

Setting up and using a Globus Toolkit 5 based Grid

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Outline

- Introduction
 - ◆ Grid and Globus Toolkit
- Grid Security Infrastructure
- GT5 Installation and Configuration
- GridFTP
- GRAM



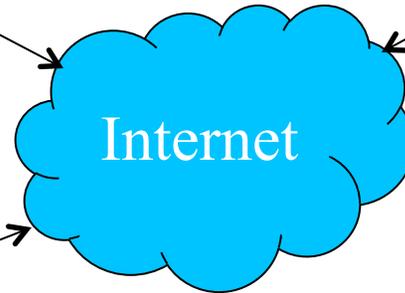
Distributed Computing Use Case



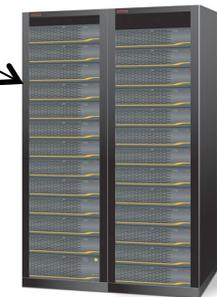
Supercomputer A



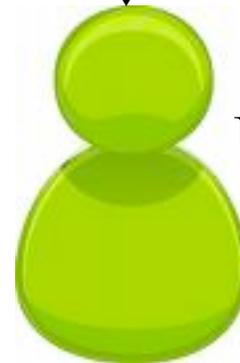
Data Store A



Supercomputer B



Data Store B



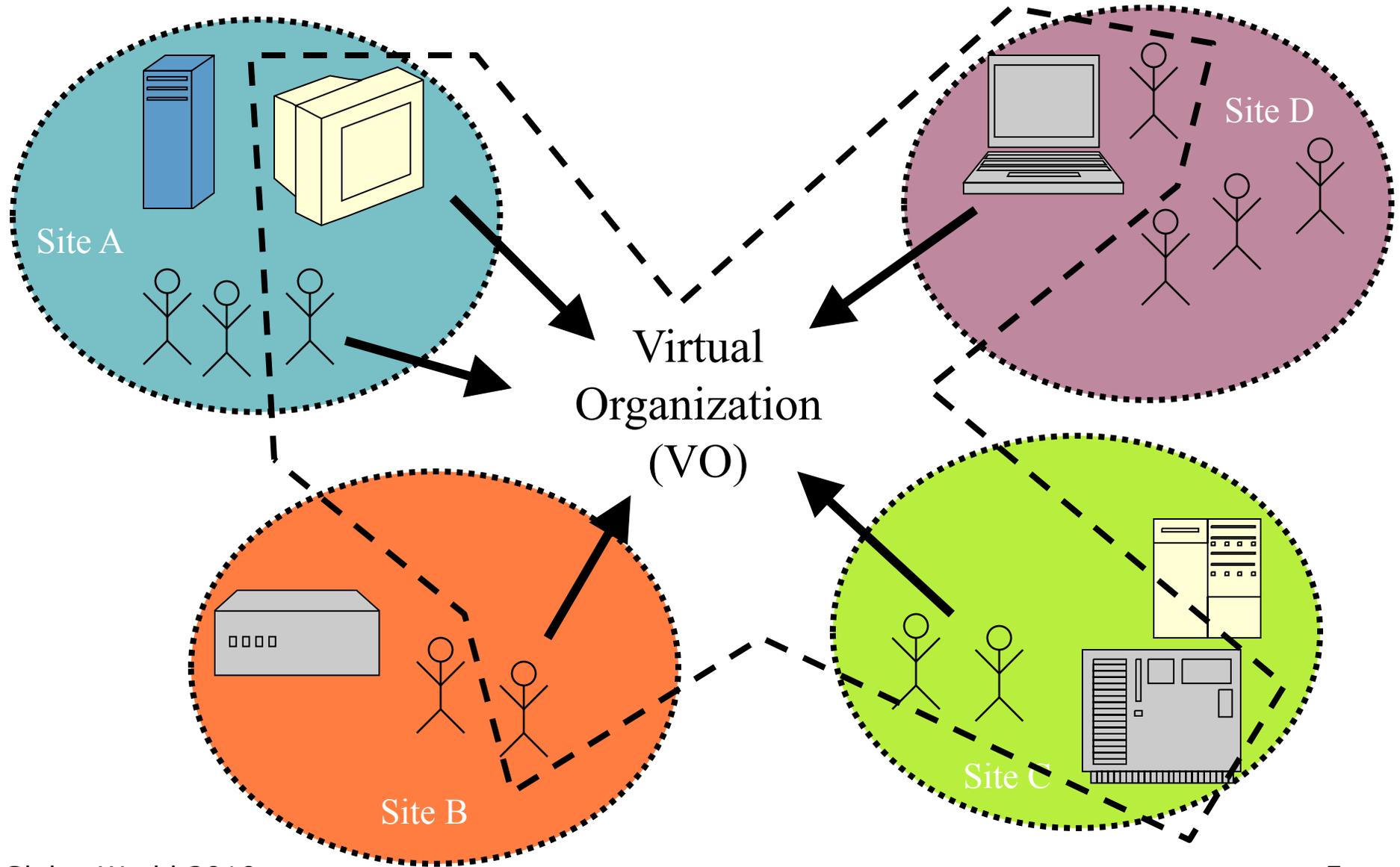
User



The Grid

- Resource sharing & coordinated problem solving in dynamic, multi-institutional virtual organizations
 - ◆ “On-demand” access to ubiquitous distributed computing
 - ◆ Transparent access to distributed data
 - ◆ Easy to plug resources into
 - ◆ Complexity of the infrastructure is hidden

Virtual Organization



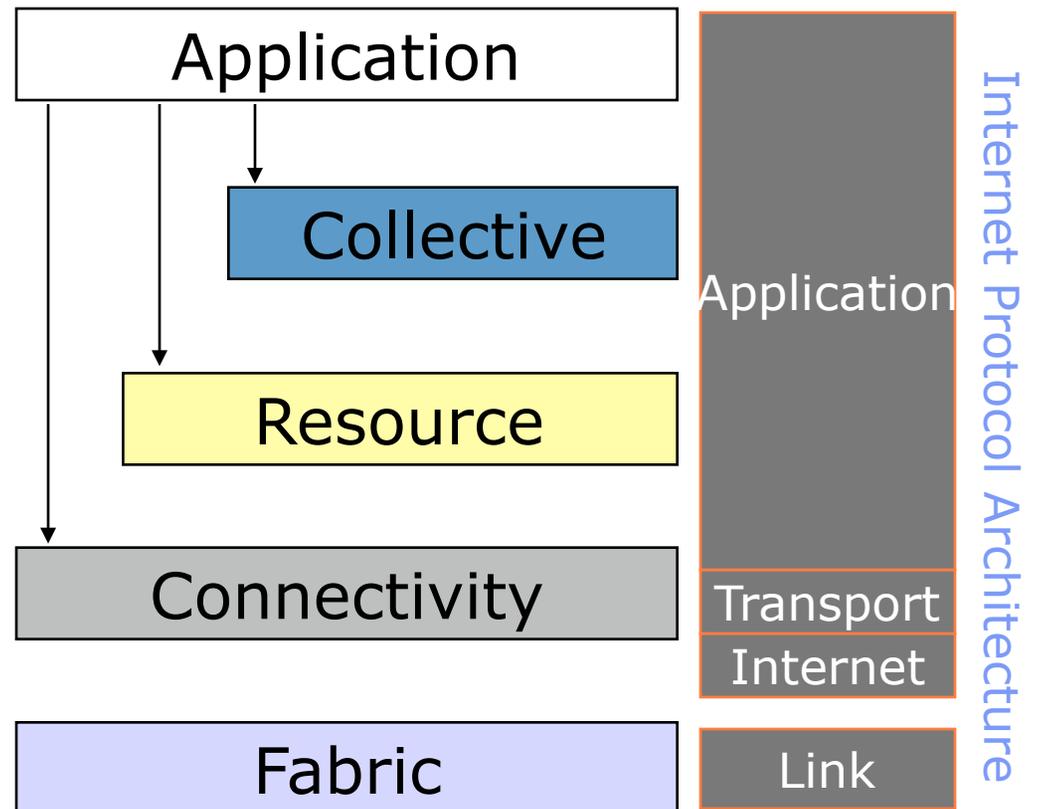
The Grid

“Coordinating multiple resources”: ubiquitous infrastructure services, app-specific distributed services

“Sharing single resources”: negotiating access, controlling use

“Talking to things”: communication (Internet protocols) & security

“Controlling things locally”: Access to, & control of, resources



Globus Toolkit

- The Globus Toolkit centers around
 - ◆ Connectivity layer:
 - *Security*: Grid Security Infrastructure (GSI) - allows collaborators to share resources without blind trust
 - ◆ Resource layer:
 - *Resource Management*: Grid Resource Allocation Management (GRAM)
 - *Data Transfer*: Grid File Transfer Protocol (GridFTP)
- Also collective layer protocol
 - ◆ Replica Management (RLS)
- Focuses on simplifying heterogeneity for application developers



Grid Security Infrastructure (GSI)

- Open source libraries, tools and standards which provide security functionality of the Globus Toolkit
- Goal is to support VO
- Provides for cross-organizational:
 - ◆ Authentication
 - ◆ Authorization
 - ◆ Single sign-on

Terminology



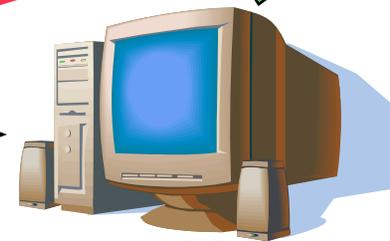
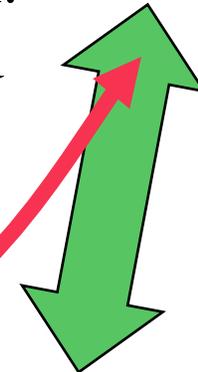
Delegation:
Granting a
right to another
entity.



John Doe @ NCSA

Authentication: Proving
who you are.

Authorization:
What are you
allowed to
do?



- Based on asymmetric cryptography
 - ◆ Private and Public Key - allows for two entities to authenticate with minimal cross-organizational support
- Certificates - Central concept in GSI
 - ◆ Information vital to identifying and authenticating user/service
 - ◆ Distinguished Name – unique Grid id for user/service
 - ◆ "/DC=org/DC=doegrids/OU=People/CN=Raj Kettimuthu 227852"
- Certificate Authority (CA)
 - ◆ Trusted 3rd party that confirms identity
- Host credential
 - ◆ Long term credential
- User credential
 - ◆ Passphrase protected



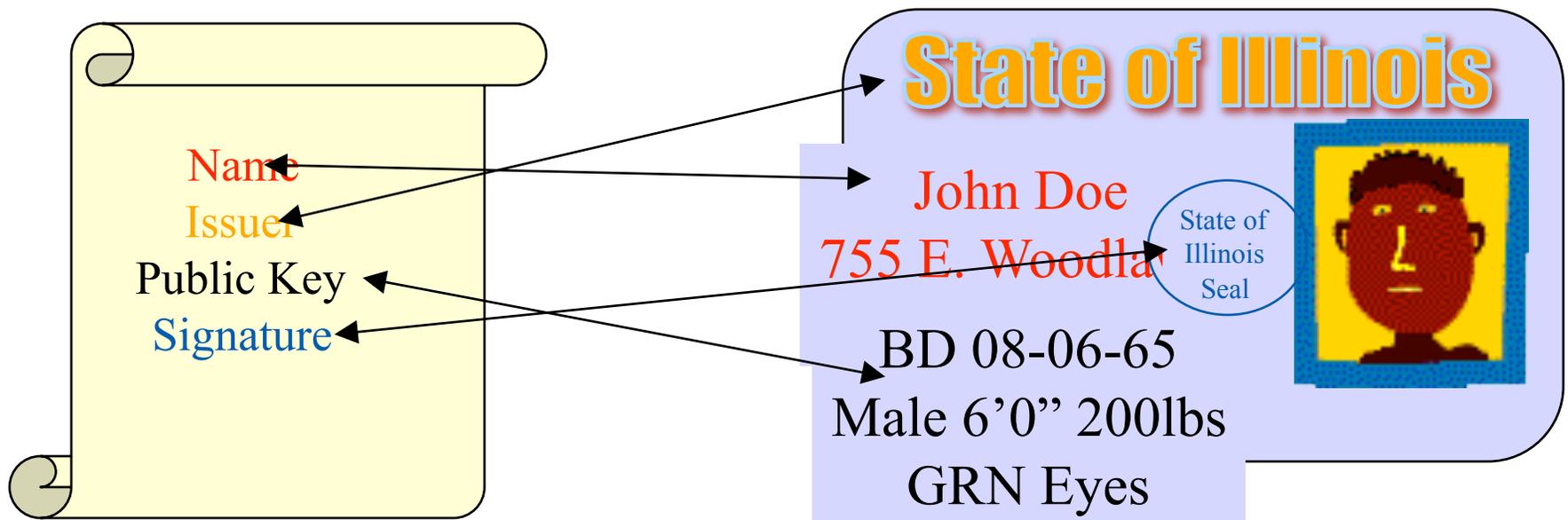
Digital Signatures

- Used to determine if the data has been tampered
- Also, identify who signed the data
- Digital signatures are generated by
 - ◆ Creating secure hash of the data
 - ◆ encrypting the hash with private key
- The resulting encrypted data is the signature
- This hash can then be decrypted only by the corresponding public key



Certificates

- Allow for binding of an Identity (John Doe) to a key or person



Proxy Certificates

- X.509 Proxy Certificates are our extension
- Standardized in IETF
- Allow for dynamic delegation
- Proxy credentials are short-lived credentials created by user
 - ◆ Proxy signed by user certificate private key
- Stored unencrypted for easy repeated access

Delegation

- Enabling another entity to run on behalf of you
- E.g Service that runs a job needs to transfer files.
- Ensure
 - ◆ Limited lifetime
 - ◆ Limited capability
- GSI uses proxy certificates for delegation



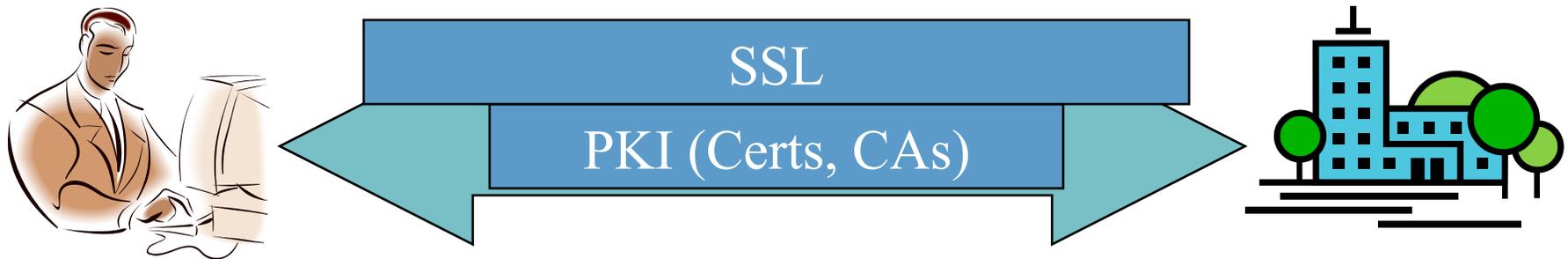
Authorization

- Establishing rights of an identity
 - ◆ Can user do some action on some resource
- Identity based authorization
 - ◆ Establish identity using authentication
 - ◆ Check policy to see what identity can do
 - ◆ Eg: Gridmap authorization a list of mappings from allowed DNs to user name
 - ◆ "/DC=org/DC=doegrids/OU=People/CN=Raj Kettimuthu 227852" kettimut
 - ◆ Identity based authorization may not scale
- Attribute based authorization
 - ◆ Attributes are information about an entity
 - Employee of Argonne National Lab
 - Member of virtual organization ABC

GSI Stack

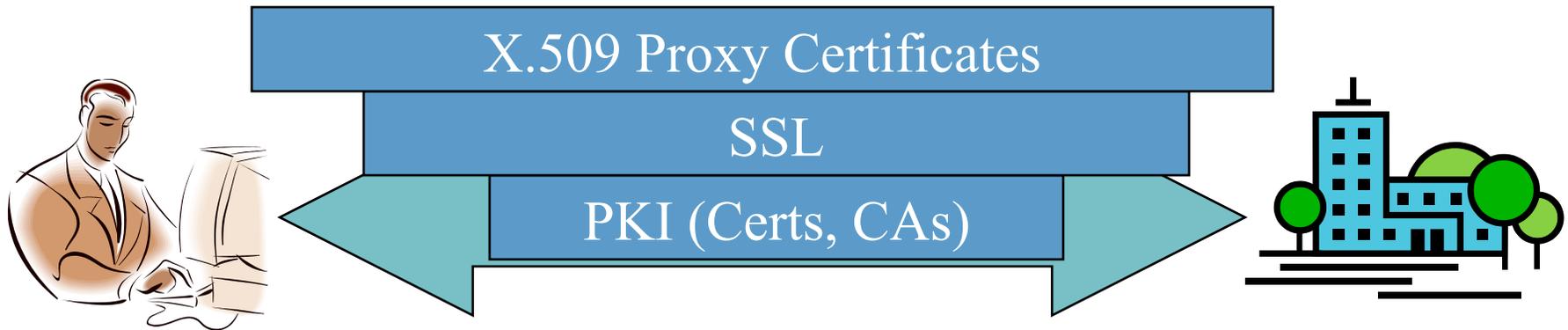


GSI Stack





GSI Stack

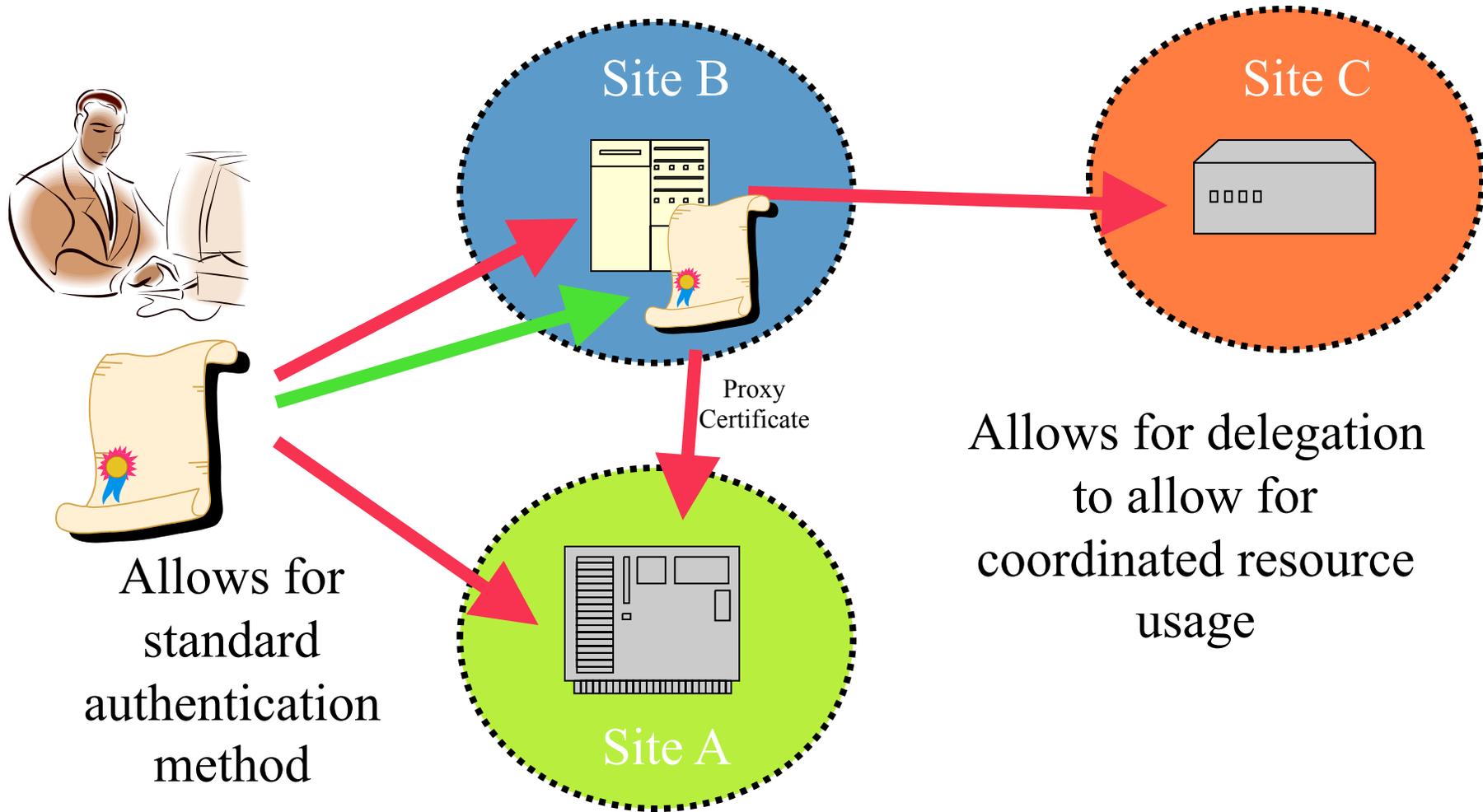


GSI Stack

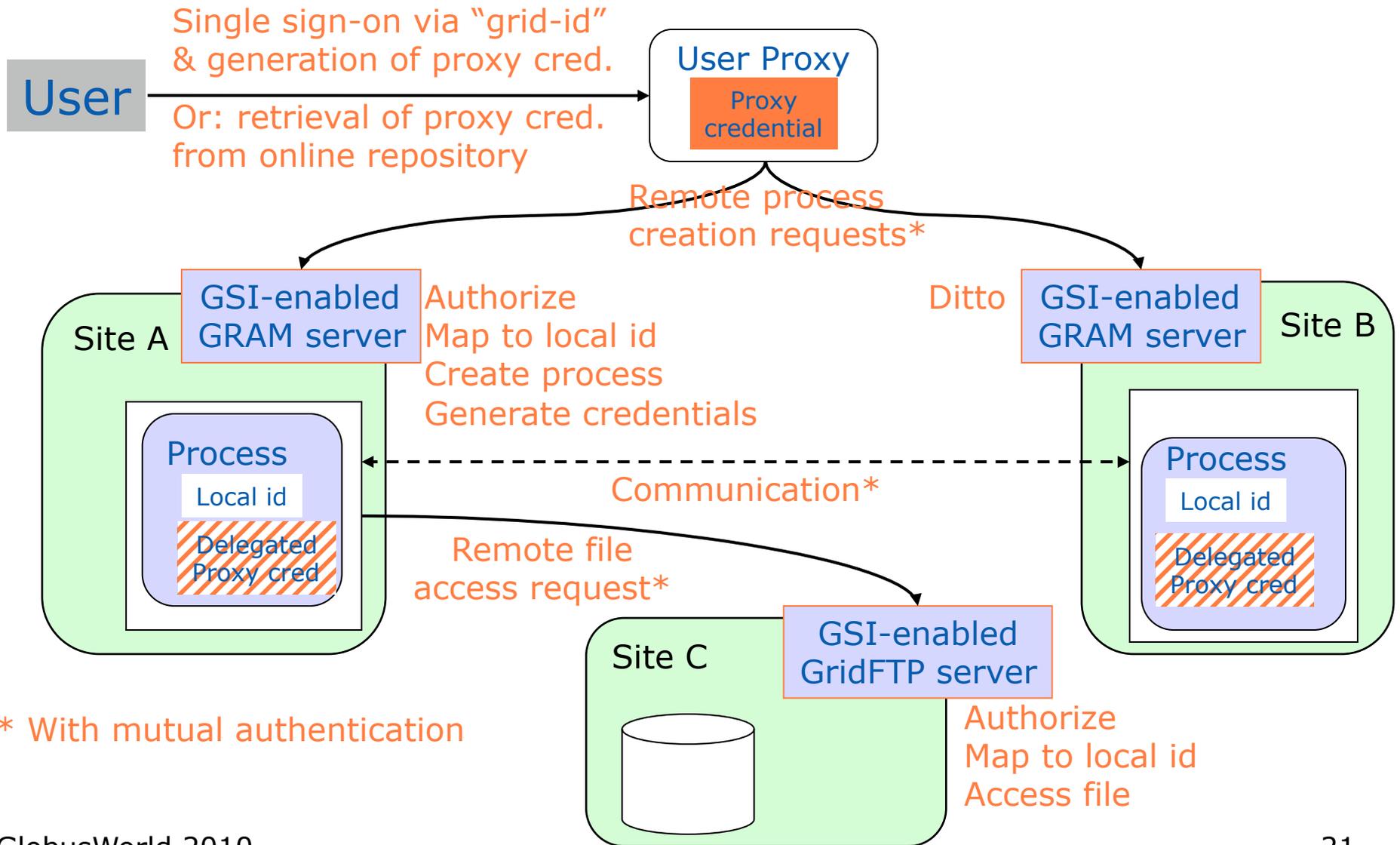




GSI-Enabled Coordination

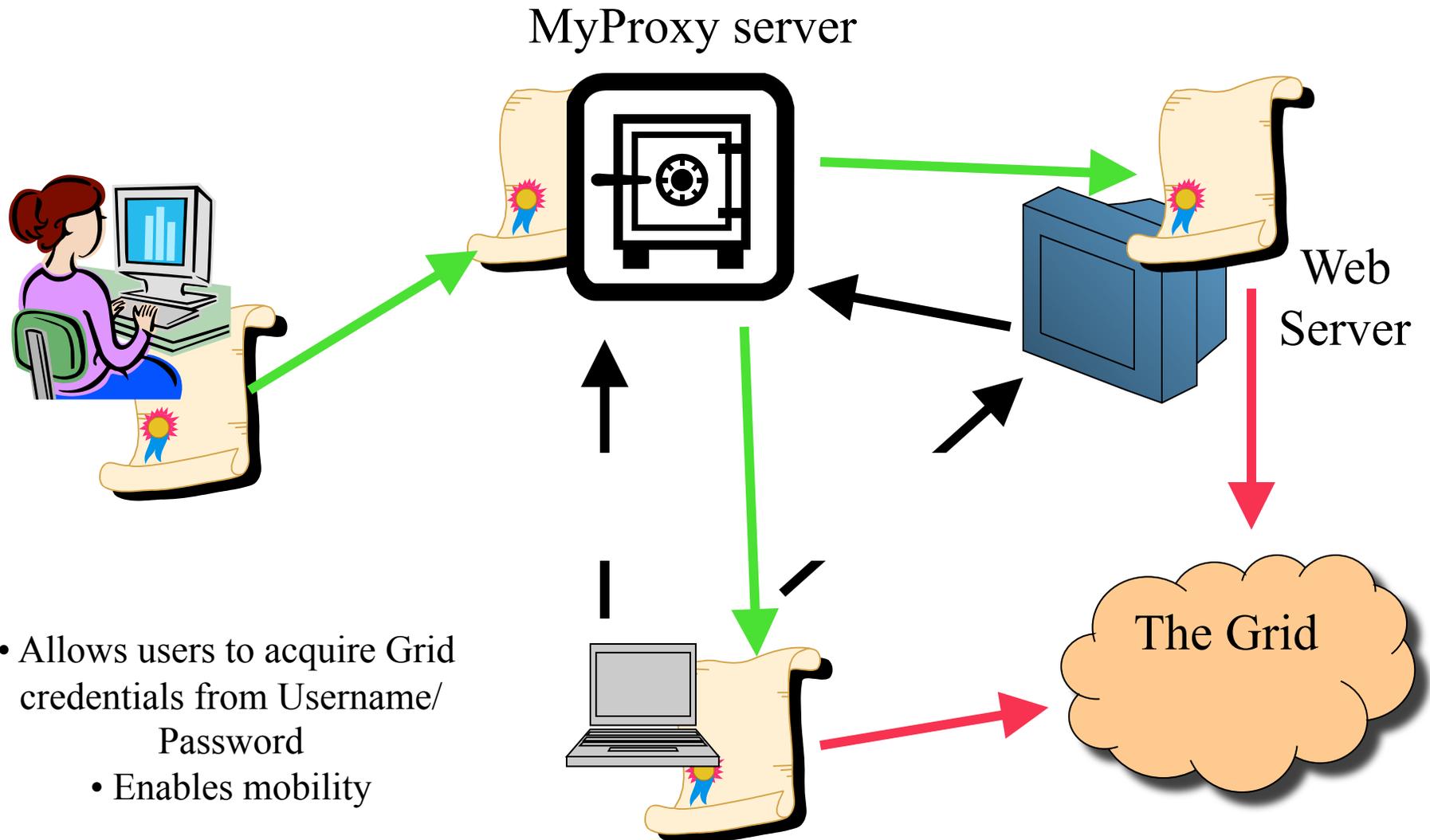


GSI in Action: "Create Processes at A and B that Communicate & Access Files at C"



* With mutual authentication

MyProxy – credential repository





Globus Toolkit 5 Installation Demo

Installation Steps

● Installing Globus

- ◆ `wget http://www.globus.org/ftppub/gt5/5.0/5.0.0/installers/src/gt5.0.0-all-source-installer.tar.bz2`
- ◆ `tar xvfz gt5.0.0-all-source-installer.tar.bz2`
- ◆ `cd gt5.0.0-all-source-installer`
- ◆ `./configure -prefix /path/to/install`
- ◆ `make`
- ◆ `make install`



Fetching User and Host Certs

- <https://pki1.doe grids.org/ca/>
- download the DOE support CA files tarball from <http://pki1.doe grids.org/Other/doe grids.tar>
- `untar it into /etc/grid-security/certificates`
- `cp /etc/grid-security/doe grids/globus-host-ssl.conf.1c3f2ca8 /etc/grid-security/globus-host-ssl.conf`
`cp /etc/grid-security/doe grids/globus-user-ssl.conf.1c3f2ca8 /etc/grid-security/globus-user-ssl.conf`
`cp /etc/grid-security/doe grids/grid-security.conf.1c3f2ca8/etc/grid-security/grid-security.conf`
- run `'grid-cert-request -host <hostname>'` from your Globus install
- Go to <http://pki1.doe grids.org/ca/>
Select "Grid or SSL Server". Paste the Certificate Signing Request into the "PKCS#10 Request" text box. Fill out the rest of the form and "Submit".

GridFTP

What is GridFTP?

- High-performance, reliable data transfer protocol optimized for high-bandwidth wide-area networks
- Based on FTP protocol - defines extensions for high-performance operation and security
- Standardized through Open Grid Forum (OGF)
- GridFTP is the OGF recommended data movement protocol

GridFTP

- We (Globus Alliance) provide a reference implementation:
 - ◆ Server
 - ◆ Client tools (globus-url-copy)
 - ◆ Development Libraries
- Multiple independent implementations can interoperate
 - ◆ Fermi Lab and U. Virginia have home grown servers that work with ours

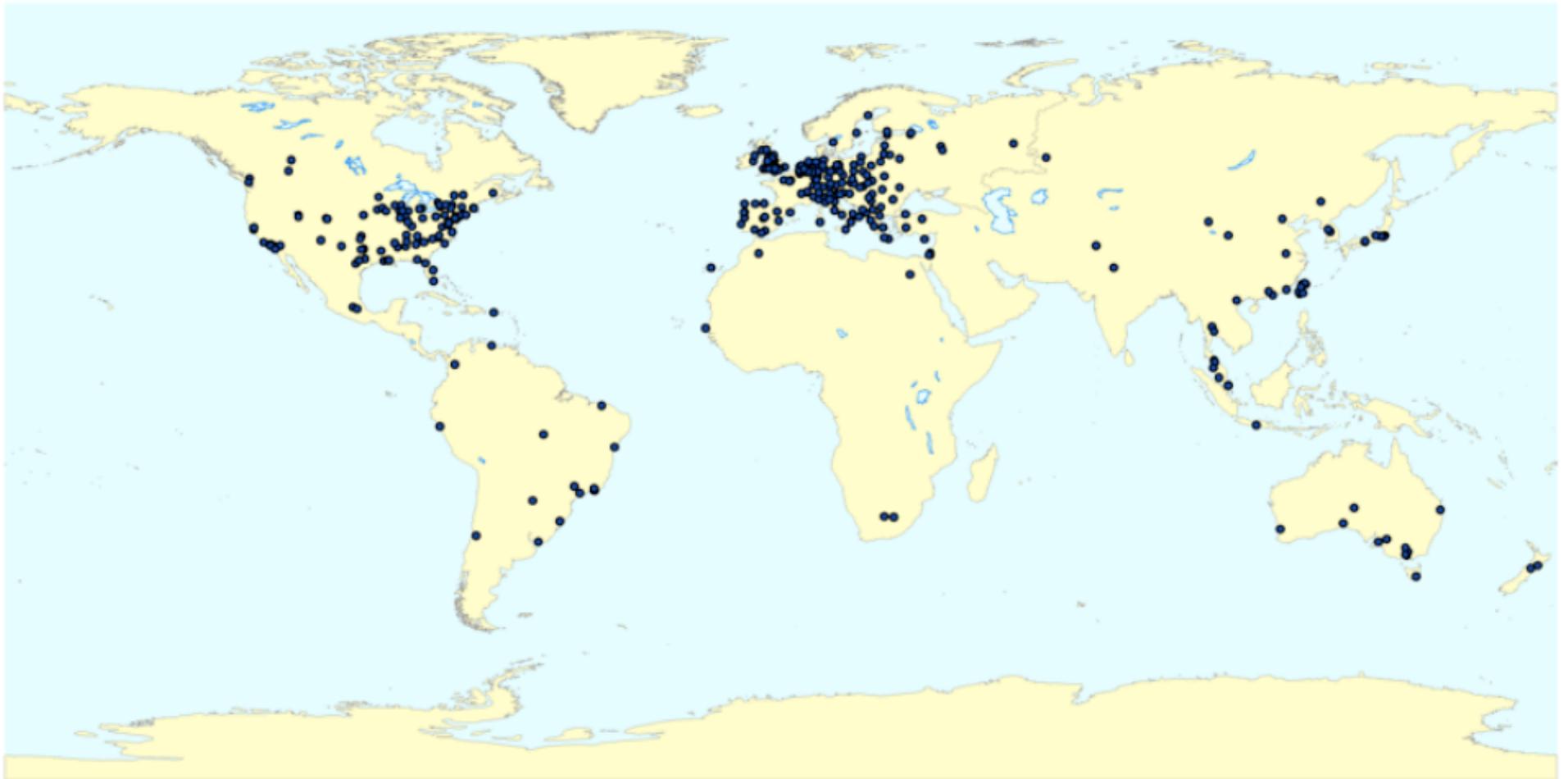
Globus GridFTP

- Performance
 - ◆ Parallel TCP streams, optimal TCP buffer
 - ◆ Non TCP protocol such as UDT
- Cluster-to-cluster data movement
- Multiple security options
 - ◆ Anonymous, password, SSH, GSI
- Support for reliable and restartable transfers



the globus® alliance
dev.globus.org

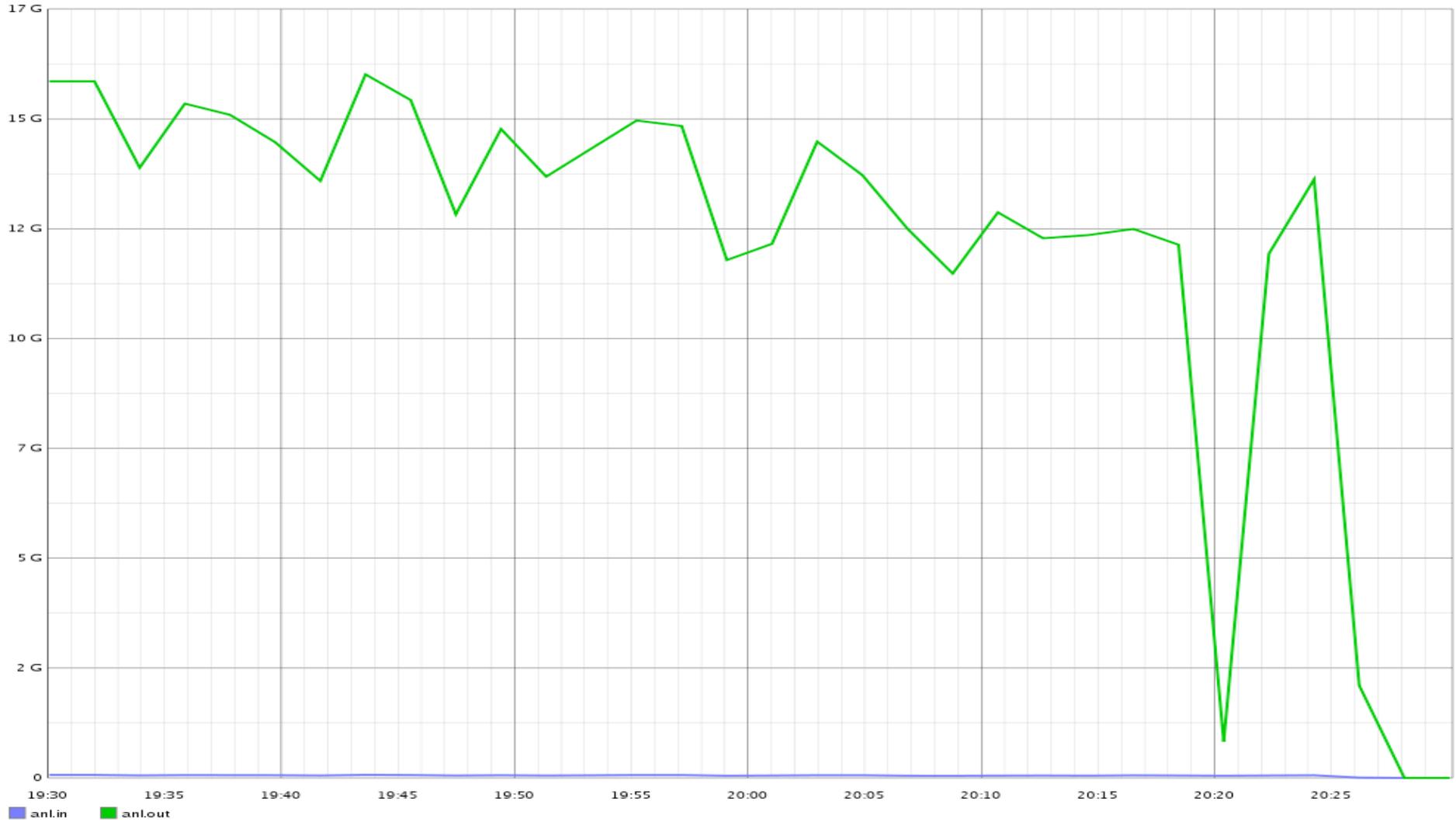
GridFTP Servers Around the World



Created by Tim Pinkawa (Northern Illinois University) using MaxMind's GeoIP technology (<http://www.maxmind.com/app/ip-locate>).



Performance





Understanding GridFTP

- Two channel protocol like FTP
- Control Channel
 - ◆ Command/Response
 - ◆ Used to establish data channels
 - ◆ Basic file system operations eg. mkdir, delete etc
- Data channel
 - ◆ Pathway over which *file* is transferred
 - ◆ Many different underlying protocols can be used
 - MODE command determines the protocol

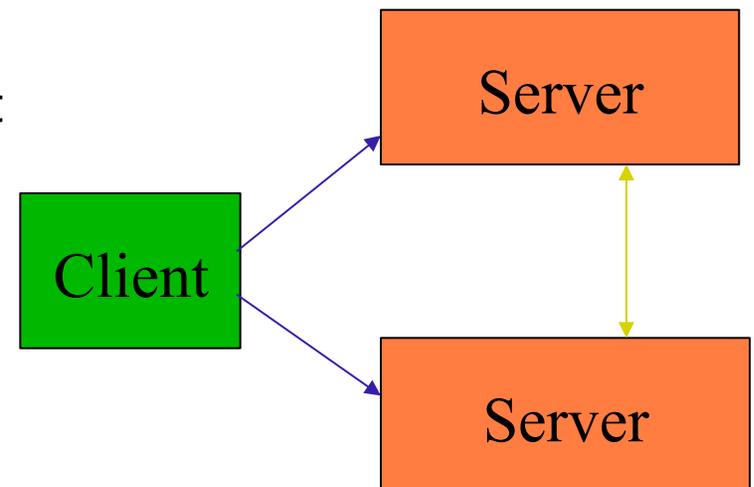
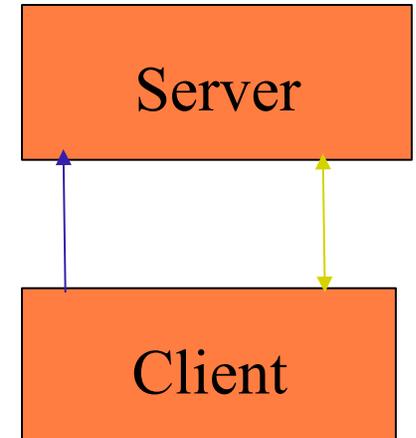
Client/Server and 3rd Party Transfers

- Two party transfer

- ◆ The client connects and forms a CC with the server
- ◆ Information is exchanged to establish the DC
- ◆ A file is transferred over the DC

- Third party transfer

- ◆ Client initiates data transfer between 2 servers
- ◆ Client forms CC with 2 servers.
- ◆ Information is routed through the client to establish DC between the two servers.
- ◆ Data flows directly between servers
- ◆ Client is notified by each server SPI when the transfer is complete

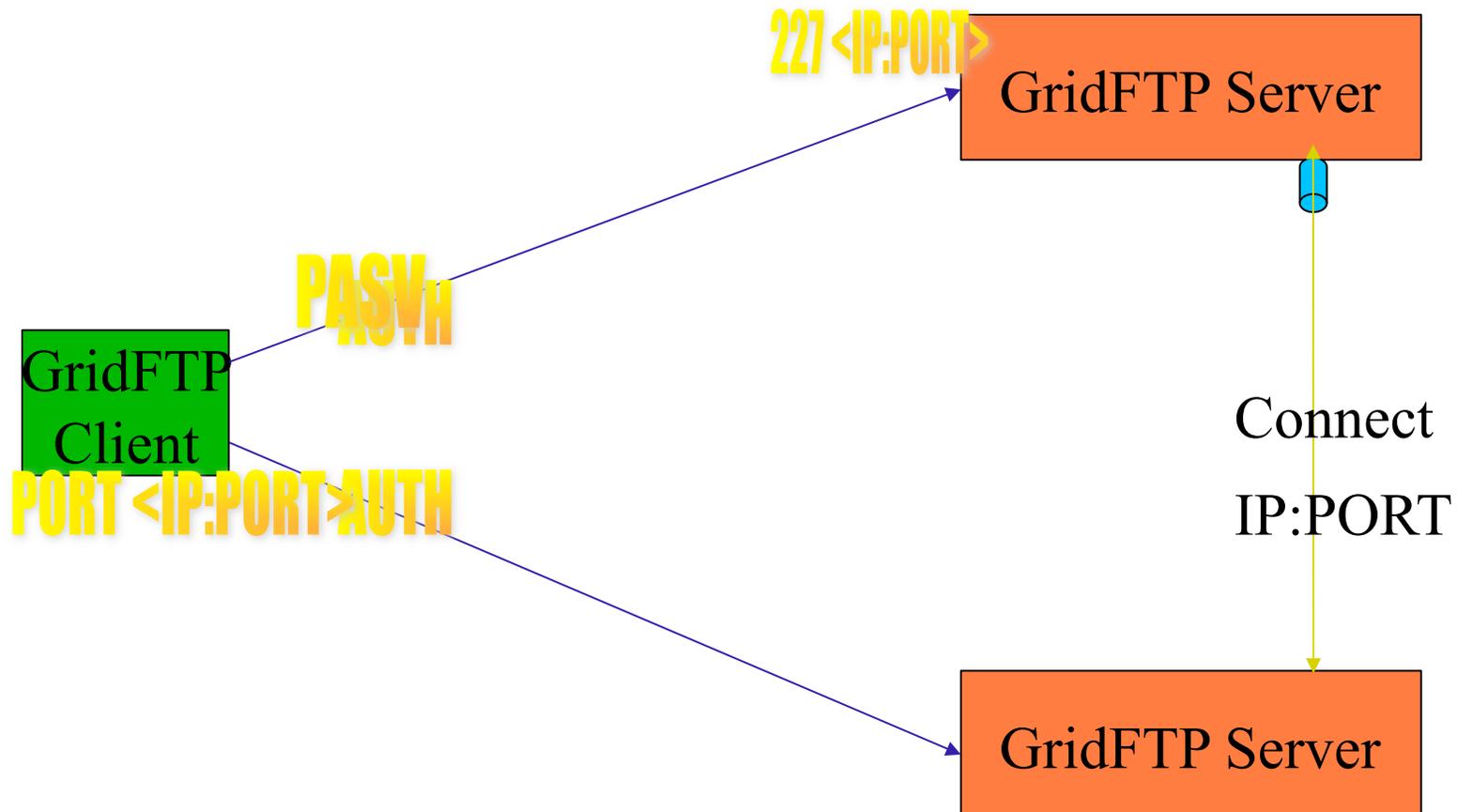




Control Channel Establishment

- Server listens on a well-known port (2811)
- Client form a TCP Connection to server
- 220 banner message
- Authentication
 - ◆ Anonymous
 - ◆ Clear text USER <username>/PASS <pw>
 - ◆ Base 64 encoded GSI handshake
- 230 Accepted/530 Rejected

Data Channel Establishment





Data Channel Protocols

- **MODE Command**
 - ◆ Allows the client to select the data channel protocol
- **MODE S**
 - ◆ Stream mode, no framing
 - ◆ Legacy RFC959
- **MODE E**
 - ◆ GridFTP extension
 - ◆ Parallel TCP streams
 - ◆ Data channel caching

Descriptor (8 bits)	Size (64 bits)	Offset (64 bits)
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Globus-url-copy

- Command line scriptable client
- Globus does not provide an interactive client
- Commonly used client for GridFTP
- Syntax overview
 - ◆ `globus-url-copy [options] srcURL dstURL`
 - ◆ `guc gsiftp://localhost/foo file:///bar`
 - Client/server, using FTP stream mode
 - ◆ `guc -vb -dbg -tcp-bs 1048576 -p 8 gsiftp://localhost/foo gsiftp://localhost/bar`
 - 3rd party transfer, MODE E
- URL rules
 - ◆ `protocol://[user:pass@][host]/path`
 - ◆ host can be anything resolvable - IP address, localhost, DNS name



Demonstration

- globus-gridftp-server options
 - ◆ globus-gridftp-server --help
- Start the server in anonymous mode
 - ◆ globus-gridftp-server -control-interface 127.0.0.1 -aa -p 5000
- Run a two party transfer
 - ◆ globus-url-copy -v <file:///etc/group> <ftp://localhost:5000/tmp/group>
- Run 3rd party transfer
 - ◆ globus-url-copy -v <ftp://localhost:<port>/etc/group> <ftp://localhost:<port>/tmp/group2>
- Experiment with -dbg, -vb -fast options
 - ◆ globus-url-copy -dbg <file:///etc/group> <ftp://localhost:5000/tmp/group>
 - ◆ globus-url-copy -vb <file:///dev/zero> <ftp://localhost:5000/dev/null>
- Kill the server

Demonstration

Examine debug output

- TCP connection formed from client to server
- Control connection authenticated
- Several session establishment options sent
- Data channel established
 - ◆ PASV sent to server
 - Server begins listening and replies to client with contact info
 - ◆ Client connected to the listener
 - ◆ File is sent across data connection

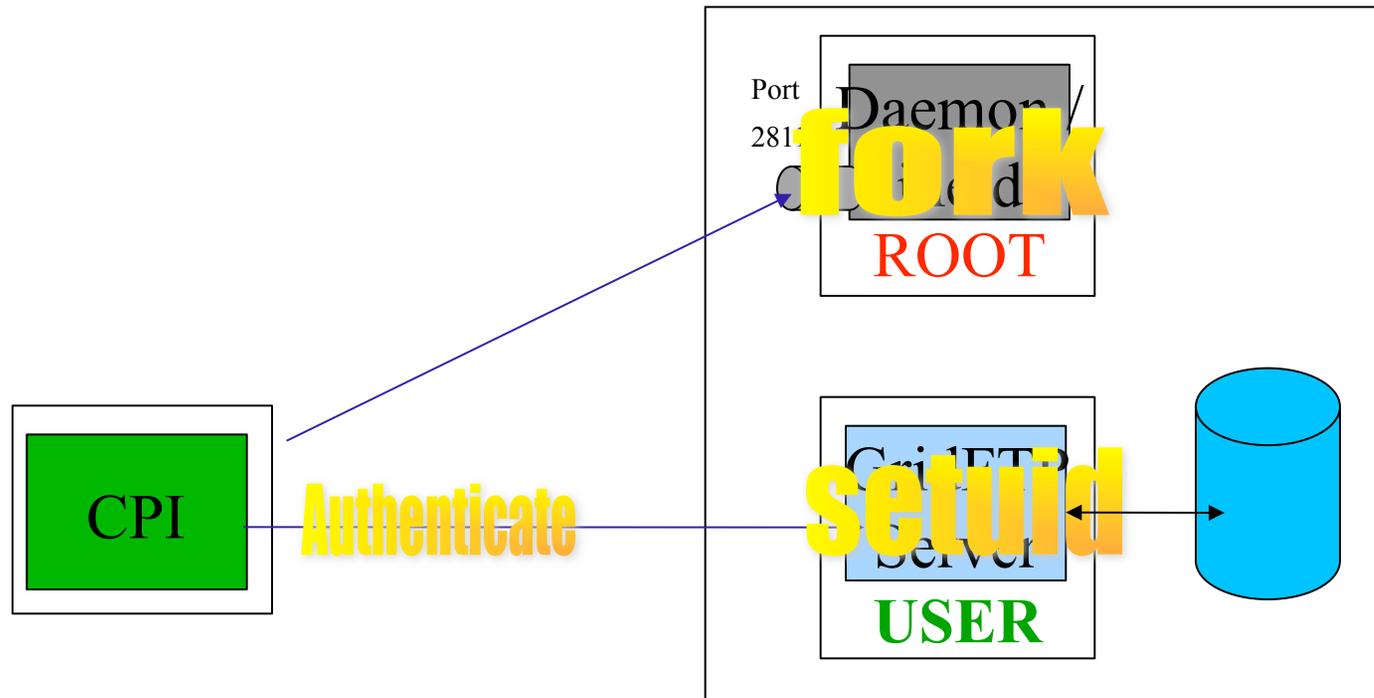
Security Options

- Clear text (RFC 959)
 - ◆ Username/password
 - ◆ Anonymous mode (anonymous/<email addr>)
 - ◆ Password file
- SSHFTP
 - ◆ Use ssh/sshd to form the control connection
- GSIFTP
 - ◆ Authenticate control and data channels with GSI

User Permissions

- User is mapped to a local account and file permissions are handled by the OS
- `inetd` or daemon mode
 - ◆ Daemon mode - GridFTP server is started by hand and listens for connections on port 2811
 - ◆ `Inetd/xinetd` - super server daemon that manages internet services
 - ◆ `Inetd` can be configured to start up a GridFTP server upon receiving a connection on port 2811

inetd/daemon Interactions





(x)inetd Entry Examples

● xinetd

```
service gsiftp
{
    socket_type = stream
    protocol = tcp
    wait = no
    user = root
    env += GLOBUS_LOCATION=<GLOBUS_LOCATION>
    env += LD_LIBRARY_PATH=<GLOBUS_LOCATION>/lib
    server = <GLOBUS_LOCATION>/sbin/globus-gridftp-server
    server_args = -i
    disable = no
}
```

● inetd

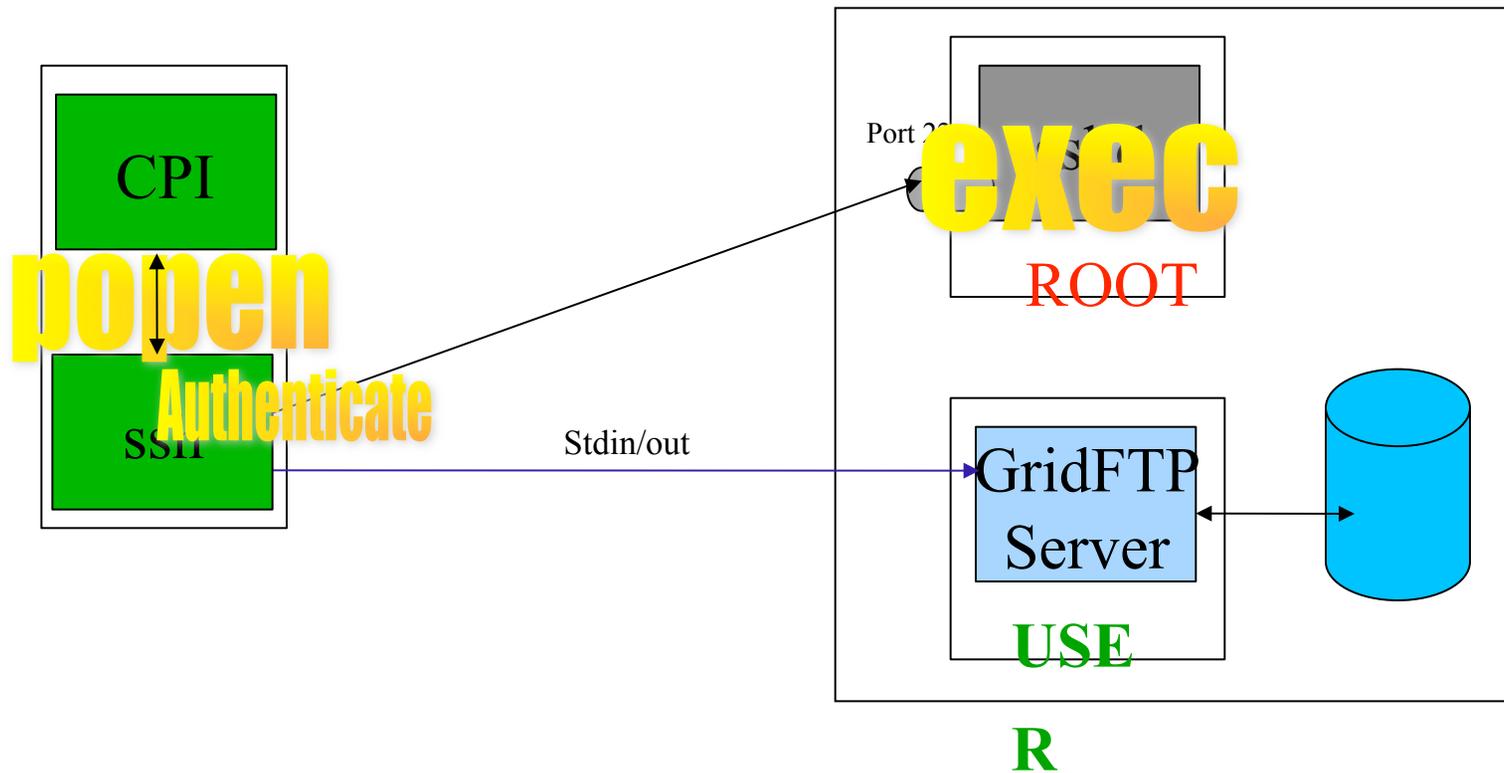
```
gsiftp stream tcp nowait root /usr/bin/env env \
    GLOBUS_LOCATION=<GLOBUS_LOCATION> \
    LD_LIBRARY_PATH=<GLOBUS_LOCATION>/lib \
    <GLOBUS_LOCATION>/sbin/globus-gridftp-server -i
```

- Remember to add 'gsiftp' to /etc/services with port 2811.

GridFTP Over SSH

- sshd acts similar to inetd
- control channel is routed over ssh
 - ◆ globus-url-copy *popens* ssh
 - ◆ ssh authenticates with sshd
 - ◆ ssh/sshd remotely starts the GridFTP server as user
 - ◆ stdin/out becomes the control channel

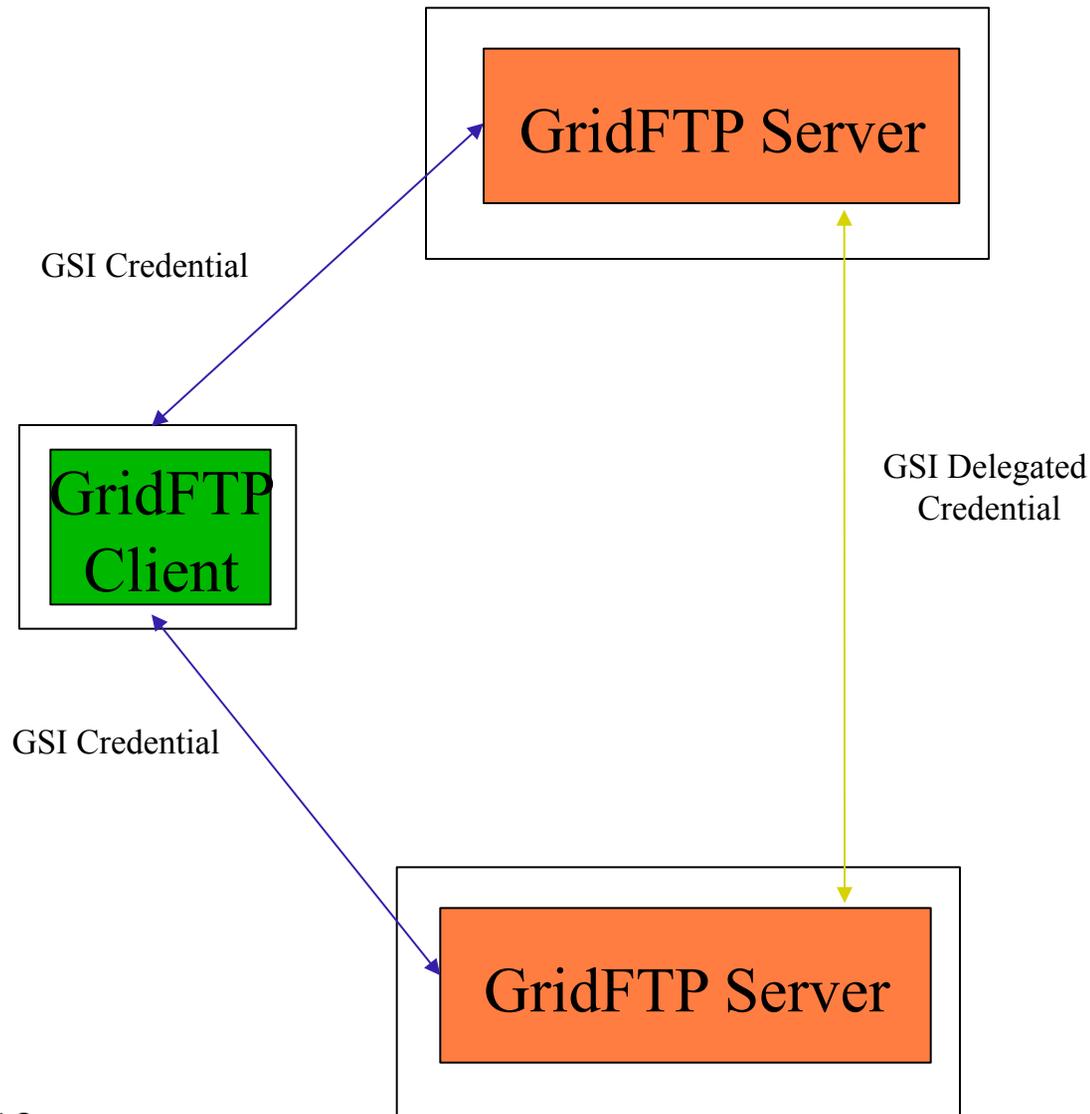
sshftp:// Interactions



GSI Authentication

- Strong security on both channels
 - ◆ SSH does not give us data channel security
- Delegation
 - ◆ Authenticates DC on clients behalf
 - ◆ Flexibility for grid services such as RFT
 - Agents can authenticate to GridFTP servers on users behalf
 - ◆ Enables encryption, integrity on data channel

GSI Authentication



Troubleshooting

- Can I get connected?
 - ◆ telnet to the port: telnet hostname port
 - ◆ 2811 is the default port
- You should get something like this:
 - ◆ <add GridFTP banner>
- If not, you have firewall problems, or server config problems.



Troubleshooting

- no proxy
 - ◆ grid-proxy-destroy
 - ◆ guc gsiftp://localhost/dev/zero file:///dev/null
 - ◆ add -dbg
 - ◆ grid-proxy-init
 - ◆ guc gsiftp://localhost/dev/zero file:///dev/null
 - ◆ add -dbg



Setting TCP buffer sizes

- It is critical to use the optimal TCP send and receive socket buffer sizes for the link you are using.
 - ◆ Recommended size to fill the pipe
 - 2 x Bandwidth Delay Product (BDP)
 - ◆ Recommended size to leave some bandwidth for others
 - around 20% of (2 x BDP) = .4 * BDP



Setting TCP buffer sizes

- Default TCP buffer sizes are way too small for today's high speed networks
 - ◆ Until recently, default TCP send/receive buffers were typically 64 KB
 - ◆ tuned buffer to fill Argonne to LBL link: **8 MB**
 - 125X bigger than the default buffer size
 - ◆ with default TCP buffers, you can only get a small % of the available bandwidth!

TCP tuning

- Many OS's now include TCP autotuning
 - ◆ TCP send buffer starts at 64 KB
 - ◆ As the data transfer takes place, the buffer size is continuously re-adjusted up to max autotuning size

- Default autotuning maximum buffers on Linux 2.6: 256K to 1MB, depending on version

```
net.core.rmem_max = 16777216
```

```
net.core.wmem_max = 16777216
```

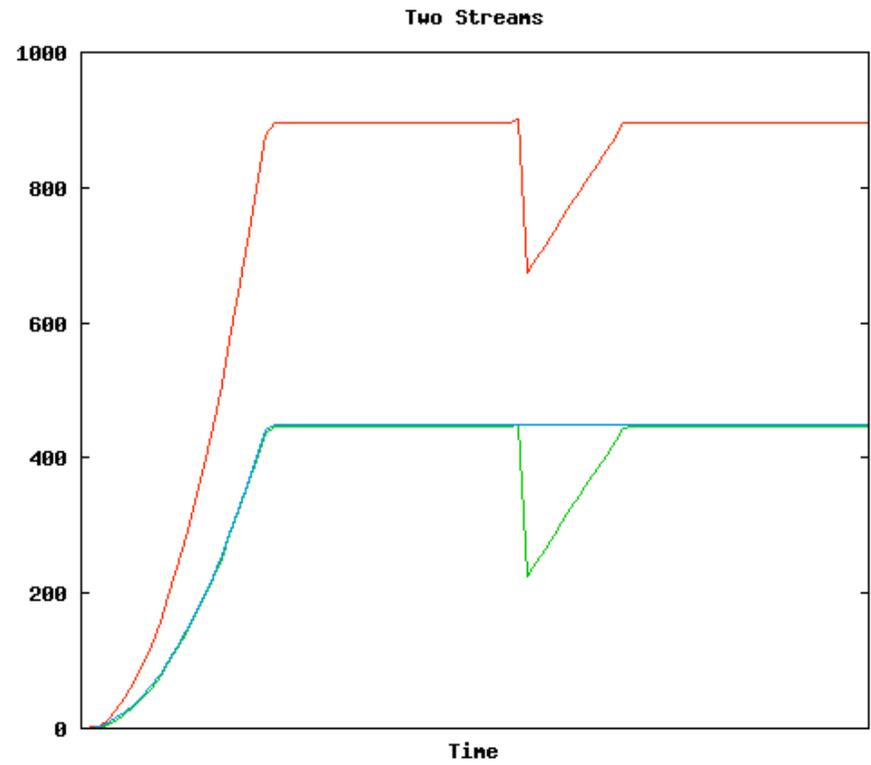
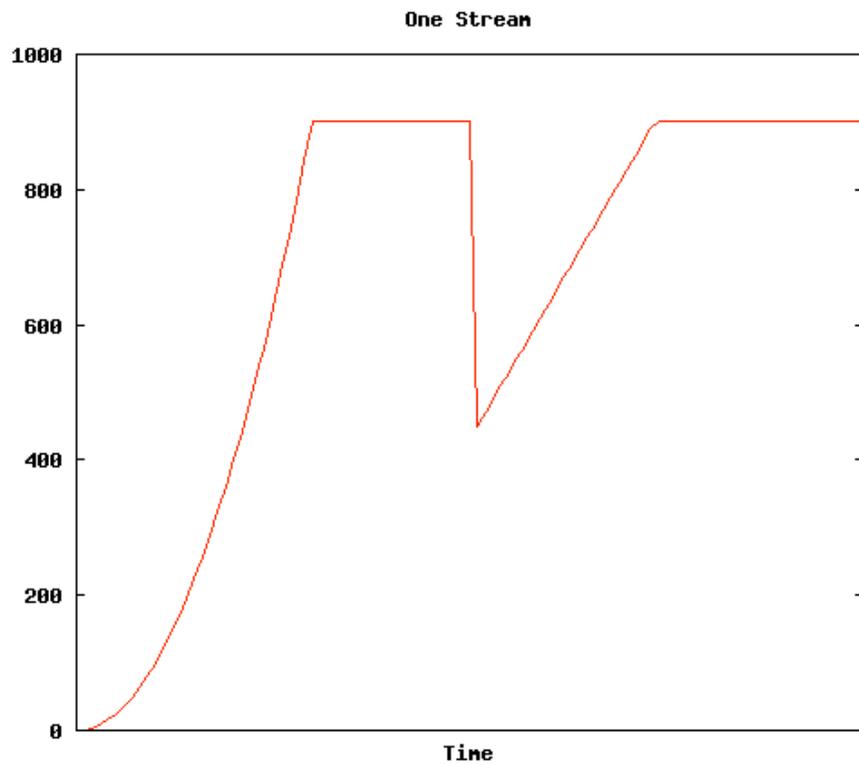
```
# autotuning min, default, and max number of bytes to use
```

```
net.ipv4.tcp_rmem = 4096 87380 16777216
```

```
net.ipv4.tcp_wmem = 4096 65536 16777216
```

- <http://fasterdata.es.net/TCP-tuning/>

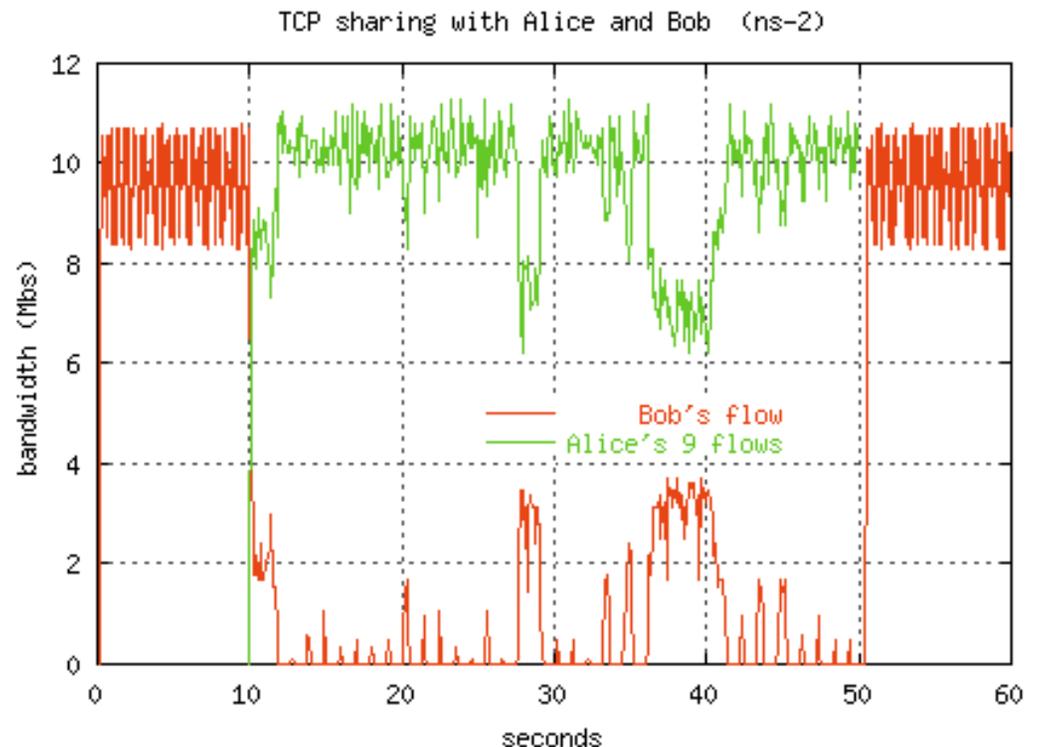
Parallel Streams





Parallel TCP Streams

- Potentially unfair
- Reduces the severity of a congestion event
 - ◆ Only effects $1/p$ of the overall transfer
- Faster recovery
 - ◆ Smaller size to recover
- But they are necessary when you don't have root access, and can't convince the sysadmin to increase the max TCP buffers



graph from Tom Dunigan, ORNL



Data channel caching

- Establishing a data channel can be expensive
 - ◆ Round trips over high latency links
 - ◆ Security handshake can be expensive
- Mode E introduces data channel caching
 - ◆ Mode S closes the connection to indicate end of data
 - ◆ Mode E uses meta data to indicate file barriers
 - Doesn't need to close

Descriptor (8 bits)	Size (64 bits)	Offset (64 bits)
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Demonstration Performance

- Transfer on a real network
 - ◆ Show performance markers
 - ◆ Show transfer rate
- Calculate the BWDP
- Vary -tcp-bs
- Vary -p



Data Channel Protocols

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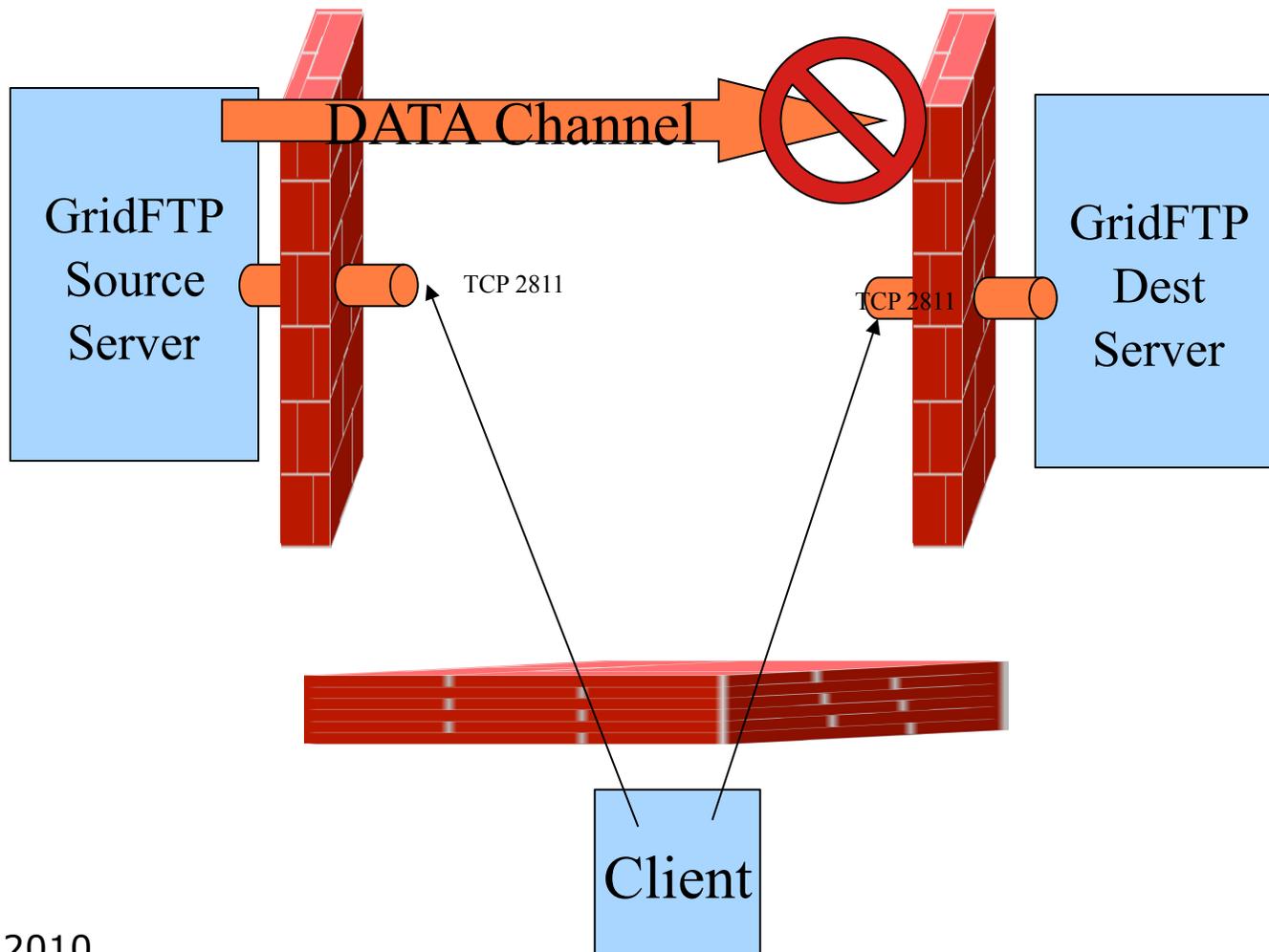
Descriptor (8 bits)	Size (64 bits)	Offset (64 bits)
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Firewall

- Control channel port is statically assigned
- Data channel ports dynamically assigned
- Mode E requires that the data sender make an active connection

Firewall

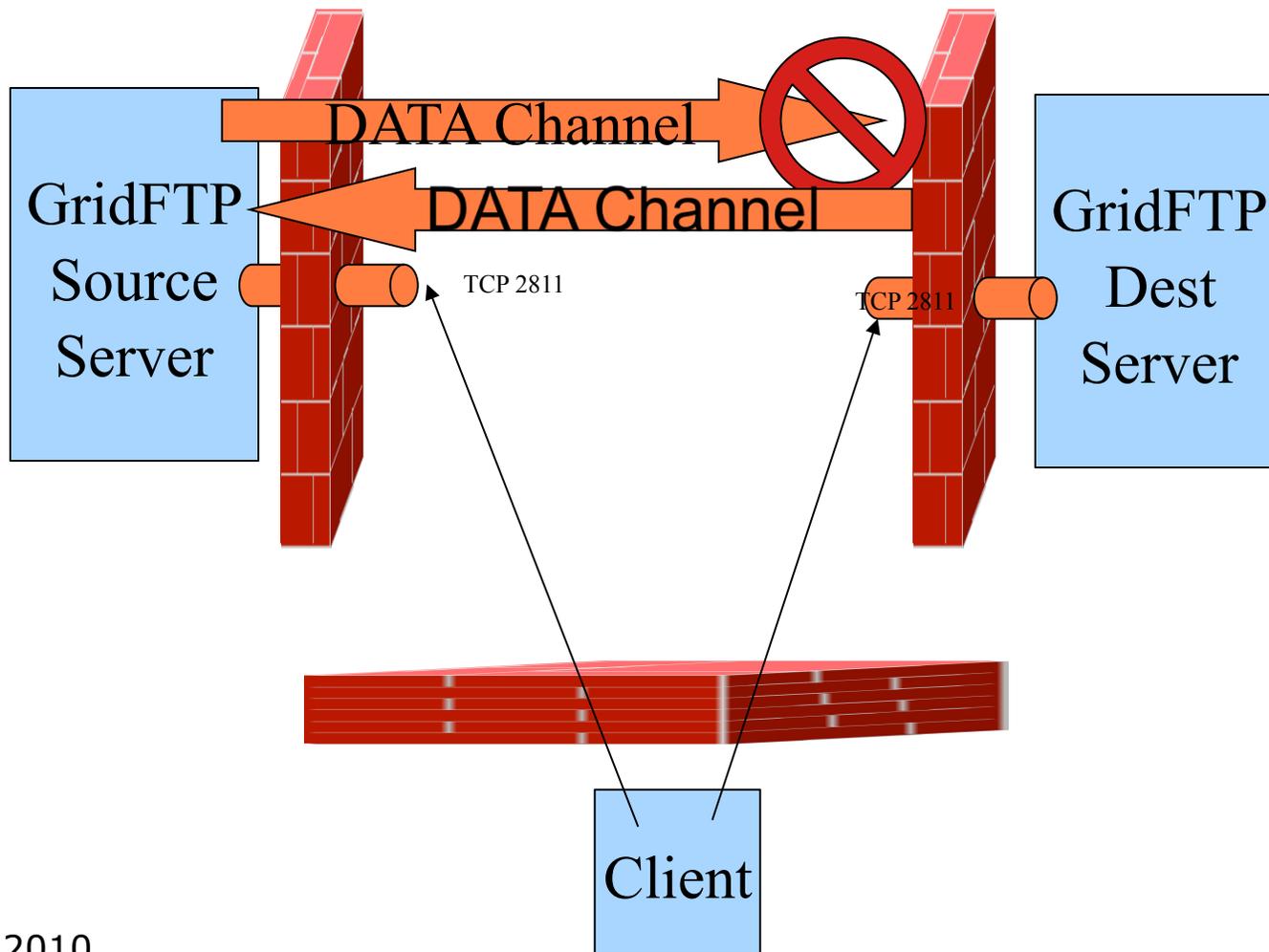
- Outgoing allowed at sender, incoming blocked at receiver



Firewall

- Outgoing allowed at sender, incoming blocked at receiver

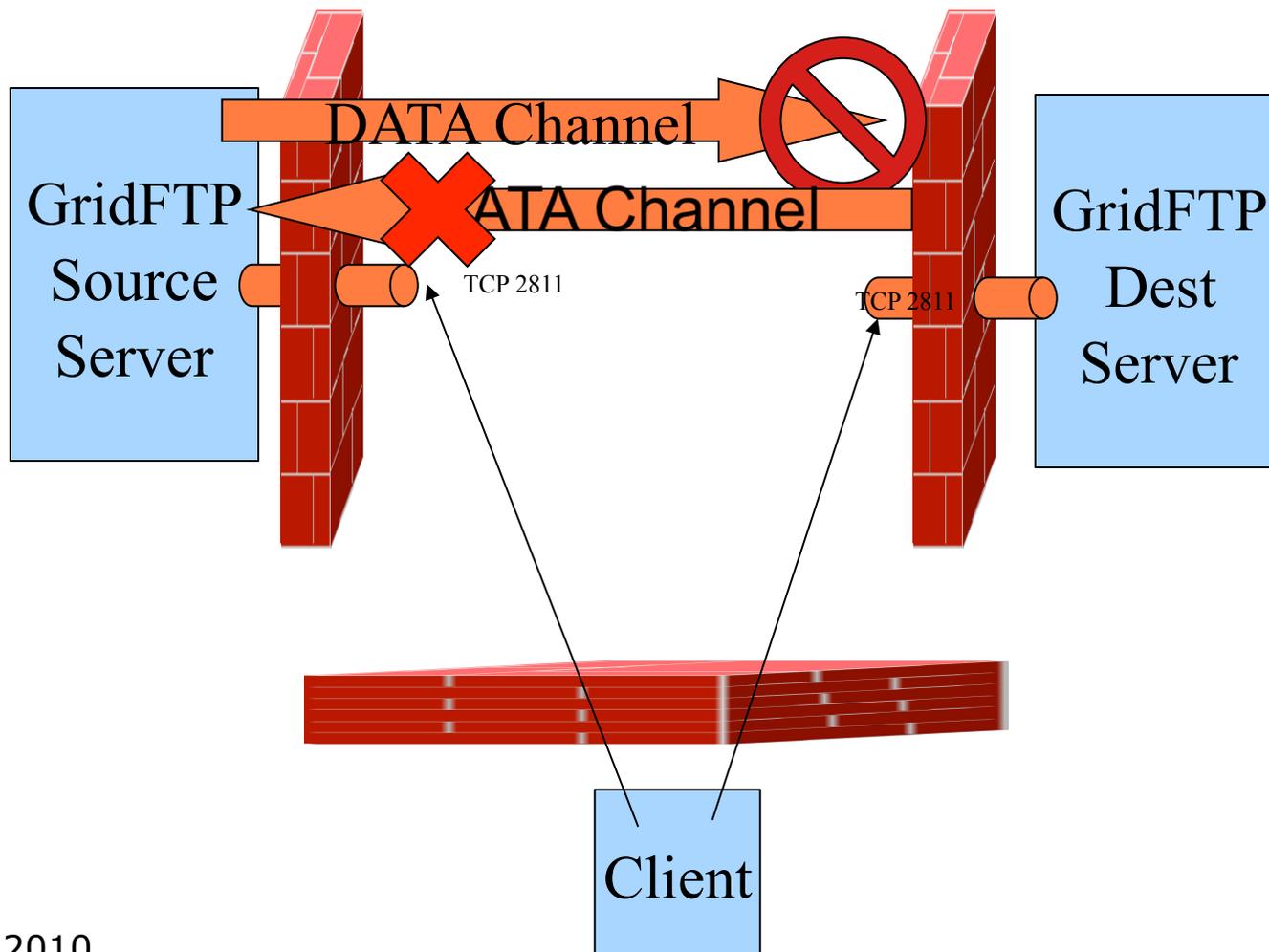
Mode S



Firewall

- Outgoing allowed at sender, incoming blocked at receiver

Mode E



Firewall

- Open a port range on the receiver's ends firewall and set `GLOBUS_TCP_PORT_RANGE` to that open range
- 50000-51000 is the recommended port range for data channel connections
- `export GLOBUS_TCP_PORT_RANGE = 50000,51000`

Firewall

- **Outgoing blocked at sender**
 - ◆ Can open a range of ports for outgoing connections to specific set of remote hosts (any remote port)
 - ◆ Use `GLOBUS_TCP_SOURCE_RANGE` to make the local end bound to a specified range
 - ◆ If outgoing connections can be opened up only for specific remote port range at specific remote hosts
 - firewall rule needs to be modified on a case-by-case basis



Partial File Transfer

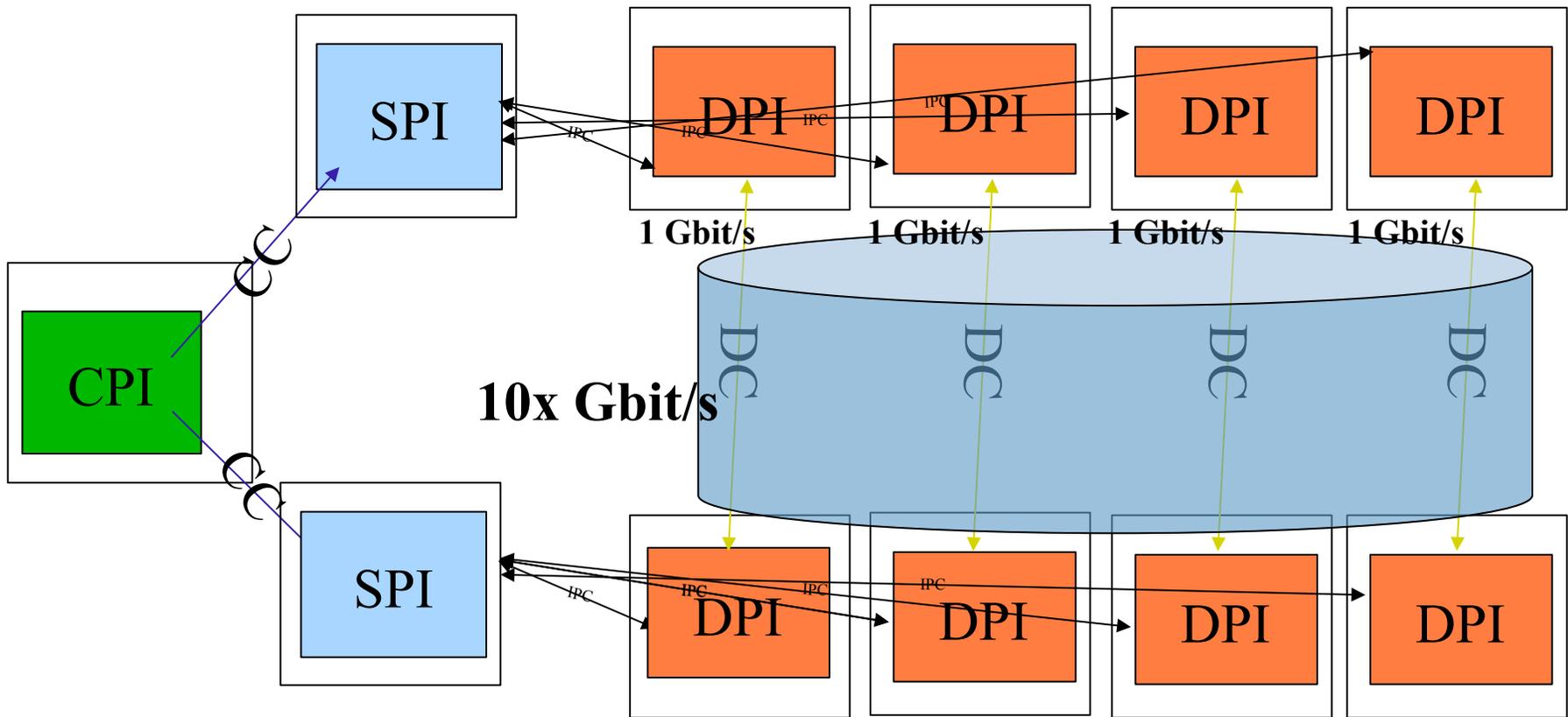
- Large file transfer fails
 - ◆ We don't want to start completely over
 - ◆ Ideally we start where we left off
- Restart markers sent periodically
 - ◆ Contain blocks written to disk
 - ◆ Sent every 5s by default
 - ◆ In worst case recovery sends 5s of redundant data



Striping or Cluster-to-cluster transfer

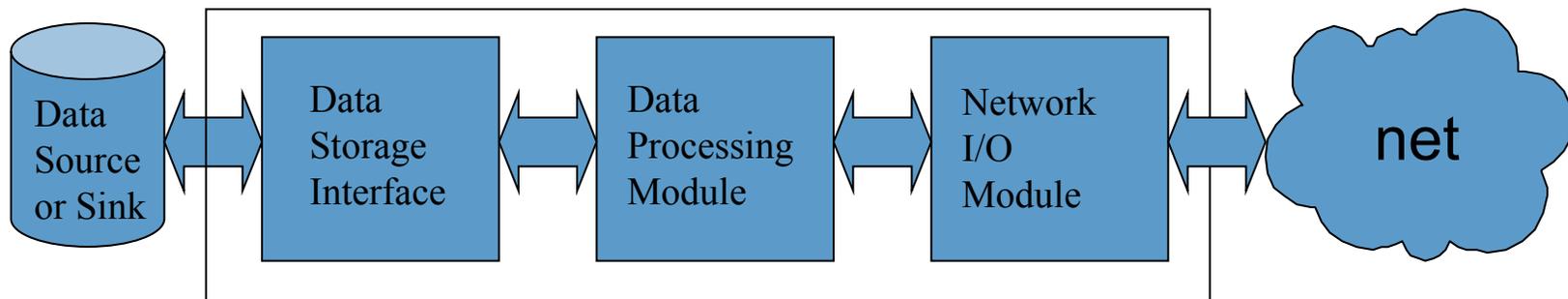
- A coordinated transfer between multiple nodes at end of the transfer
 - ◆ 1 SPI at each end
 - ◆ Many DPIs per SPI
 - ◆ Each DPI transfers a portion of the file
 - ◆ Allows for fast transfers
 - ◆ Many NICs per transfer

Cluster-to-cluster transfer



Modular

- Globus GridFTP is based on XIO and is modular
- Well-defined interfaces



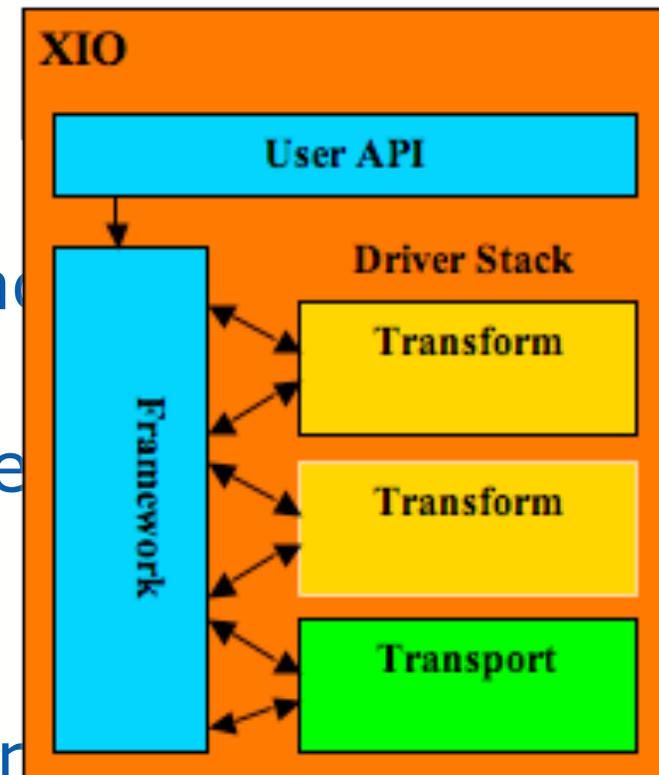


Data Storage Interface (DSI)

- Number of storage systems in use by the scientific and engineering community
 - ◆ High Performance Storage System (HPSS)
 - ◆ Distributed File System (DFS)
 - ◆ Storage Resource Broker (SRB)
- Use incompatible protocols for accessing data and require the use of their own clients
- Modular abstraction to storage systems

Globus XIO

- Framework to compose different protocols
- Provides a unified interface open/close/read/write
- Driver interface to hook 3rd party protocol libraries





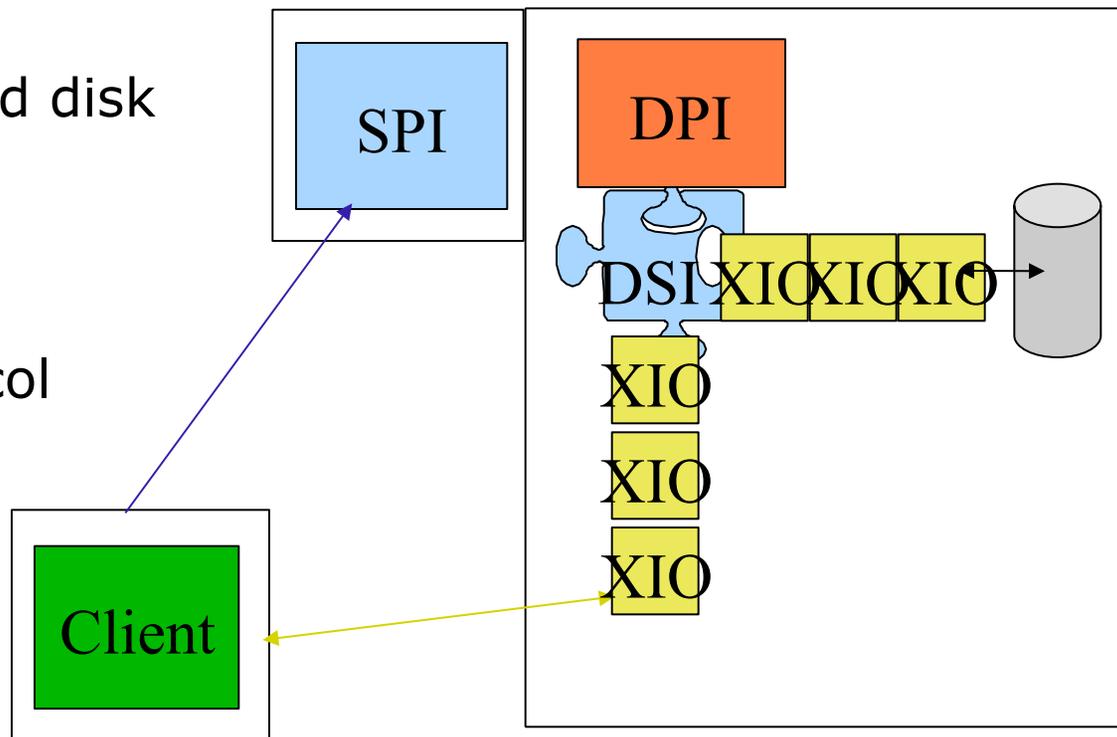
Alternative stacks

- All I/O in GridFTP is done with Globus XIO
 - ◆ data channel and disk
- XIO allows you to set an I/O software stack
 - ◆ transport and transform drivers
 - ◆ ex: compression, gsi,tcp
- Substitute UDT for TCP
- Add BW limiting, or netlogger

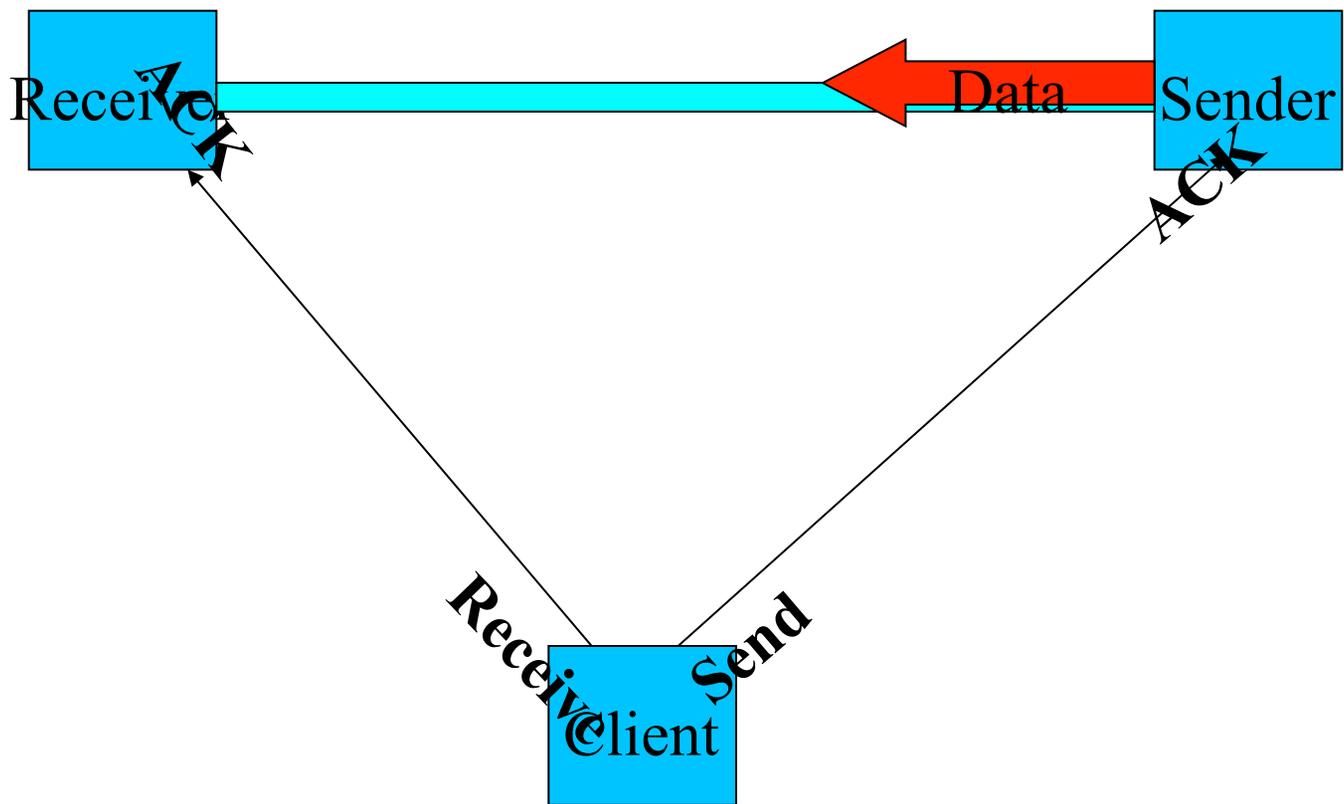
XIO Driver Stacks

- All data passes through XIO driver stacks

- ◆ to network and disk
- ◆ observe data
- ◆ change data
- ◆ change protocol



Lots of Small Files (LOSF) Problem



Concurrency

- Use concurrency optimization for transferring lots of small files
- What is a small file?
 - ◆ Depends on the network bandwidth and latency
 - ◆ Files of size ≤ 100 MB
- Transfer multiple files concurrently
 - ◆ `globus-url-copy -cc`

GRAM



What is GRAM?

- GRAM is a Globus Toolkit component
 - ◆ For Grid *job management*
- GRAM is a unifying remote interface to Resource Managers
 - ◆ Yet preserves local site security/control
- GRAM provides stateful job control
 - ◆ Reliable create operation
 - ◆ Asynchronous monitoring and control
 - ◆ Remote credential management
 - ◆ Remote file staging and file cleanup

Grid Job Management Goals

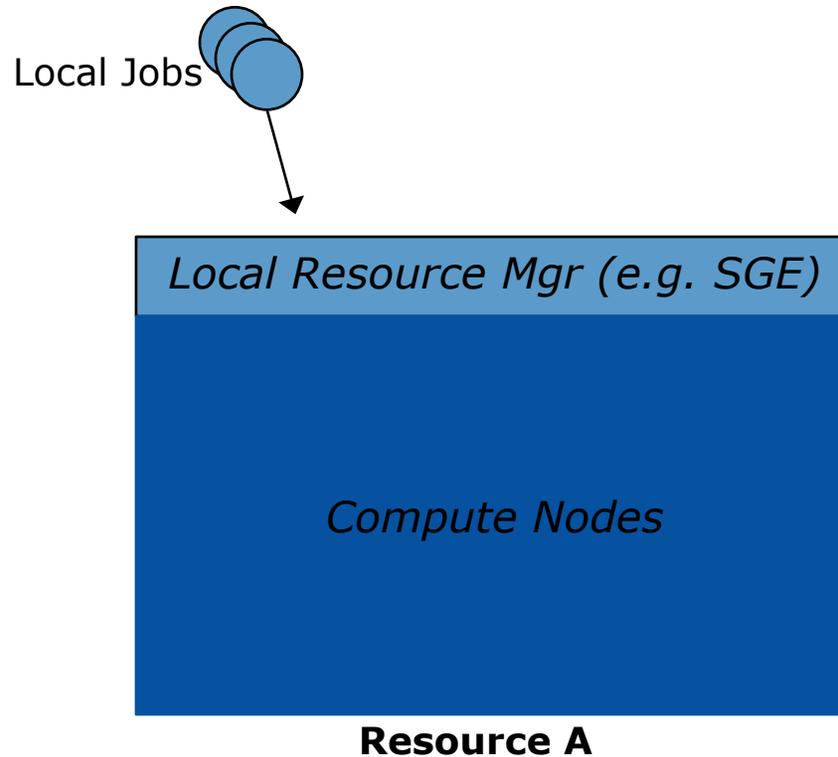
Provide a service to securely:

- Create an environment for a job
- Stage files to/from environment
- Cause execution of job process(es)
 - ◆ Via various local resource managers
- Monitor execution
- Signal important state changes to client



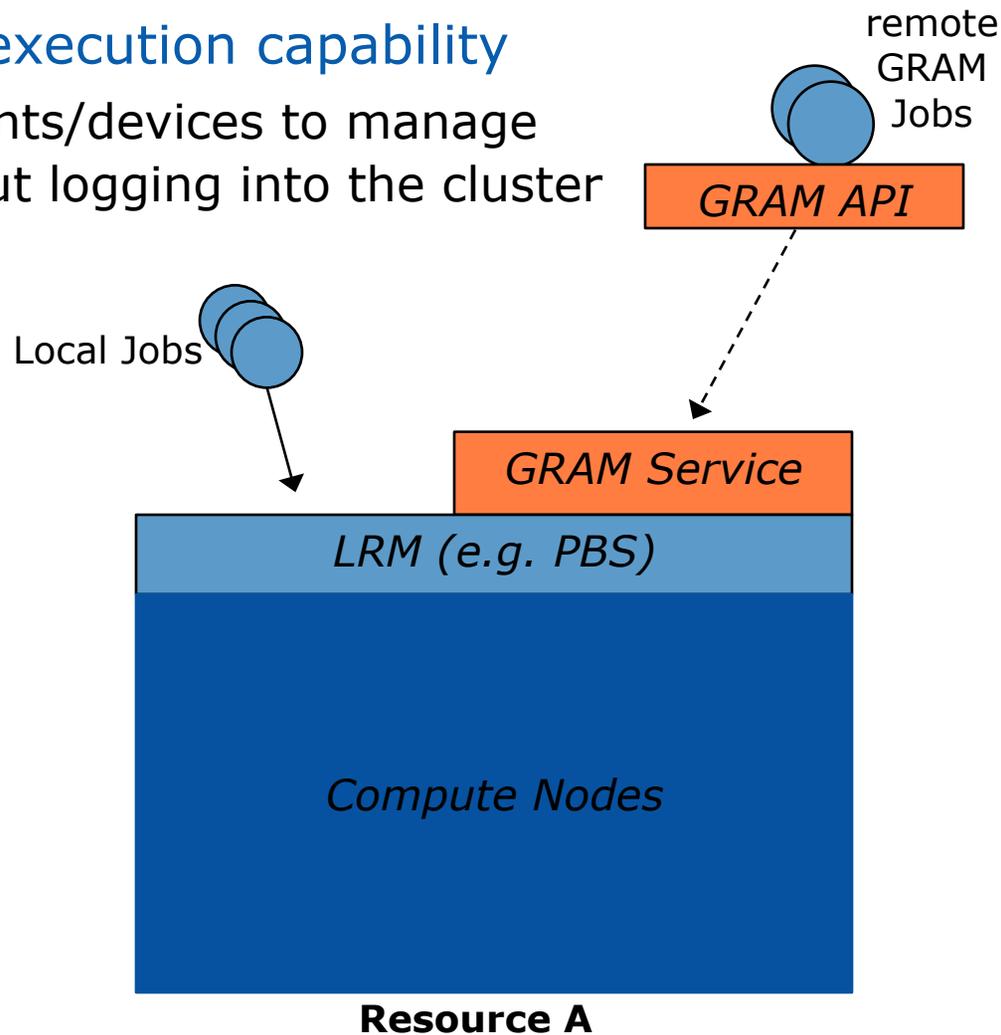
Traditional Interaction

- Satisfies many use cases
- TACC's Ranger (62976 cores!) is the Costco of HTC ;-), one stop shopping, why do we need more?



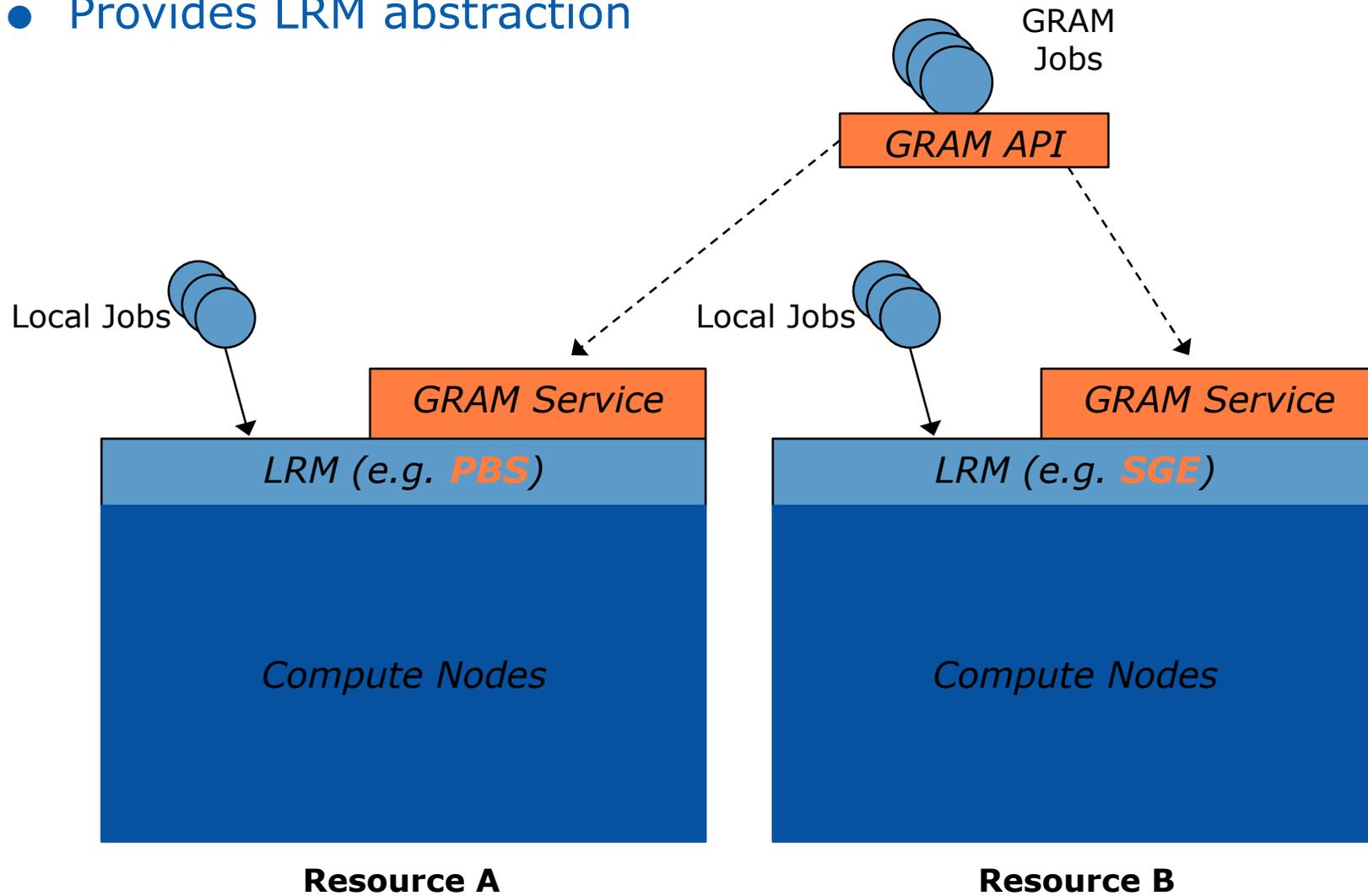
GRAM Benefit

- Add remote execution capability
 - ◆ Enable clients/devices to manage jobs without logging into the cluster



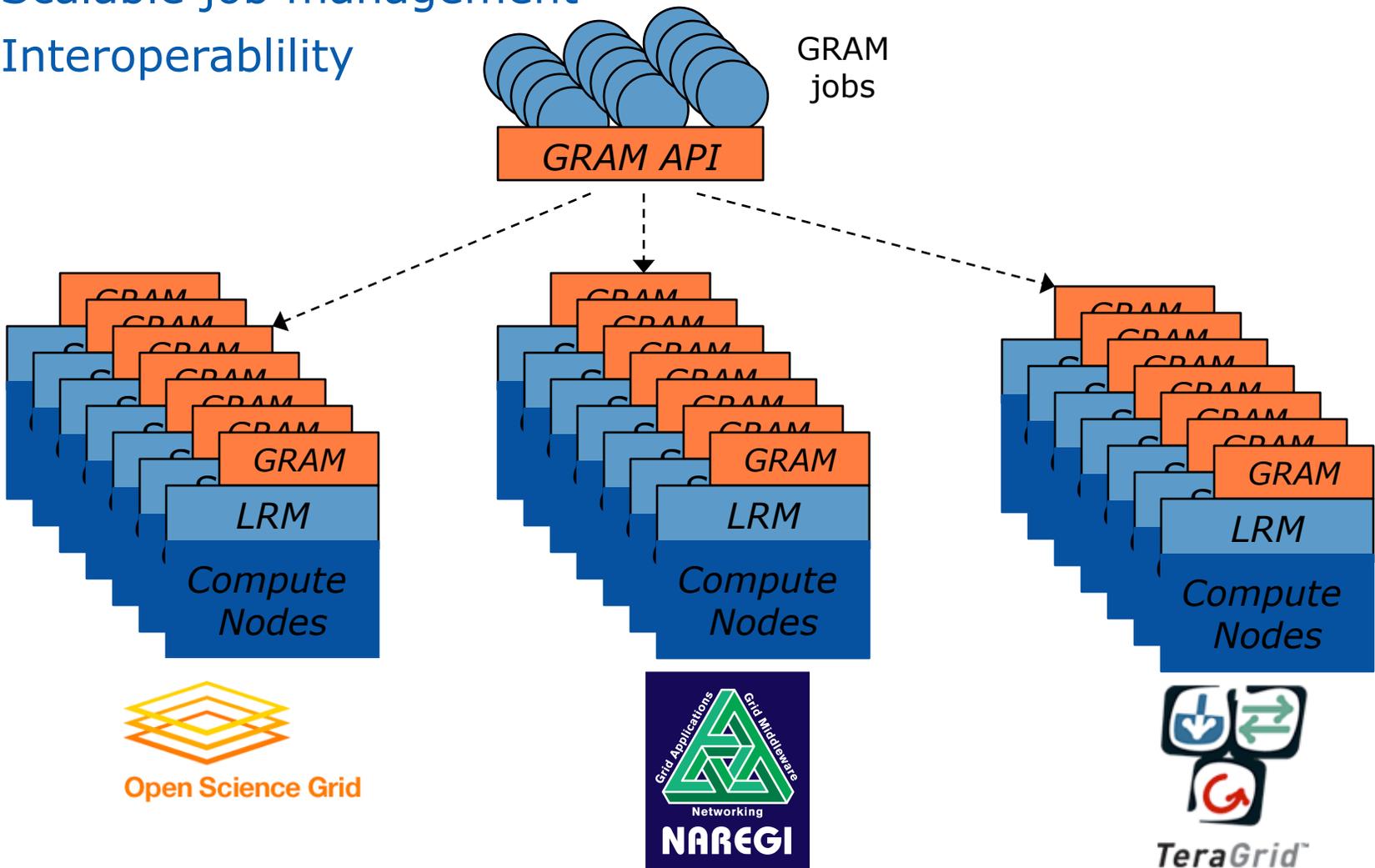
GRAM Benefit

- Provides LRM abstraction



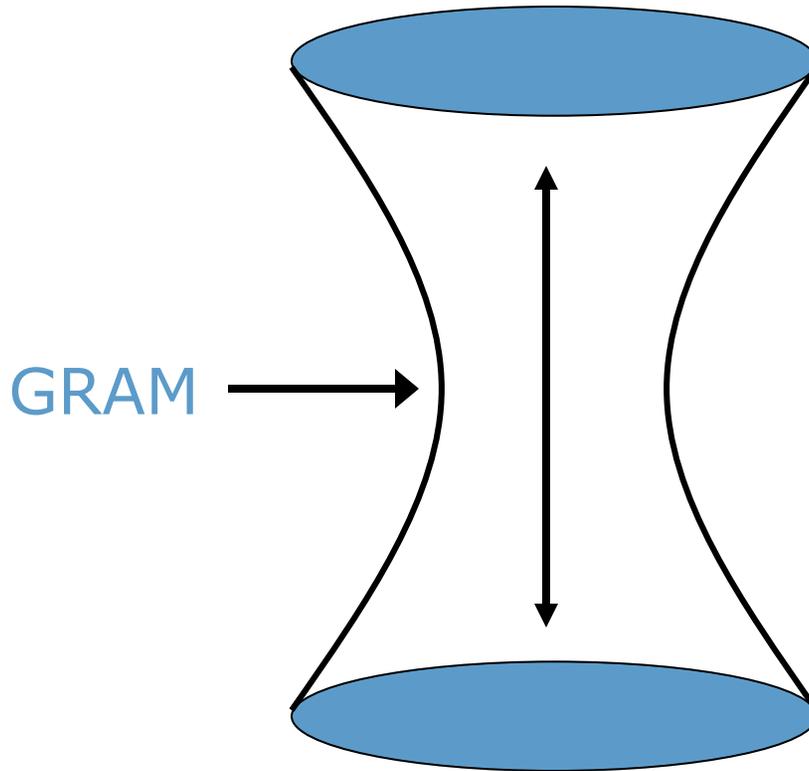
GRAM Benefit

- Scalable job management
- Interoperability





Users/Applications:
Science Gateways, Portals, CLI scripts,
App Specific Web Service, etc.



Local Resource Managers:
PBS, Condor, LSF, SGE, Fork



GRAM Client Interfaces

- **CLIs**

- ◆ globusrun, globus-job-run, globus-job-submit, globus-job-clean, globus-job-get-output

- **C APIs**

- ◆ www.globus.org/api/c-globus-5.0.0
- ◆ Blocking and async functions for
 - submission, RSL manipulation, callbacks, cancelling, status

- **Java CoG JGlobus APIs**

- ◆ www.cogkit.org/release/4_1_4/api/jglobus/
- ◆ Classes: Gram, GramJob, GramAttributes



GRAM Authentication Test

- `globusrun -a -r never-1`
- Resource Names
 - ◆ *HOST:PORT/SERVICE:SUBJECT*
- `globusrun -a -r never-1.ci.uchicago.edu:2119/
jobmanager:/DC=org/DC=doegrids/
OU=Services/CN=host/never-1.ci.uchicago.edu`

globus-job-*

- bourn shell scripts that call globusrun
- Hide details of RSL

globus-job-run

- Blocking CLI to gram service
- `globus-job-run never-1 /bin/hostname`
 - ◆ Basic job
- `globus-job-run never-1 -np 5 /bin/sleep 10`
 - ◆ Multiple processes
- `globus-job-run never-1 /bin/sleep 90`
 - ◆ Cancel execution by CTRL-C
- `globus-job-run never-1 -env TEST=1 -env GRID=1 /usr/bin/env`
 - ◆ Augment job environment

globus-job-run cont..

- `globus-job-run never-1 -env TEST=1 -env GRID=1 /usr/bin/env`
 - ◆ Augment job environment
- `globus-job-run -dumprsl never-1 -env TEST=1 -env GRID=1 /usr/bin/env -u TEST`
 - ◆ `&(executable="/usr/bin/env")
(environment= ("TEST" "1") ("GRID" "1")
(arguments= "-u" "TEST"))`

globus-job-submit, clean, get-output

- Non-blocking CLI to gram service
- `globus-job-submit never-1 /bin/hostname`
 - ◆ Returns job contact string
 - `https://never-1.ci.uchicago.edu:37980/16073836513828969566/7364555675185249161/`
 - ◆ Service will save the output, use `get-output`
- `globus-job-get-output <job contact>`
 - ◆ Returns – “never-1.ci.uchicago.edu”
- `globus-job-clean <job contact>`
 - ◆ Clean up after yourself!

globus-job-status

- globus-job-submit never-1 /bin/sleep 10
 - ◆ Get your remote job running
- globus-job-status <job contact>
ACTIVE
- globus-job-status <job contact>
DONE
 - ◆ Monitor status
- globus-job-clean <job contact>
 - ◆ Don't forget to cleanup

globusrun

- C program
- Takes an Resource Specification Language (RSL) as an argument
- globusrun -p "&(executable=/bin/lis)"
 - ◆ RSL Parsed Successfully...
- globusrun -p "&(executable=/bin/lis)(howabout=this)(eventhough=(this doesnt make sense))"
 - ◆ RSL Parsed Successfully...



globusrun continued

- `globusrun -j -r never-1 "&(executable=/bin/lis)"`
 - ◆ Toolkit version: 4.3.0-HEAD Job Manager
version: 10.5 (1256257907-0)
- `globusrun -b -r never-1 "&(executable=/bin/sleep)(arguments=10)"`
 - ◆ `globus_gram_client_callback_allow` successful
GRAM Job submission successful
`https://never-1.ci.uchicago.edu:`
`34159/16073843111170748796/7364555675185`
`248438/`
`GLOBUS_GRAM_PROTOCOL_JOB_STATE_ACTIVE`



globusrun continued

- globusrun -status <job contact>
 - ◆ Getting status of a job
- globusrun -k <job contact>
 - ◆ Cancelling a job



globusrun expired proxy

- Create a new proxy via `grid-proxy-init`
- Restarting a job will cause the JM to use the new proxy for all jobs
 - ◆ `globusrun -r never-1 "&(restart=<job contact>)"`



File staging and RSL substitution

- Run ls on never-1, but first stage the file from never-2
 - ◆ `globusrun -s -r never-1 '&(rsl_substitution = (GRIDFTP_SERVER gsiftp://never-2.ci.uchicago.edu)) (executable=/bin/ls) (arguments=/tmp/staged_file) (file_stage_in = ($(GRIDFTP_SERVER)/home/tutorial1/junk /tmp/staged_file))'`



File Stage In Shared

- Run ls on never-1, but first stage the file from never-2
 - ◆ `globusrun -s -r never-1 '&(rsl_substitution = (GRIDFTP_SERVER gsiftp://never-2.ci.uchicago.edu)) (executable=/bin/ls) (arguments=/tmp/staged_file) (file_stage_in = ($(GRIDFTP_SERVER)/home/tutorial1/junk /tmp/staged_file))'`



File stage in shared

- Run ls on never-1, but first stage the file from never-2 into the gass cache from globusrun's built in GASS server
 - ◆ globusrun -s -r never-1 `&(executable=/bin/ls)
(arguments = -l /tmp/staged_file_link1)
(file_stage_in_shared =
\$(GLOBUSRUN_GASS_URL)/home/tutorial1/junk
/tmp/staged_file_link1))`
 - lrwxrwxrwx 1 tutorial1 tutorial1 122 Mar 2 01:22 /tmp/staged_file_link1
-> /home/tutorial1/.globus/.gass_cache/local/
md5/73/6a9ff8a069d11515f240090bf77327/md5/cb/
20eadb906d8fd93d30cd6385f6703a/data



File stage out

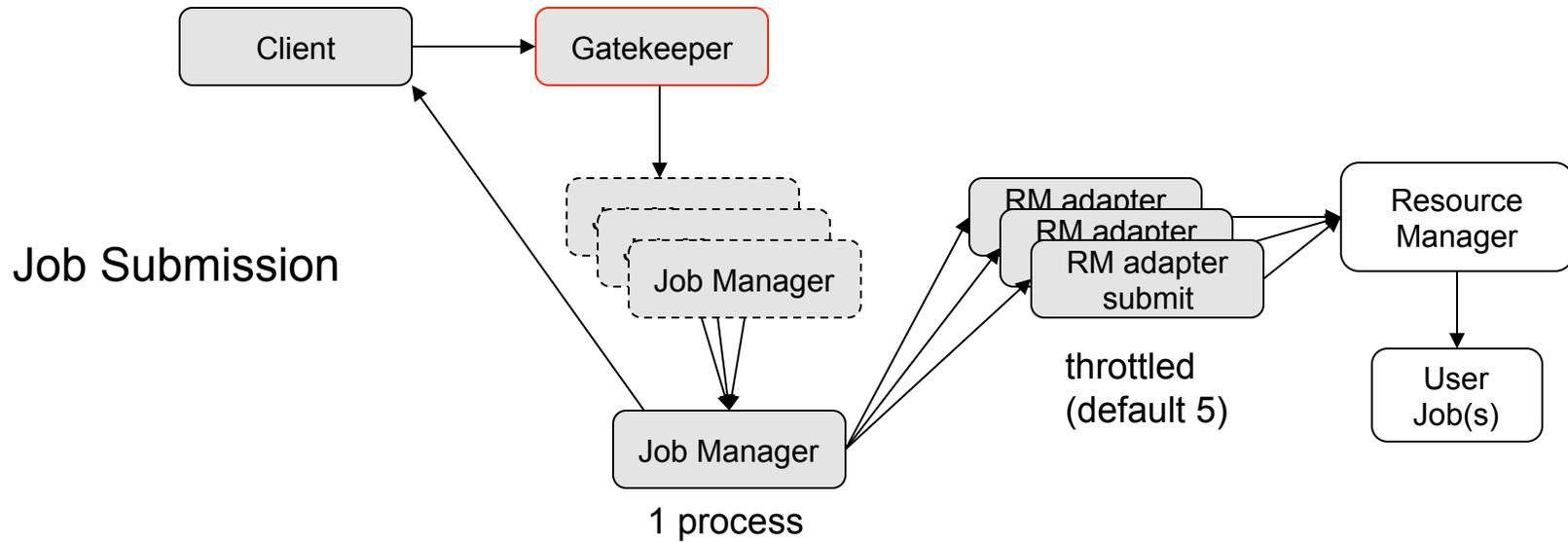
- Run ls on never-1, then transfer the output using the gridftp server running on never-2
 - ◆ globusrun -r never-1 '&(executable=/bin/ls)
(stdout=\$(HOME)/results.txt)
(file_stage_out =
 (\$(HOME)/results.txt
 gsiftp://never-2.ci.uchicago.edu/home/tutorial1/
never-1-ls-results.txt))'

file clean up

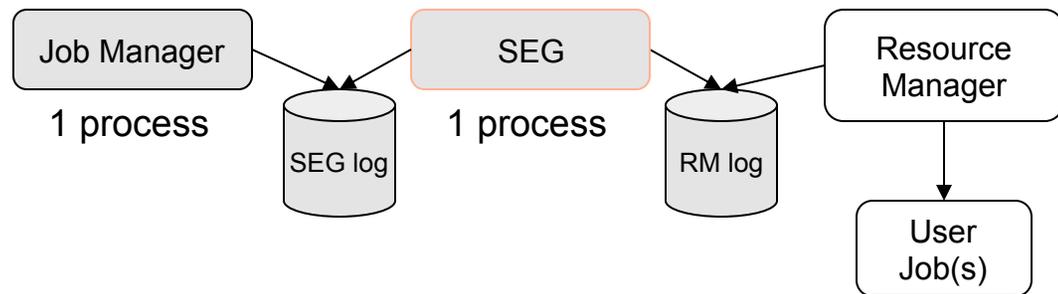
- Same thing only remove the results.txt file on never-1 after the contents have been staged out.
 - ◆ globusrun -r never-1 '&(executable=/bin/lis)
(stdout=\$(HOME)/results.txt)
(file_stage_out =
 \$(HOME)/results.txt
 gsiftp://never-2.ci.uchicago.edu/home/tutorial1/
never-1-ls-results.txt))(file_clean_up=\$(HOME)/
results.txt)'



GRAM5 Architecture



Job Monitoring





Running the SEG

- By Default, jobs are monitored via polling
- But, SEG can be used and is more scalable and provides better performance
- For Fork, add “-seg-module fork” to `$GLOBUS_LOCATION/etc/grid-services/jobmanager-fork`
- Start the SEG
 - ◆ `$GLOBUS_LOCATION/sbin/globus-job-manager-event-generator -scheduler fork -background -pidfile $GLOBUS_LOCATION/var/fork-pid`

Examples of Production Scientific Grids

- APAC (Australia)
- China Grid
- DGrid (Germany)
- EGEE
- NAREGI (Japan)
- Open Science Grid
- Taiwan Grid
- TeraGrid
- ThaiGrid
- UK Nat'l Grid Service



Feedback

- Comments welcome
- If you need any specific functionality requirement, please let us know

Thank you

- More Information:

- ◆ <http://www.gridftp.org>
- ◆ <http://www.globus.org/toolkit>
- ◆ gt-user@globus.org