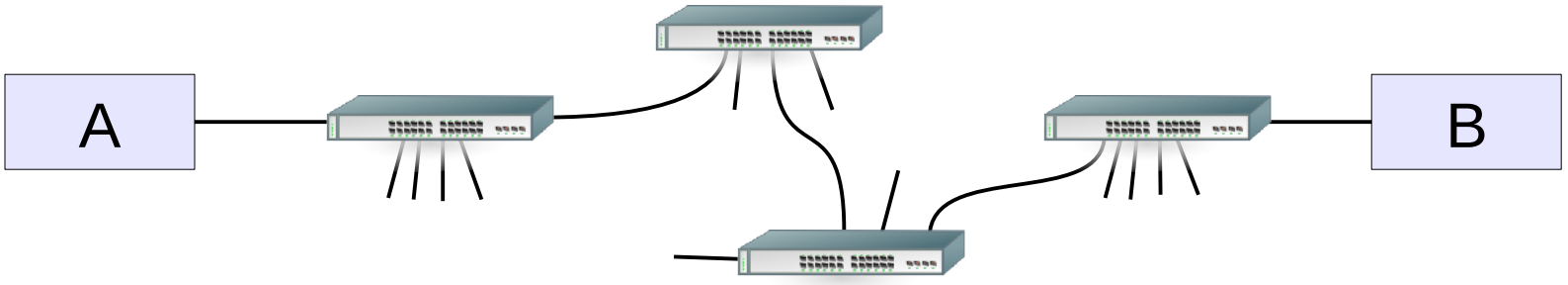
- Can your quota be increased?
- Can you use a different area?
- Can you delete some of your old files?

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

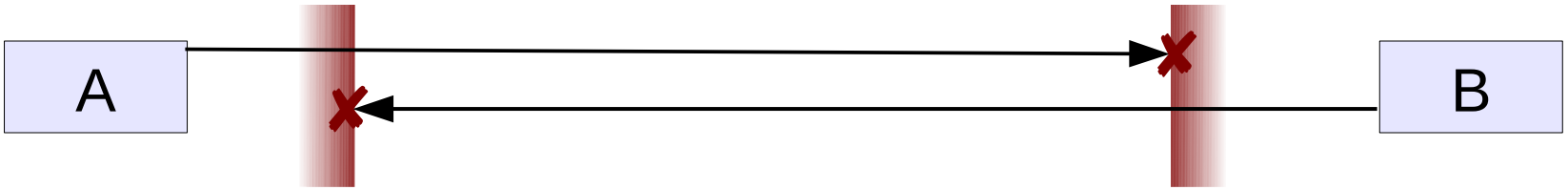
- The network is like the CPU
  - If you don't use it, it is lost
- However, most network admins are not happy you use all the bandwidth
  - Due to the massively shared nature of it

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 tunning?
  - WAN very different from LAN
- Are you sending very small packets?
  - Using a very inefficient protocol?

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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

Questions?

- Questions? Comments?
- Feel free to ask me questions later:

  Igor Sfiligoi, isfiligoi@ucsd.edu
- Upcoming sessions
  - **None!**
  - Enjoy the evening