

GT 5.0.2 GridFTP: User's Guide

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Introduction

The GridFTP User's Guide provides general end user-oriented information.

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Chapter 1. Managing Files on a Grid (GridFTP Quickstart)

1. Building and installing the GridFTP client

If the GridFTP client is not installed and that is all you need, follow the instructions [here](#) to build only the GridFTP client.

2. Java Client API Download

GT 5.0 does not include any of the CoG JGlobus Java APIs that were included in the GT4 release series. But, the JGlobus APIs can still be used with the GT5 services. You can get them directly from the CoG JGlobus releases; see the following link:

http://dev.globus.org/wiki/CoG_jglobus

Consider the following when determining which version of CoG JGlobus to use:

- The GRAM development team used CoG JGlobus version 1.6.0 for performance testing.
- The BIRN project used CoG JGlobus version 1.6.0 (plus patches) for GridFTP testing. All patches are included in 1.8.0.
- At the time of the GT 5.0.2 release, 1.8.0 was the recommended version. In general, the latest recommended CoG JGlobus version should be used.

3. Configuring the GridFTP client

3.1. If client is behind a firewall

If the GridFTP *client* is behind a firewall:

1. Contact your network administrator to open up a range of ports (for GridFTP data channel connections) for the incoming connections. If the firewall blocks the outgoing connections, open up a range of ports for outgoing connections as well.

2. Set the environment variable GLOBUS_TCP_PORT_RANGE

```
export GLOBUS_TCP_PORT_RANGE=min,max
```

where min,max specify the port range that you have opened for the incoming connections on the firewall. This restricts the listening ports of the GridFTP client to this range. Recommended range is 1000 (e.g., 50000-51000) but it really depends on how much use you expect.

3. If you have a firewall blocking the outgoing connections and you have opened a range of ports, set the environment variable GLOBUS_TCP_SOURCE_RANGE:

```
export GLOBUS_TCP_PORT_RANGE=min,max
```

where min,max specify the port range that you have opened for the outgoing connections on the firewall. This restricts the outbound ports of the GridFTP client to this range. Recommended range is twice the range used for GLOBUS_TCP_PORT_RANGE, because if parallel TCP streams are used for transfers, the listening port would remain the same for each connection but the connecting port would be different for each connection.

Additional information on Globus Toolkit Firewall Requirements is available [here](#)¹.

3.2. Configuring security

3.2.1. SSH Security

There is no additional configuration required to use GridFTP in conjunction with SSH.

3.2.2. GSI Security

In order to use GSI security for the transfers, you need to obtain and install a user certificate from a certificate authority trusted by the GridFTP servers that you wish to move data in and out of, and configure the client to trust the certificate authority that signed the certificates of the GridFTP server(s)

- [Obtaining user certificates](#)
- [Configuring the client to trust a particular certificate authority](#)
- [Creating a proxy credential](#)

4. Basic procedure for using GridFTP (globus-url-copy)

If you just want the "rules of thumb" on getting started (without all the details), the following options using `globus-url-copy` will normally give acceptable performance:

For a single file transfer:

```
globus-url-copy -vb -tcp-bs 1048576 -p 4 source_url destination_url
```

where:

`-vb` specifies verbose mode and displays:

- number of bytes transferred,
- performance since the last update (currently every 5 seconds), and
- average performance for the whole transfer.

`-tcp-bs` specifies the size (in bytes) of the TCP buffer to be used by the underlying ftp data channels. This is critical to good performance over the WAN.

[How do I pick a value?](#)

¹ <http://www.globus.org/toolkit/security/firewalls/>

-p Specifies the number of parallel data connections that should be used. This is one of the most commonly used options.

How do I pick a value?

For a directory transfer:

```
globus-url-copy -vb -tcp-bs 1048576 -p 4 -r -cd - cc 4 source_url destination_url
```

where:

-vb specifies verbose mode and displays:

- number of bytes transferred,
- performance since the last update (currently every 5 seconds), and
- average performance for the whole transfer.

-tcp-bs specifies the size (in bytes) of the TCP buffer to be used by the underlying ftp data channels. This is critical to good performance over the WAN.

How do I pick a value?

-p Specifies the number of parallel data connections that should be used. This is one of the most commonly used options.

How do I pick a value?

-cc Specifies the number of concurrent FTP connections to use for multiple transfers.

-cd Creates destination directories, if needed.

-r Copies files in subdirectories.

The source/destination URLs will normally be one of the following:

- *file:///path/to/my/file* if you are accessing a file on a file system accessible by the host on which you are running your *client*.
- *gsiftp://hostname/path/to/remote/file* if you are accessing a file from a GridFTP *server*.

4.1. Putting files

One of the most basic tasks in GridFTP is to "put" files, i.e., moving a file from your file system to the server. So for example, if you want to move the file `/tmp/foo` from a file system accessible to the host on which you are running your client to a file name `/tmp/bar` on a host named `remote.machine.my.edu` running a GridFTP server, you would use this command:

```
globus-url-copy -vb -tcp-bs 2097152 -p 4 file:///tmp/foo gsiftp://remote.machine.my.edu/tmp
```



Note

In theory, `remote.machine.my.edu` could be the same host as the one on which you are running your client, but that is normally only done in testing situations.

4.2. Getting files

A `get`, i.e. moving a file from a server to your file system, would just reverse the source and destination URLs:

Tip

Remember `file:` always refers to your file system.

```
globus-url-copy -vb -tcp-bs 2097152 -p 4 gsiftp://remote.machine.my.edu/tmp/bar file:///tm
```

4.3. Third party transfers

Finally, if you want to move a file between two GridFTP servers (a *third party transfer*), both URLs would use `gsiftp:` as the protocol:

```
globus-url-copy -vb -tcp-bs 2097152 -p 4 gsiftp://other.machine.my.edu/tmp/foo gsiftp://re
```

4.4. For more information

If you want more information and details on URLs and the [command line options](#), the [Key Concepts](#) gives basic definitions and an overview of the GridFTP protocol as well as our implementation of it.

5. Using standard FTP clients with GridFTP server

You can use any standard FTP client to communicate with the GridFTP server in the following cases:

- GridFTP server is configured to allow anonymous access or username/password based authentication. Note that this method is not secure but if the data on the GridFTP server is world readable or if the GridFTP server is accessible only to the clients on a trusted internal network, the GridFTP server may be configured to allow anonymous access or username/password based authentication
- Your local system administrator has installed "GridFTP Where There is FTP (GWTFTP)", which acts as a proxy between standard FTP clients and GridFTP servers. More information on GWTFTP is available at [Section 9](#), "[GridFTP Where There Is FTP \(GWTFTP\)](#)".

6. Advanced Features

6.1. Failures and retries

To retry a transfer after a server or network failure, use the `-rst` option. To store the untransferred urls for restarting the transfer after a client failure, use the `-df` option. More information about these options is available [here](#).

For example, `globus-url-copy` can be invoked in a loop for long running transfers, as shown in the script below:

```
#!/bin/sh
STATEFILE=/path/to/statefile;
while [ ! -e $STATEFILE -o -s $STATEFILE ];
do
```

```
globus-url-copy -rst -p 4 -cc 4 -cd -vb -r -df $STATEFILE gsiftp://srchost/srcdirpat
sleep 10;
done;
```

6.2. Bottleneck detection

To determine whether the disk or the network is the bottleneck for the file transfer, use the `-nlb` option. This option uses NetLogger to estimate speeds of disk and network read/write system calls, and attempt to determine the bottleneck component.



Note

In order to use this, the server must be configured to [enable netlogger bottleneck detection](#)².

Example:

```
globus-url-copy -p 2 -nlb -vb gsiftp://host1:port/path/myfile gsiftp://host2:port/path/my
```

This will output something like the following:

```
Total instantaneous throughput:
disk read      = 17022.2 Mbits/s
disk write     = 26630.8 Mbits/s
net read       = 509.0 Mbits/s
net write      = 1053.4 Mbits/s
Bottleneck: network
```

6.3. Using UDT as an alternative transport protocol for TCP

UDT is an application-level protocol that uses UDP for data transport. It addresses some of the limitations of TCP in high-bandwidth and high-delay networks and achieves better performance than TCP on those networks. To use UDT as the underlying transport protocol for the GridFTP transfers, use the `-udt` option.



Note

Note: In order to use this for a third-party transfer, the server must be configured to [enable UDT](#). In order to use this for a client-server transfer, you need a threaded flavor of **globus-url-copy**. See [Switching between threaded and non-threaded flavors](#) for instructions on how to change the flavor.

6.4. Encryption and Integrity protection

The data channel is authenticated by default. Integrity protection and encryption are optional. To integrity protect the data, use the `-dcsafe` option. For encrypted data transfer, use the `-dcpriv` option.

6.5. Striping

The striping functionality enables one to use a set of computers at both ends of a network to transfer data. At both the source and destination ends, the computers need to have a shared file system so that the dataset is accessible from any computer.

² <http://www.cedps.net/index.php/Gridftp-netlogger>

This feature is especially useful in configurations where individual nodes at the source and destination clusters have significantly less network capacity when compared to the network capacity available between the clusters. An example would be clusters with the individual nodes connected by 1 Gbit/s Ethernet connections to a switch that is itself connected to the external network at 10 Gbit/s or faster.

To perform striped data movement, use the `-stripe` option.



Note

This option is useful only if the server is configured for striped data movement.

6.6. Multicasting

To transfer a single file to many destinations in a multicast/broadcast, use the new `-mc` option.



Note

To use this option, the admin must enable multicasting. Click [here](#) for more information.

```
globus-url-copy -vb -tcp-bs 2097152 -p 4 -mc filename source_url
```

The *filename* must contain a line-separated list of destination urls. For example:

```
gsiftp://localhost:5000/home/user/tst1
gsiftp://localhost:5000/home/user/tst3
gsiftp://localhost:5000/home/user/tst4
```

For more flexibility, you can also specify a single destination url on the command line in addition to the urls in the file. Examples are:

```
globus-url-copy -MC multicast.file gsiftp://localhost/home/user/src_file
```

or

```
globus-url-copy -MC multicast.file gsiftp://localhost/home/user/src_file gsiftp://localhos
```

6.6.1. Advanced multicasting options

Along with specifying the list of destination urls in a file, a set of options for each url can be specified. This is done by appending a `?` to the resource string in the url followed by semicolon-separated key value pairs. For example:

```
gsiftp://dst1.domain.com:5000/home/user/tst1?cc=1;tcpbs=10M;P=4
```

This indicates that the receiving host `dst1.domain.com` will use 4 parallel stream, a tcp buffer size of 10 MB, and will select 1 host when forwarding on data blocks. This url is specified in the `-mc` file as described above.

The following is a list of key=value options and their meanings:

`P=integer` The number of parallel streams this node will use when forwarding.

`cc=integer` The number of urls to which this node will forward data.

`tcpbs=format-integer` The TCP buffer size this node will use when forwarding.

`urls=string list` The list of urls that must be children of this node when the spanning tree is complete.

`local_write=boolean: y/n` Determines if this data will be written to a local disk, or just forwarded on to the next hop. This is explained more in the [Network Overlay](#) section.

`subject=string` The DN name to expect from the servers this node is connecting to.

6.6.2. Network Overlay

In addition to allowing multicast, this function also allows for creating user-defined network routes.

If the `local_write` option is set to `n`, then no data will be written to the local disk, the data will only be forwarded on.

If the `local_write` option is set to `n` and is used with the `cc=1` option, the data will be forwarded on to exactly one location.

This allows the user to create a network overlay of data hops using each GridFTP server as a router to the ultimate destination.

Chapter 2. GridFTP Client Tool

Name

globus-url-copy -- Multi-protocol data movement

globus-url-copy

Tool description

globus-url-copy is a scriptable command line tool that can do multi-protocol data movement. It supports gsiftp:// (GridFTP), ftp://, http://, https://, and file:/// protocol specifiers in the URL. For GridFTP, globus-url-copy supports all implemented functionality. Versions from GT 3.2 and later support file globbing and directory moves.

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- [If you run a GridFTP server by hand](#)
- [How do I choose a value for the TCP buffer size \(-tcp-bs\) option?](#)
- [How do I choose a value for the parallelism \(-p\) option?](#)
- [Limitations](#)
- [Interactive clients for GridFTP](#)

Before you begin

Important

To use gsiftp:// and https:// protocols in globus-url-copy, you must have a [certificate](#). However, you may use ftp://, http:// or sshftp:// protocols without a certificate.

1. First, as with all things Grid, you *must* have a valid proxy certificate to run globus-url-copy in certain protocols (gsiftp:// and https://, as noted above). If you are using ftp://, http:// or sshftp:// protocols, you may skip ahead to [Command syntax](#)

If you do not have a certificate, you must [obtain one](#).

If you are doing this for testing in your own environment, the [SimpleCA](#) provided with the Globus Toolkit should suffice.

If not, you must contact the Virtual Organization (VO) with which you are associated to find out whom to ask for a certificate.

One common source is the [DOE Science Grid CA](#)¹, although you must confirm whether or not the resources you wish to access will accept their certificates.

Instructions for proper installation of the certificate should be provided from the source of the certificate.

Please note when your certificates expire; they will need to be renewed or you may lose access to your resources.

- Now that you have a certificate, you must generate a temporary proxy. Do this by running:

```
grid-proxy-init
```

Further documentation for **grid-proxy-init** can be found [here](#).

- You are now ready to use **globus-url-copy**! See the following sections for syntax and command line options and other considerations.

Command syntax

The basic syntax for **globus-url-copy** is:

```
globus-url-copy [optional command line switches] Source_URL Destination_URL
```

where:

[optional command line switches]	See Command line options below for a list of available options.
<i>Source_URL</i>	Specifies the original URL of the file(s) to be copied. If this is a directory, all files within that directory will be copied.
<i>Destination_URL</i>	Specifies the URL where you want to copy the files. If you want to copy multiple files, this must be a directory.



Note

Any url specifying a directory must end with `/`.

URL prefixes

Versions from GT 3.2 and later support the following URL prefixes:

- file://** (on a local machine only)
- ftp://**
- gsiftp://**
- http://**

¹ <http://www.doe grids.org/pages/cert-request.htm>

- `https://`

Versions from GT 4.2 and later support the following URL prefix (in addition to the above-mentioned URL prefixes):

- `sshftp://`



Note

We do *not* provide an interactive client similar to the generic FTP client provided with Linux. See the [Interactive Clients](#) section below for information on an interactive client developed by NCSA/NMI/TeraGrid.

URL formats

URLs can be any valid URL as defined by RFC 1738 that have a [protocol](#) we support. In general, they have the following format: `protocol://host:port/path`.



Note

If the path ends with a trailing / (i.e. `/path/to/directory/`) it will be considered to be a directory and all files in that directory will be moved. If you want a recursive directory move, you need to add the `-r/-recurse` switch described below.

Table 2.1. URL formats

<code>gsiftp://myhost.mydomain.com:2812/data/foo.dat</code>	Fully specified.
<code>http://myhost.mydomain.com/mywebpage/default.html</code>	Port is not specified; therefore, GridFTP uses protocol default (in this case, 80).
<code>file:///foo.dat</code>	Host is not specified; therefore, GridFTP uses your local host. Port is not specified; therefore, GridFTP uses protocol default (in this case, 80).
<code>file:/foo.dat</code>	This is also valid but is not recommended because, while many servers (including ours) accept this format, it is <i>not</i> RFC conformant and is not recommended.



Important

For GridFTP (`gsiftp://`) and FTP (`ftp://`), it is legal to specify a user name and password in the the URL as follows:

```
gsiftp://myname:[mypassword]@myhost.mydomain.com/foo.dat
```

If you are using GSI security, then you may specify the username (but you may *not* include the `:` or the password) and the grid-mapfile will be searched to see if that is a valid account mapping for your distinguished name (DN). If it is found, the [server](#) will setuid to that account. If not, it will fail. It will NOT fail back to your default account.

If you are using anonymous FTP, the username *must* be one of the usernames listed as a valid anonymous name and the password can be anything.

If you are using password authentication, you must specify both your username and password. **THIS IS HIGHLY DISCOURAGED, AS YOU ARE SENDING YOUR PASSWORD IN THE CLEAR ON THE NETWORK.** This is worse than no security; it is a false illusion of security.

Command line options

Informational Options

-help -usage	Prints help.
-version	Prints the version of this program.
-versions	Prints the versions of all modules that this program uses.
-q -quiet	Suppresses all output for successful operation.
-vb -verbose	During the transfer, displays: <ul style="list-style-type: none">• number of bytes transferred,• performance since the last update (currently every 5 seconds), and• average performance for the whole transfer.
-dbg -debugftp	Debugs FTP connections and prints the entire control channel protocol exchange to STDERR. Very useful for debugging. Please provide this any time you are requesting assistance with a globus-url-copy problem.
-list <url>	This option will display a directory listing for the given url.
-nl-bottleneck -nlb	This option uses NetLogger to estimate speeds of disk and network read/write system calls, and attempt to determine the bottleneck component.



Note

In order to use this, the server must be configured to [enable netlogger bottleneck detection](#)².

Utility Ease of Use Options

-a -ascii	Converts the file to/from ASCII format to/from local file format.
-b -binary	Does not apply any conversion to the files. This option is turned on by default.
-cd -create-dest	Create destination directories, if needed
-f <i>filename</i>	Reads a list of URL pairs from a filename. Each line should contain: <i>sourceURL destURL</i>

² <http://www.cedps.net/index.php/Gridftp-netlogger>

Enclose URLs with spaces in double quotes ("). Blank lines and lines beginning with the hash sign (#) will be ignored.

-r | -recurse

Copies files in subdirectories.

-notpt | -no-third-party-transfers

Turns third-party transfers off (on by default).

Site firewall and/or software configuration may prevent a connection between the two servers (a *third party transfer*). If this is the case, globus-url-copy will "relay" the data. It will do a GET from the source and a PUT to the destination.

This obviously causes a performance penalty but will allow you to complete a transfer you otherwise could not do.

Reliability Options

-rst | -restart

Restarts failed FTP operations.

-rst-retries <retries>

Specifies the maximum number of times to retry the operation before giving up on the transfer.

Use 0 for infinite.

The default value is 5.

-rst-interval <seconds>

Specifies the interval in seconds to wait after a failure before retrying the transfer.

Use 0 for an exponential backoff.

The default value is 0.

-rst-timeout <seconds>

Specifies the maximum time after a failure to keep retrying.

Use 0 for no timeout.

The default value is 0.

-df <filename> | -dumpfile <filename>

Specifies path to the file where untransferred urls will be saved for later restarting. The resulting file is the same format as the -f input file. If the file exists, it will be read and all other url input will be ignored.

-stall-timeout | -st <seconds>

Specifies how long before cancelling/restarting a transfer with no data movement. Set to 0 to disable. Default is 600 seconds.

Performance Options

-tcp-bs <size> | -tcp-buffer-size <size>

Specifies the size (in bytes) of the TCP buffer to be used by the underlying ftp data channels.



Important

This is critical to good performance over the WAN.

[How do I pick a value?](#)

`-p <parallelism> | -parallel <parallelism>` Specifies the number of parallel data connections that should be used.



Note

This is one of the most commonly used options.

How do I pick a value?

`-bs <block size> | -block-size <block size>` Specifies the size (in bytes) of the buffer to be used by the underlying transfer methods.

`-pp` **(New starting with GT 4.1.3)** Allows pipelining. GridFTP is a command response protocol. A client sends one command and then waits for a "Finished response" before sending another. Adding this overhead on a per-file basis for a large data set partitioned into many small files makes the performance suffer. Pipelining allows the client to have many outstanding, unacknowledged transfer commands at once. Instead of being forced to wait for the "Finished response" message, the client is free to send transfer commands at any time.

`-mc filename source_url` > Transfers a single file to many destinations. Filename is a line-separated list of destination urls. For more information on this option, click [here](#).

Multicasting must be [enabled for use](#) on the server side.



Warning

This option is EXPERIMENTAL.

`-concurrency | -cc` Specifies the number of concurrent FTP connections to use for multiple transfers.

`-udt` Uses UDT, a reliable UDP-based transport protocol, for data transfers.

`-fast` Recommended when using GridFTP servers. Use MODE E for all data transfers, including reusing data channels between list and transfer operations.

Note: In order to use this option, the server must be configured to use [UDT](#). For third party transfers, no change is required on the client side. For client-server transfers, you need the threaded flavor of the client. Refer to [Switching between threaded and non-threaded flavors](#) for information on how to switch between threaded and non-threaded flavors of globus-url-copy.

Security Related Options

`-s <subject> | -subject <subject>` Specifies a subject to match with both the source and destination servers.



Note

Used when the server does not have access to the host certificate (usually when you are running the server as a user). See [the section called "If you run a GridFTP server by hand..."](#).

`-ss <subject> | -source-subject <subject>` Specifies a subject to match with the source server.

**Note**

Used when the server does not have access to the host certificate (usually when you are running the server as a user). See [the section called “If you run a GridFTP server by hand...”](#).

`-ds <subject> | -dest-subject <subject>`

Specifies a subject to match with the destination server.

**Note**

Used when the server does not have access to the host certificate (usually when you are running the server as a user). See [the section called “If you run a GridFTP server by hand...”](#).

`-nodcau | -no-data-channel-authentication`

Turns off data channel authentication for FTP transfers (the default is to authenticate the data channel).

**Warning**

We do *not* recommend this option, as it is a security risk.

`-dcsafe | -data-channel-safe`

Sets data channel protection mode to SAFE.

Otherwise known as *integrity* or *checksumming*.

Guarantees that the data channel has not been altered, though a malicious party may have observed the data.

**Warning**

Rarely used as there is a substantial performance penalty.

`-dcpriv | -data-channel-private`

Sets data channel protection mode to PRIVATE.

The data channel is encrypted and checksummed.

Guarantees that the data channel has not been altered and, if observed, it won't be understandable.

**Warning**

VERY rarely used due to the VERY substantial performance penalty.

Advanced Options


`-stripe`



Enables striped transfers on supported servers.

`-striped-block-size | -sbs`

Sets layout mode and blocksize for striped transfers.

If not set, the server defaults will be used.

	If set to 0, partitioned mode will be used.
	If set to >0, blocked mode will be used, with this setting used as the blocksize.
-t <transfer time in seconds>	Runs the transfer for the specified number of seconds and then ends. Useful for performance testing or forced restart loops.
-ipv6	Uses ipv6 when available.
 Warning	
This option is EXPERIMENTAL. Use at your own risk.	
-dp -delayed-pasv	Enables delayed passive.
-g2 -gridftp2	Uses GridFTP v2 protocol enhancements when possible.
-mn -module-name <gridftp storage module name>	Specifies the backend storage module to use for both the source and destination in a GridFTP transfer.
-mp -module-parameters <gridftp storage module parameters>	Specifies the backend storage module arguments to use for both the source and destination in a GridFTP transfer.
-smn -src-module-name <gridftp storage module name>	Specifies the backend storage module to use for the source file in a GridFTP transfer.
-smp -src-module-parameters <gridftp storage module parameters>	Specifies the backend storage module arguments to use for the source file in a GridFTP transfer.
-dmn -dst-module-name <gridftp storage module name>	Specifies the backend storage module to use for the destination file in a GridFTP transfer.
-dmp -dst-module-parameters <gridftp storage module parameters>	Specifies the backend storage module arguments to use for the destination file in a GridFTP transfer.
-aa -authz-assert <authorization assertion file>	Uses the assertions in the specified file to authorize access to both the source and destination servers.
-saa -src-authz-assert <authorization assertion file>	Uses the assertions in the specified file to authorize access to the source server.
-daa -dst-authz-assert <authorization assertion file>	Uses the assertions in the specified file to authorize access to the destination server.
-cache-aa -cache-authz-assert	Caches the authorization assertion for subsequent transfers.
-cache-saa -cache-src-authz-assert	Caches the source authorization assertion for subsequent transfers.
-cache-daa -cache-dst-authz-assert	Caches the destination authorization assertion for subsequent transfers.
-nl-bottleneck -nlb	Uses NetLogger to estimate speeds of disk and network read/write system calls, and attempt to determine the bottleneck component.
	Note: In order to use this, the server must be configured to enable netlogger bottleneck detection.

<code>-src-pipe -SP <command line></code>	Sets the source end of a remote transfer to use piped-in input with the given command line.
	 Warning
	Do not use with the <code>-fsstack</code> option.
<code>-dst-pipe -DP <command line></code>	Sets the destination end of a remote transfer to write data to then standard input of the program run via the given command line.
	 Warning
	Do not use with the <code>-fsstack</code> option.
<code>-pipe <command line></code>	Sets both <code>-src-pipe</code> and <code>-dst-pipe</code> to the same value.
<code>-dcstack -data-channel-stack</code>	Specifies the XIO driver stack for the network on both the source and the destination. Both must be GridFTP servers.
<code>-fsstack -file-system-stack</code>	Specifies the XIO driver stack for the disk on both the source and the destination. Both must be GridFTP servers.
<code>-src-dcstack -source-data-channel-stack</code>	Specifies the XIO driver stack for the network on the source GridFTP server.
<code>-src-fsstack -source-file-system-stack</code>	Specifies the XIO driver stack for the disk on the source GridFTP server.
<code>-dst-dcstack -dest-data-channel-stack</code>	Specifies the XIO driver stack for the network on the destination GridFTP server.
<code>-dst-fsstack -dest-file-system-stack</code>	Specifies the XIO driver stack for the disk on the destination GridFTP server.
<code>-cred <path to credentials or proxy file>, -src-cred -sc <path to credentials or proxy file>, -dst-cred -dc <path to credentials or proxy file></code>	Specifies the credentials to use for source, destination, or both FTP connections.
<code>-af <filename> -alias-file <filename></code>	Specifies a file that maps logical host aliases to lists of physical hosts. When used with multiple concurrent connections, each connection uses the next host in the list. Each line should either be an alias (noted with the @ symbol), or a hostname[:port]. Currently, only the aliases @source and @destination are valid, and they are used for every source or destination url.

Synchronization Options

<code>-sync</code>	Only transfer files where the destination does not exist or differs from the source. <code>-sync-level</code> controls how to determine if files differ.
<code>-sync-level <number></code>	Choose criteria for determining if files differ when performing a sync transfer. Level 0 will only transfer if the destination does not exist. Level 1 will transfer if the size of the destination does not match the size of the source. Level 2 will transfer if the timestamp of the destination is older than the timestamp of the source. Level 3 will

perform a checksum of the source and destination and transfer if the checksums do not match. The default sync level is 2.

Default globus-url-copy usage

A **globus-url-copy** invocation using the **gsiftp** protocol with no options (i.e., using all the defaults) will perform a transfer with the following characteristics:

- binary
- stream mode (which implies no parallelism)
- host default TCP buffer size
- encrypted and checksummed control channel
- an authenticated data channel

MODES in GridFTP

GridFTP (as well as normal FTP) defines multiple wire protocols, or MODES, for the data channel.

Most normal FTP servers only implement *stream mode* (MODE S), i.e. the bytes flow in order over a single TCP connection. GridFTP defaults to this mode so that it is compatible with normal FTP servers.

However, GridFTP has another MODE, called Extended Block Mode, or *MODE E*. This mode sends the data over the data channel in blocks. Each block consists of 8 bits of flags, a 64 bit integer indicating the offset from the start of the transfer, and a 64 bit integer indicating the length of the block in bytes, followed by a payload of length bytes. Because the offset and length are provided, out of order arrival is acceptable, i.e. the 10th block could arrive before the 9th because you know explicitly where it belongs. This allows us to use multiple TCP channels. If you use the `-p 1` | `-parallelism` option, **globus-url-copy** automatically puts the servers into MODE E.



Note

Putting `-p 1` is not the same as no `-p` at all. Both will use a single stream, but the default will use stream mode and `-p 1` will use MODE E.

If you run a GridFTP server by hand...

If you run a GridFTP server by hand, you will need to explicitly specify the subject name to expect. The subject option provides **globus-url-copy** with a way to validate the remote servers with which it is communicating. Not only must the server trust **globus-url-copy**, but **globus-url-copy** must trust that it is talking to the correct server. The validation is done by comparing host DNs or subjects.

If the GridFTP server in question is running under a host certificate then the client assumes a subject name based on the server's canonical DNS name. However, if it was started under a user certificate, as is the case when a server is started by hand, then the expected subject name must be explicitly stated. This is done with the `-ss`, `-sd`, and `-s` options.

`-ss` Sets the `sourceURL` subject.

`-ds` Sets the `destURL` subject.

`-s` If you use this option alone, it will set both urls to be the same. You can see an example of this usage under the Troubleshooting section.

**Note**

This is an *unusual* use of the client. Most times you need to specify both URLs.

How do I choose a value?

How do I choose a value for the TCP buffer size (`-tcp-bs`) option?

The value you should pick for the TCP buffer size (`-tcp-bs`) depends on how fast you want to go (your bandwidth) and how far you are moving the data (as measured by the Round Trip Time (RTT) or the time it takes a packet to get to the destination and back).

To calculate the value for `-tcp-bs`, use the following formula (this assumes that Mega means 1000^2 rather than 1024^2 , which is typical for bandwidth):

$$-tcp-bs = \text{bandwidth in Megabits per second (Mbs)} * \text{RTT in milliseconds (ms)} * 1000 / 8$$

As an example, if you are using fast ethernet (100 Mbs) and the RTT was 50 ms it would be:

$$-tcp-bs = 100 * 50 * 1000 / 8 = 625,000 \text{ bytes.}$$

So, how do you come up with values for bandwidth and RTT? To determine RTT, use either ping or traceroute. They both list RTT values.

**Note**

You must be on one end of the transfer and ping the other end. This means that if you are doing a third party transfer you have to run the ping or traceroute between the two server hosts, not from your client.

The bandwidth is a little trickier. Any point in the network can be the bottleneck, so you either need to talk with your network engineers to find out what the bottleneck link is or just assume that your host is the bottleneck and use the speed of your network interface card (NIC).

**Note**

The value you pick for `-tcp-bs` limits the top speed you can achieve. You will NOT get bandwidth any higher than what you used in the calculation (assuming the RTT is actually what you specified; it varies a little with network conditions). So, if for some reason you want to limit the bandwidth you get, you can do that by judicious choice of `-tcp-bs` values.

So where does this formula come from? Because it uses the bandwidth and the RTT (also known as the latency or delay) it is called the *bandwidth delay product*. The very simple explanation is this: TCP is a reliable protocol. It must save a copy of everything it sends out over the network until the other end acknowledges that it has been received.

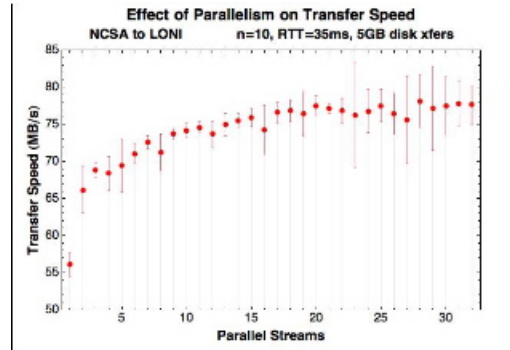
As a simple example, if I can put one byte per second onto the network, and it takes 10 seconds for that byte to get there, and 10 seconds for the acknowledgment to get back (RTT = 20 seconds), then I would need at least 20 bytes of storage. Then, hopefully, by the time I am ready to send byte 21, I have received an acknowledgement for byte 1 and I can free that space in my buffer. If you want a more detailed explanation, try the following links on TCP tuning:

- http://www.psc.edu/networking/perf_tune.html
- <http://www-didc.lbl.gov/TCP-tuning/>
- <http://www.ncne.nlanr.net/research/tcp/>

How do I choose a value for the parallelism (`-p`) option?

For most instances, using 4 streams is a very good rule of thumb. Unfortunately, there is not a good formula for picking an exact answer. The shape of the graph shown here is very characteristic.

Figure 2.1. Effect of Parallel Streams in GridFTP



You get a strong increase in bandwidth, then a sharp knee, after which additional streams have very little impact. Where this knee is depends on many things, but it is generally between 2 and 10 streams. Higher bandwidth, longer round trip times, and more congestion in the network (which you usually can only guess at based on how applications are behaving) will move the knee higher (more streams needed).

In practice, between 4 and 8 streams are usually sufficient. If things look really bad, try 16 and see how much difference that makes over 8. However, anything above 16, other than for academic interest, is basically wasting resources.

Limitations

There are no limitations for `globus-url-copy` in GT 5.0.2.

Interactive clients for GridFTP

The Globus Project does *not* provide an interactive client for GridFTP. Any normal FTP client will work with a GridFTP server, but it cannot take advantage of the advanced features of GridFTP. The interactive clients listed below take advantage of the advanced features of GridFTP.

There is no endorsement implied by their presence here. We make no assertion as to the quality or appropriateness of these tools, we simply provide this for your convenience. We will *not* answer questions, accept bugs, or in any way shape or form be responsible for these tools, although they should have mechanisms of their own for such things.

UberFTP was developed at the NCSA under the auspices of NMI and TeraGrid:

- NCSA Uberftp only download: <http://dims.ncsa.uiuc.edu/set/uberftp/download.html>
- UberFTP User's Guide: <http://dims.ncsa.uiuc.edu/set/uberftp/userdoc.html>

Name

`globus-url-sync` -- Used in conjunction with `globus-url-copy` to synchronize directories.

`globus-url-sync`

Tool description

globus-url-sync is a command line tool which provides a list of files to be transferred, in order to synchronize two directories. It currently supports `gsiftp://` (GridFTP) and `sshftp://` protocol specifiers in the URL.

The program **globus-url-sync** compares two endpoints, using GridFTP, and prints a list of GSI file transfers that should be performed using **globus-url-copy**.

The current implementation of **globus-url-sync** supports very basic features for directory synchronization. It includes comparators for existence checks, file size checks, modification timestamp checks, but not checksum comparison.

- [Before you begin](#)
- [Command syntax](#)
- [Command line options](#)
- [Limitations](#)

Before you begin

1. First, as with **globus-url-copy**, you must have a valid proxy certificate to run **globus-url-sync** using protocol "`gsiftp://`".

If you do not have a certificate, you must [obtain one](#).

If you are doing this for testing in your own environment, the [SimpleCA](#) provided with the Globus Toolkit should suffice.

If not, you must contact the Virtual Organization (VO) with which you are associated to find out whom to ask for a certificate.

One common source is the [DOE Science Grid CA](#)¹, although you must confirm whether or not the resources you wish to access will accept their certificates.

Instructions for proper installation of the certificate should be provided from the source of the certificate.

Please note when your certificates expire; they will need to be renewed or you may lose access to your resources.

2. Now that you have a certificate, you must generate a temporary proxy. Do this by running:

```
grid-proxy-init
```

Further documentation for **grid-proxy-init** can be found [here](#).

¹ <http://www.doe grids.org/pages/cert-request.htm>

Command syntax

The basic syntax for **globus-url-sync** is:

```
globus-url-sync [optional command line switches] Source_URL Destination_URL
```

where:

[optional command line switches]	See Command line options below for a list of available options.
<i>Source_URL</i>	Specifies the original URL of the file(s) to be copied. If this is a directory, all files within that directory that need to be synchronized will be listed.
<i>Destination_URL</i>	Specifies the URL where you want to copy the files. The types of the source and the destination must match. In other words, if the source is a file, the destination must be a file, and if the source is a directory, the destination must be a directory.

Note

Any url specifying a directory must end with `/`.

URL prefixes

The following URL prefixes are supported:

- **gsiftp://**
- **sshftp://**

URL formats

URLs can be any valid URL as defined by RFC 1738 that have a [protocol](#) we support. In general, they have the following format: ***protocol://host:port/path***.

Note

If the path ends with a trailing `/` (i.e. `/path/to/directory/`) it will be considered to be a directory and all files in that directory that are not synchronized will be listed.

Table 2.2. URL formats

<code>gsiftp://myhost.mydomain.com//tmp/file1</code>	File name, absolute path.
<code>gsiftp://myhost.mydomain.com/~file1</code>	File name, absolute path.
<code>gsiftp://myhost.mydomain.com/file1</code>	File name, relative path.
<code>gsiftp://myhost.mydomain.com//tmp/dir1/</code>	Directory, absolute path.

Command line options

-help -usage	Print help text.
-version	Print the version of this program.
-d -debug -v -verbose	Print additional detail.
-r -recursive-dir-copy	Output directory names, when an entire directory is to be copied recursively.
-n -newer	File is to be transferred, if the source timestamp is newer than the destination timestamp.
-o -older	File is to be transferred, if the source timestamp is older than the destination timestamp.
-s -size	File is to be transferred, if the sizes of the source and the destination are not the same.

Limitations

- This is an early version of **globus-url-sync**. In the event that unexpected results are returned, please re-run the command with the **-verbose** option.
- **globus-url-copy** should be invoked with the **-r** (copy files in subdirectories) **-cd** (create directory) options, so that directories can be copied recursively (for "globus-url-sync -r"), and so that directories at the destination can be created.
- Authentication errors may be erroneously be reported as though a file is missing.
- Order of options does not currently effect order in which matching criteria are evaluated.

Chapter 3. Graphical User Interface

1. Globus GridFTP GUI (pre-alpha)

The Globus GridFTP GUI is Java web start application. Users can get it by clicking a link; the program will be downloaded and started automatically. A pre-alpha version of the GUI is available now.

- [Download the GUI client](#)¹

The GUI client provides an easy-to-use interface for connecting to GridFTP servers and transferring files. It has the following features:

- Allows you to browse the local file system and transfer files and directories between the local system and remote GridFTP servers and between two remote GridFTP servers (third-party transfers).
- Supports file system operations such as creating, deleting and renaming files and directories.

Prerequisites:

- JDK 1.5.0+

Supported Platforms:

- Windows
- Linux
- MAC

The GUI provides two ways for generating a proxy credential required for the data transfer:

1. Creating a proxy credential using a locally stored key pair.
2. Obtaining a proxy from a MyProxy Server. For more information about MyProxy, please visit: <http://myproxy.ncsa.uiuc.edu/>.

[A demo of using the GridFTP GUI is available here](#)². Open the file ending in .htm with any browser with the Flash plugin to start the Flash demo - then just click the green arrows to progress through each screen.

2. UberFTP

NCSA, as part of their TeraGrid activity, produces a text based interactive client called UberFTP, which you may want to check out. See [the section called "Interactive clients for GridFTP"](#) for more information.

¹ <http://www-unix.globus.org/cog/demo/ogce/ftp.jnlp>

² [../demo.tar.gz](#)

Chapter 4. Troubleshooting

If you are having problems using the GridFTP *server*, try the steps listed below. If you have an error, try checking the server logs if you have access to them. By default, the server logs to stderr, unless it is running from inetd, or its execution mode is detached, in which case logging is disabled by default.

The command line options `-d`, `-log-level`, `-L` and `-logdir` can affect where logs will be written, as can the configuration file options `log_single` and `log_unique`. See the [globus-gridftp-server\(1\)](#) for more information on these and other configuration options.

For a list of common errors in GT, see [Error Codes](#).

1. Error Codes in GridFTP

Table 4.1. GridFTP Errors

Error Code	Definition	Possible Solutions
<p>globus_ftp_client: the server responded with an error 530 530-globus_xio: Authentication Error 530-OpenSSL Error: s3_srvr.c:2525: in library: SSL routines, function SSL3_GET_CLIENT_CERTIFICATE: no certificate returned 530-globus_gsi_callback_module: Could not verify credential 530-globus_gsi_callback_module: Can't get the local trusted CA certificate: Untrusted self-signed certificate in chain with hash d1b603c3 530 End.</p>	<p>This error message indicates that the GridFTP server doesn't trust the certificate authority (CA) that issued your certificate.</p>	<p>You need to ask the GridFTP server administrator to install your CA certificate chain in the GridFTP server's trusted certificates directory.</p>
<p>globus_ftp_control: gss_init_sec_context failed OpenSSL Error: s3_clnt.c:951: in library: SSL routines, function SSL3_GET_SERVER_CERTIFICATE: certificate verify failed globus_gsi_callback_module: Could not verify credential globus_gsi_callback_module: Can't get the local trusted CA certificate: Untrusted self-signed certificate in chain with hash d1b603c3</p>	<p>This error message indicates that your local system doesn't trust the certificate authority (CA) that issued the certificate on the resource you are connecting to.</p>	<p>You need to ask the resource administrator which CA issued their certificate and install the CA certificate in the local trusted certificates directory.</p>

Error Code	Definition	Possible Solutions
530-globus_xio: Authentication Error 530-globus_gsi_callback_module: Could not verify credential 530-globus_gsi_callback_module: Could not verify credential 530-globus_gsi_callback_module: Invalid CRL: The available CRL has expired 530 End.	This error message indicates one of the following: Certificate Revocation List (CRL) for the source or destination server CA at the client has expired or CRL for client CA has expired at source or destination server or CRL for source (destination) server CA has expired at destination (source) server. CRL is a file {CA_hash}.r0 in /etc/grid-security/certificates or \${USER_HOME}/.globus/certificates or \${X509_CERT_DIR}	The tool available at http://dist.eu-gridpma.info/distribution/util/fetch-crl/ can be run in a crontab to keep the CRLs up to date.

2. Establish control channel connection

Verify that you can establish a control channel connection and that the server has started successfully by telnetting to the port on which the server is running:

```
% telnet localhost 2811
      Trying 127.0.0.1...
      Connected to localhost.
      Escape character is '^]'.
      220 GridFTP Server mldev.mcs.anl.gov 2.0 (gcc32dbg, 1113865414-1) ready.
```

If you see anything other than a 220 banner such as the one above, the server has not started correctly.

Verify that there are no configuration files being unexpectedly loaded from /etc/grid-security/gridftp.conf or \$GLOBUS_LOCATION/etc/gridftp.conf. If those files exist, and you did not intend for them to be used, rename them to .save, or specify -c none on the command line and try again.

If you can log into the machine where the server is, try running the server from the command line with only the -s option:

```
$GLOBUS_LOCATION/sbin/globus-gridftp-server -s
```

The server will print the port it is listening on:

```
Server listening at gridftp.mcs.anl.gov:57764
```

Now try and telnet to that port. If you still do not get the banner listed above, something is preventing the socket connection. Check firewalls, tcp-wrapper, etc.

If you now get a correct banner, add -p 2811 (you will have to disable (x)inetd on port 2811 if you are using them or you will get port already in use):

```
$GLOBUS_LOCATION/sbin/globus-gridftp-server -s -p 2811
```

Now telnet to port 2811. If this does not work, something is blocking port 2811. Check firewalls, tcp-wrapper, etc.

If this works correctly then re-enable your normal server, but remove all options but -i, -s, or -S.

Now telnet to port 2811. If this does not work, something is wrong with your service configuration. Check /etc/services and (x)inetd config, have (x)inetd restarted, etc.

If this works, begin adding options back one at a time, verifying that you can telnet to the server after each option is added. Continue this till you find the problem or get all the options you want.

At this point, you can establish a control connection. Now try running `globus-url-copy`.

3. Try running `globus-url-copy`

Once you've verified that you can establish a control connection, try to make a transfer using `globus-url-copy`.

If you are doing a *client*/server transfer (one of your URLs has `file:` in it) then try:

```
globus-url-copy -vb -dbg gsiftp://host.server.running.on/dev/zero file:///dev/null
```

This will run until you control-c the transfer. If that works, reverse the direction:

```
globus-url-copy -vb -dbg file:///dev/zero gsiftp://host.server.running.on/dev/null
```

Again, this will run until you control-c the transfer.

If you are doing a *third party transfer*, run this command:

```
globus-url-copy -vb -dbg gsiftp://host.server1.on/dev/zero gsiftp://host.server2.on/dev/nu
```

Again, this will run until you control-c the transfer.

If the above transfers work, try your transfer again. If it fails, you likely have some sort of file permissions problem, typo in a file name, etc.

4. If your server starts...

If the server has started correctly, and your problem is with a security failure or gridmap lookup failure, verify that you have security configured properly [here](#).

If the server is running and your client successfully authenticates but has a problem at some other time during the session, please ask for help on gt-user@globus.org¹. When you send mail or submit bugs, please always include as much of the following information as possible:

- Specs on all hosts involved (OS, processor, RAM, etc).
- `globus-url-copy -version`
- `globus-url-copy -versions`
- Output from the telnet test above.
- The actual command line you ran with `-dbg` added. Don't worry if the output gets long.
- Check that you are getting a FQDN and `/etc/hosts` that is sane.
- The server configuration and setup (`/etc/services` entries, `(x)inetd` configs, etc.).
- Any relevant lines from the server logs (not the entire log please).

¹ http://dev.globus.org/wiki/Mailing_Lists

5. High latency for GridFTP server connections

If you run GridFTP servers via Xinetd and notice high latency for connections and/or transfers, check if `/etc/xinetd.conf` or the `gsiftp` service configuration inside `/etc/xinetd.d` is set to log `USERID` as follows:

```
log_on_success += USERID
log_on_failure += USERID
```

Such a configuration tells Xinetd to log the remote user using the method defined in RFC 1413, which causes an ident client to attempt to query the machine that the connection is coming from before the service will run. Even when this succeeds, the response can't be trusted, and more often than not it is rejected or simply dropped (which results in the longest delays) by the remote firewall.

Latency can be reduced by making sure Xinetd does *not* log the `USERID`.

Chapter 5. Usage statistics collection by the Globus Alliance

1. GridFTP-specific usage statistics

The following GridFTP-specific usage statistics are sent in a UDP packet at the end of each transfer, in addition to the standard header information described in the [Usage Stats](#)¹ section.

- Start time of the transfer
- End time of the transfer
- Version string of the server
- TCP buffer size used for the transfer
- Block size used for the transfer
- Total number of bytes transferred
- Number of parallel streams used for the transfer
- Number of stripes used for the transfer
- Type of transfer (STOR, RETR, LIST)
- FTP response code -- Success or failure of the transfer



Note

The client (`globus-url-copy`) does NOT send any data. It is the *servers* that send the usage statistics.

We have made a concerted effort to collect only data that is not too intrusive or private and yet still provides us with information that will help improve and gauge the usage of the GridFTP server. Nevertheless, if you wish to disable this feature for GridFTP only, use the `-disable-usage-stats` option of `globus-gridftp-server`. Note that you can disable transmission of usage statistics globally for all C components by setting "GLOBUS_USAGE_OPTOUT=1" in your environment.

Also, please see our [policy statement](#)² on the collection of usage statistics.

¹ /toolkit/docs/5.0/5.0.2/Usage_Stats.html

² /toolkit/docs/latest-stable/Usage_Stats.html

Glossary

C

client A process that sends commands and receives responses. Note that in GridFTP, the client may or may not take part in the actual movement of data.

E

extended block mode (MODE E) MODE E is a critical GridFTP components because it allows for out of order reception of data. This in turn, means we can send the data down multiple paths and do not need to worry if one of the paths is slower than the others and the data arrives out of order. This enables parallelism and striping within GridFTP. In MODE E, a series of “blocks” are sent over the data channel. Each block consists of:

- an 8 bit flag field,
- a 64 bit field indicating the offset in the transfer,
- and a 64 bit field indicating the length of the payload,
- followed by length bytes of payload.

Note that since the offset and length are included in the block, out of order reception is possible, as long as the receiving side can handle it, either via something like a seek on a file, or via some application level buffering and ordering logic that will wait for the out of order blocks.

S

server A process that receives commands and sends responses to those commands. Since it is a server or service, and it receives commands, it must be listening on a port somewhere to receive the commands. Both FTP and GridFTP have IANA registered ports. For FTP it is port 21, for GridFTP it is port 2811. This is normally handled via inetd or xinetd on Unix variants. However, it is also possible to implement a daemon that listens on the specified port. This is described more fully in the Architecture section of the GridFTP Developer's Guide.

stream mode (MODE S) The only mode normally implemented for FTP is MODE S. This is simply sending each byte, one after another over the socket in order, with no application level framing of any kind. This is the default and is what a standard FTP server will use. This is also the default for GridFTP.

T

third party transfers In the simplest terms, a third party transfer moves a file between two GridFTP servers.

The following is a more detailed, programmatic description.

In a third party transfer, there are three entities involved. The client, who will only orchestrate, but not actually take place in the data transfer, and two servers one of which will be sending data to the other. This scenario is common in Grid applications where you may wish to stage data from a data store somewhere to a super-computer you have reserved. The commands are quite similar to the client/server transfer. However, now the client must establish two control channels, one to each server. He will then choose one to listen, and send it the PASV command. When it responds with the IP/port it is listening on, the client will send that IP/port as part of the PORT command to the other server. This will cause the second server to connect to the first server, rather than the client. To initiate the actual movement of the data, the client then sends the RETR “filename” command to the server that will read from disk and write to the network (the “sending” server) and will send the STOR “filename” command to the other server which will read from the network and write to the disk (the “receiving” server).

See Also [client/server transfer](#).

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