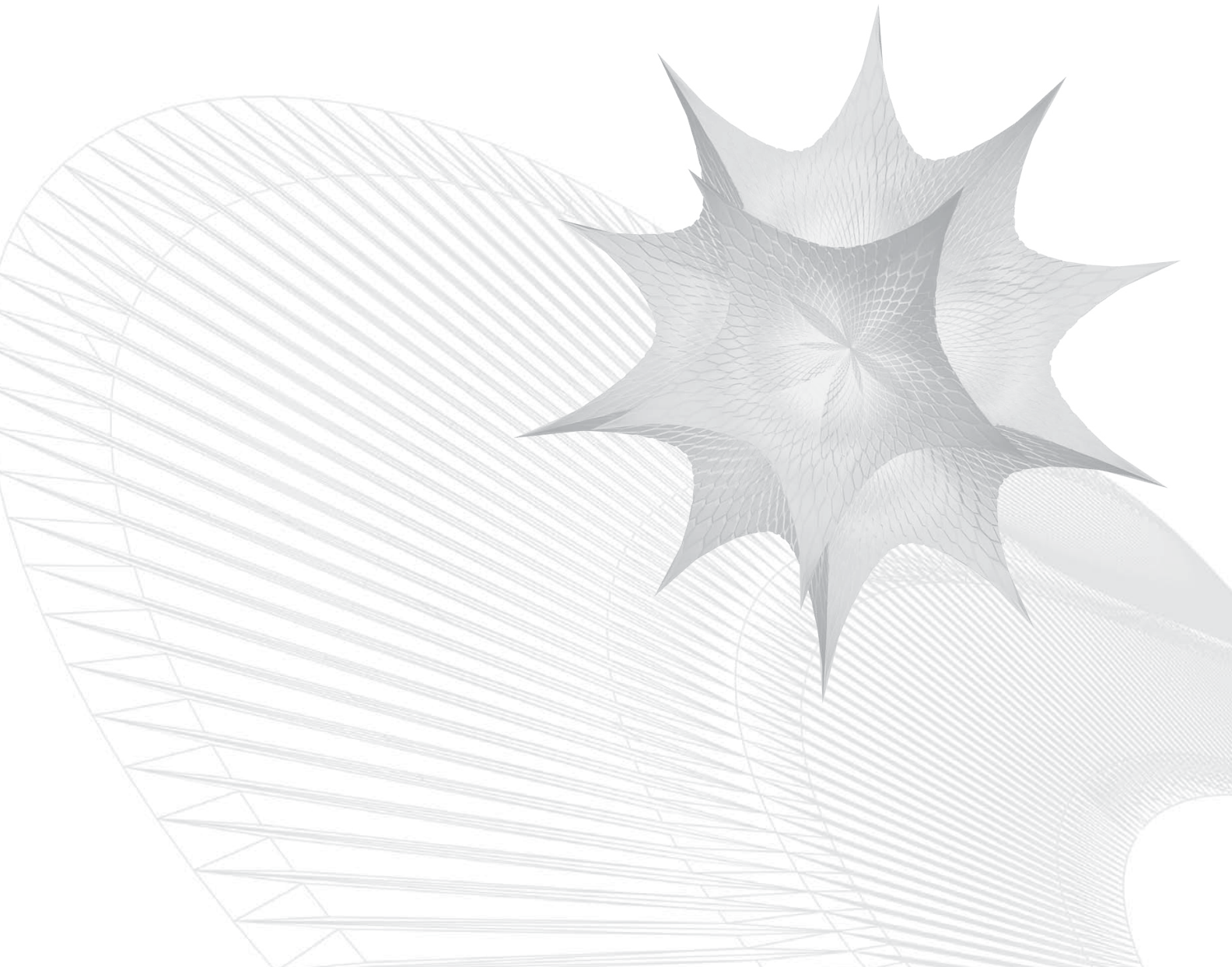


Wolfram **Lightweight Grid™** Manager

USER GUIDE



For use with Wolfram *Mathematica*[®] 7.0 and later.

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Introduction

The Wolfram Lightweight Grid is a system for launching, managing, and using *Mathematica* kernels across a network. It is particularly useful for creating an ad hoc grid built out of a collection of different types of computers. An important application is to enable parallel computing in *Mathematica* to run over a collection of computers; each copy of *Mathematica* comes with a Lightweight Grid Client, which has tools to find and then connect to the Lightweight Grid.

Each node runs a copy of the Lightweight Grid Manager, which is a server that broadcasts itself and waits for a request to launch *Mathematica* kernels for parallel computation. The manager also allows connections from a web browser, and this lets an administrator monitor usage and make configuration changes.

This document describes the operation of the Lightweight Grid Manager, the server component of the Lightweight Grid. It covers issues relating to installation, configuring, and operation, as well as troubleshooting.

grid $Mathematica$ Server

Parallel computing as a standard feature was introduced in *Mathematica 7*. This means that *Mathematica* running on a multicore computer can run multiple parts of a computation concurrently.

grid $Mathematica$ Server lets you go beyond a single multicore machine and add kernels that run on other machines across the network to drive parallel computation. Since it works to extend *Mathematica*, each unit is priced more competitively than a full version of *Mathematica*. In addition, when you install grid $Mathematica$ Server you have the option of configuring the Wolfram Lightweight Grid Manager. Note that grid $Mathematica$ Server only provides parallel or subkernels; it does not contain a controlling or master kernel. This means that grid $Mathematica$ Server is an extension to *Mathematica*.

Alternatives to the Lightweight Grid

The Wolfram Lightweight Grid is a convenient way for *Mathematica* to use *gridMathematica* Server for parallel computation. However, there are alternative ways to use *gridMathematica* Server.

Cluster Integration Package

The Cluster Integration Package allows *Mathematica* to connect across the network to *gridMathematica* when you have a standard cluster management system. At present, the following systems are supported:

- Windows Computer Cluster Server
- Windows HPC Server 2008
- Platform™ LSF®
- Altair® PBS Professional®
- Sun Grid Engine

If you want to use one of these, you should install *gridMathematica* Server, but not activate the Lightweight Grid. When you run the master version of *Mathematica*, you can then use the built-in tools to connect to the cluster.

More information is available in the documentation about the Cluster Integration Package.

Remote Kernels

The Remote Kernels connection method provides another way for *Mathematica* to connect across the network to *gridMathematica*. The Remote Kernels method requires that you configure your own remote shell invocation tools, perhaps using *ssh*, and is more involved to set up.

You would install *gridMathematica* Server, but not activate the Lightweight Grid, and then configure your network to allow remote shell invocation launching of *Mathematica*. When you run the master version of *Mathematica*, you can then use the built-in tools to connect to the cluster.

More information is available in the "Remote Kernels" section of the Parallel Tools tutorial "Connection Methods".

Lightweight Grid Technology

The Lightweight Grid consists of a network of servers, each of which knows how to launch *Mathematica* kernels for parallel computation. The server is a version of Apache Tomcat, with suitable extensions. When the server runs it broadcasts itself on the network with a multicast DNS service discovery technology.

The server also accepts HTTP connections. You can connect to it with a web interface, which is useful for various management purposes. The server also accepts HTTP requests from a *Mathematica* kernel that wishes to obtain parallel kernels for computation. When it gets a request, the server launches a kernel (this will be a parallel kernel) and responds with the name of a link that can be used to connect to this parallel kernel. The master *Mathematica* kernel can use this link to set up parallel computation. When the link is finished the parallel kernel will exit.

Each Lightweight Grid server needs an account to run. This account (defined by a username and password) is known by the computer on which the server runs. The account is also used to run parallel kernels launched by the server. In addition, to carry out administration of the server using the web interface, a password is required. This web interface administrator password is managed by the server and is used only in the web interface.

It is good to understand that the password for the user account that runs the server is distinct from the web interface administrator password, which is the password that allows configuration changes to the server. When you install the Lightweight Grid you can choose to let the installer activate the server. In this case the account to run the server is set up and the administrator password is entered.

The multicast-based service discovery that the server provides allows other computers to find it on the local network. This is built into *Mathematica*, which will automatically find any servers in the Lightweight Grid on the local subnet, when you enable the **Lightweight Grid** tab in the parallel preferences.

If *Mathematica* is not running on the same network as computers running the Lightweight Grid, you will have to enter the name of one computer that runs the Lightweight Grid. When you do

this, all the other computers that this one computer knows about will be made available to *Mathematica*. This works because each Lightweight Grid server keeps track of any other servers that it finds with the service discovery technology.

Installation

The Wolfram Lightweight Grid Manager is installed when *gridMathematica* Server is installed. During installation, you can choose not to activate the Lightweight Grid. You would choose this option if you want to use *gridMathematica* Server but not use the Lightweight Grid or if you want to activate the Lightweight Grid manually.

What Installation Does

The full *gridMathematica* Server installation, including the Lightweight Grid Manager, carries out the following steps:

- Installs a version of *Mathematica* to provide parallel kernels across the network. This is installed in a folder called *gridMathematicaServer* ("gridMathematica Server" on Windows).
- Installs files for a server (this is a version of Apache Tomcat).
- Creates an account (username and password) that runs the server, if requested.
- Sets the server to run as a service when the machine is started.
- Sets a password to allow web server configuration changes.
- Starts the server running.

The installer gives you the option of activating the Lightweight Grid Manager, in which case it carries out the last four steps. If you do not want to use the Lightweight Grid Manager or you want to activate it manually, you would not choose to activate the Lightweight Grid. Remember that if you want to use a managed cluster or configure your own launching technology, you will not want to activate the Lightweight Grid. The "Introduction" has a summary of the Lightweight Grid technology.

The installer always installs a version of *Mathematica* for parallel computation. This is installed in a folder called *gridMathematicaServer* ("gridMathematica Server" on Windows), and by default it will appear in the standard location for the type of computer on which the installer is running.

If you choose to let the installer activate the Lightweight Grid server, here are some recommendations:

- Run the installer with administrative privileges. This is necessary to let it create the account and set the server as a service.
- Decide what user account the server will use. This account runs the server and it also runs the *Mathematica* parallel kernels. You can create a new account or use an existing one.
- Decide on the web administrator password to use. This password allows the web interface to make configuration changes.
- Check that the server port is not in use already. The server listens for HTTP connections on port 3737. You can change the port after installation.
- Check that your software firewall allows other hosts to connect to port 3737. Check that your software firewall allows traffic both ways on port 5353 (mDNS) to allow the service discovery technology to function.

Windows

When you run the *gridMathematica* Server installer, make sure that you have decided whether to activate the Wolfram Lightweight Grid Manager. The section "What Installation Does" should help you to decide. Whichever you do, you should make sure that *Mathematica* or an installation of the Lightweight Grid is not running.

If you do not let the installer activate the Lightweight Grid, then it will run very similarly to the regular *Mathematica* installer.

If you let the installer activate the Lightweight Grid, then you should make sure you run it with administrative privileges. As explained previously, the Lightweight Grid server needs a user account under which to run. This account also runs the *Mathematica* parallel kernels that the Lightweight Grid launches. The installer gives you the option of creating a new account or using an existing account. If you are not sure which option to choose, then creating a new account is recommended.

The installer will also ask you to enter a password to use for making administrative changes through the web interface. It is a good practice to use a different password from that used in the account that runs the server.

When the installer has finished it may suggest a restart of the system. If it does then it is a good idea to restart. When the system restarts, the server should be running and you can connect to the web interface and install a *Mathematica* license.

If the installer does not suggest a restart of the system, it will suggest connecting to the web interface and installing a *Mathematica* license.

You can see more details about operation of the Lightweight Grid in the section "Service Operation: Windows".

To uninstall *gridMathematica* Server, including the Lightweight Grid, you would use the normal procedure for uninstalling programs under Windows. Typically, it is good practice to stop the service before running the uninstaller. If the installer created a user, the user account will be deleted but its documents and settings folder will be retained.

Linux and Unix

When you run the *gridMathematica* Server installer, make sure that you have decided whether to activate the Wolfram Lightweight Grid Manager. The section "What Installation Does" should help you to decide. Whichever you do, you should make sure that *Mathematica* or an installation of the Lightweight Grid is not running.

The installer can only activate the server for certain operating systems. If your operating system is not supported for activation, then do not let the installer activate the Lightweight Grid. Follow a manual process instead. At present, we have tested Lightweight Grid installation for the following Linux distributions: CentOS 5.2, Red Hat Enterprise Linux WS 4, and Ubuntu 8.0.4. If you want to install on Solaris we recommend carrying out a manual installation.

If you do not let the installer activate the Lightweight Grid, then it will run very similarly to the regular *Mathematica* installer.

If you let the installer activate the Lightweight Grid, then you should make sure you run it with root privileges, such as with the `sudo` command. As explained previously, the Lightweight Grid server needs a user account under which to run, and this account also runs the *Mathematica* parallel kernels that the Lightweight Grid launches. The installer gives you the option of creating a new account or using an existing account. If you are not sure which option to choose, then creating a new account is recommended.

The installer will also ask you to enter a password to use for making administrative changes through the web interface. It is a good practice to use a different password from that used in the account that runs the server.

When setup is complete, you should connect to the web interface using `http://localhost:3737/WolframRemoteServices/Licensing/` and install a *Mathematica* license.

You can see more details about operation of the Lightweight Grid in the section "Service Operation: Linux and Unix". This also contains information on manual configuration of the Lightweight Grid in case you do not activate it from the installer.

To uninstall *gridMathematica* Server, including the Lightweight Grid, you would shut down the server, remove `/etc/init.d/wolframlightweightgrid`, remove other init scripts, and delete the installation directory. If the installer created a user account, you will need to manually delete the user account and remove the home directory if desired. In Linux this is typically done with the `userdel` command. The following shows an example of these steps.

```
linux> sudo /etc/init.d/wolframlightweightgrid stop
linux> sudo rm /etc/init.d/wolframlightweightgrid
linux> sudo rm /etc/rc3.d/S99wolframlightweightgrid
linux> sudo rm /etc/rc3.d/K99wolframlightweightgrid
linux> sudo rm /etc/rc4.d/S99wolframlightweightgrid
linux> sudo rm /etc/rc4.d/K99wolframlightweightgrid
linux> sudo rm /etc/rc5.d/S99wolframlightweightgrid
linux> sudo rm /etc/rc5.d/K99wolframlightweightgrid
linux> sudo rm -rf /usr/local/Wolfram/gridMathematicaServer/7.0
linux> sudo userdel -r wolframgrid
```

Mac OS X

When you run the *gridMathematica* Server installer, make sure that you have decided whether to activate the Wolfram Lightweight Grid Manager. The section "What Installation Does" should help you to decide. Whichever you do, you should make sure that *Mathematica* or an installation of the Lightweight Grid is not running.

On the Macintosh, *gridMathematica* Server is built as a Macintosh bundle application, contained in a folder named `gridMathematicaServer.app`. When you unpack the archive, it is suggested that you copy the application into `/Applications`, though it could be installed elsewhere. Once

you have copied `gridMathematicaServer.app` you should launch it. This opens a configuration tool that will let you set up the Lightweight Grid. Typically, on starting the configuration tool Mac OS X will ask for authentication to get root privileges.

If you do not launch the `gridMathematica` Server application, then the Lightweight Grid will not get set up.

As explained previously, the Lightweight Grid server needs a user account under which to run. This account also runs the *Mathematica* parallel kernels that the Lightweight Grid launches. The installer gives you the option of creating a new account or using an existing account. If you are not sure which option to choose, then creating a new account is recommended.

The installer will also ask you to enter a password to use for making administrative changes through the web interface. It is a good practice to use a different password from that used in the account that runs the server.

When setup is complete, you should connect to the web interface using `http://localhost:3737/WolframRemoteServices/Licensing/` and install a *Mathematica* license.

You can see more details about operation of the Lightweight Grid in the section "Service Operation: Mac OS X". This also contains information on manual configuration of the Lightweight Grid in case you do not activate it with the setup application.

To uninstall `gridMathematica` Server, including the Lightweight Grid, you would shut down the service, remove the entry in `/Library/StartupItems`, and delete `gridMathematicaServer.app`. If the installer created a user account, you will need to manually delete the user account and remove the home directory if desired. The following shows an example of these steps.

```
macosx> sudo /sbin/SystemStarter stop "Wolfram Lightweight Grid"
macosx> sudo rm -rf /Library/StartupItems/WolframLightweightGridManager
macosx> sudo rm -rf /Applications/gridMathematicaServer.app
macosx> sudo /usr/bin/dscl . delete /Users/wolframgrid
macosx> sudo rm -rf /Users/wolframgrid
```

Testing and Configuring

When you have finished installing the Lightweight Grid and you think that it is running, you can use the web interface to carry out configuration and testing.

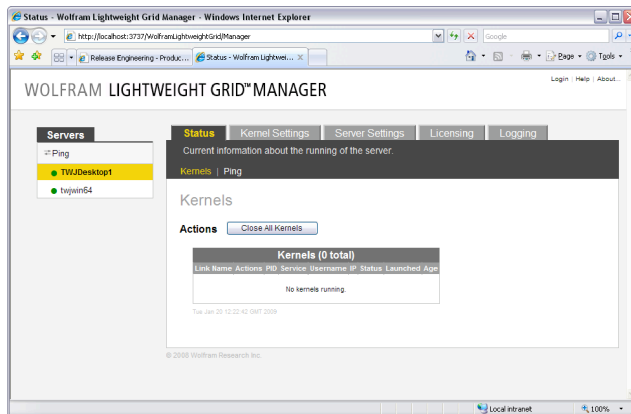
The main feature for configuration is to install a *Mathematica* license. There is a convenient way to do this with the **Licensing** tab of the web interface. After this you can check the license status in the **Kernel Settings** tab of the web interface by examining the `LicenseState` property. If this says the license is valid, then your server should be ready for operation.

If you installed *gridMathematica* Server into a non-default location, you should confirm that the value of the `KernelCommand` property is correct. You can see this in the **Kernel Settings** tab of the web interface.

Web Interface

The Lightweight Grid consists of a network of servers, each of which knows how to launch *Mathematica* kernels for parallel computation; a description of the technology is given in the "Introduction". Each server accepts HTTP connections. Typically these are used to set up links from a master *Mathematica* kernel that wants to launch parallel kernels to use for computation. However, you can also connect to the server with a web browser for configuration and monitoring.

The server runs, by default, on port 3737, so you should be able to connect to it from a web browser using a URL such as `http://localhost:3737` or `http://server:3737` depending on whether you are on the machine or not. A sample of the front page of the server is shown below.



The page shows on the left panel other servers that are found with service discovery. In this case it lists itself (highlighted in yellow) and other servers.

Across the top are tabs for different sections of the interface. These sections are described in more detail below.

Server Administrator

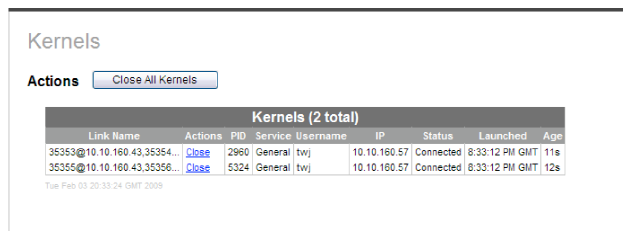
For some operations of the server, such as license operations, changing configuration, or shutting down kernels, you need to enter a password that authenticates your right to carry out the operation. The server will ask you to enter the administrator password when you try to carry out one of these operations. The web interface uses a standard session-based login session, so once you authenticate, you do not need to enter your password until the session expires (typically after about 30 minutes with no activity).

Note that the administrator password is used in a different way from the password of the account that runs the server. You can read more about this in the "Introduction", which has a summary of the Lightweight Grid technology.

The administrator password is typically set when you install the Lightweight Grid. It can be changed after installation.

Status

The **Status** tab shows the basics of operation of the server. A sample is shown below; in this case it has launched two kernels.



Kernels (2 total)							
Link Name	Actions	PID	Service Username	IP	Status	Launched	Age
35359@10.10.160.43.35354...	Close	2960	General twj	10.10.160.57	Connected	8:33:12 PM GMT	11s
35355@10.10.160.43.35356...	Close	5324	General twj	10.10.160.57	Connected	8:33:12 PM GMT	12s

Tue Feb 03 20:33:24 GMT 2009

From this panel you can close some or all of the kernels. When you do so you need to be logged in as the server administrator.

Kernel Settings

The **Kernel Settings** tab shows the service configuration page for the services that the server provides. Each service is a template for launching kernels, constructed from the properties shown below.

Service: General (default) ▾

Configuration	
Property	Value
ConfigVersion	1
Name	General
Enabled	true
KernelCommand	/Applications/gridMathematica.app/Contents/MacOS/MathKernel -mathlink -su
LinkHost	
FrontEndLaunchName	
FrontEndLaunchFlags	
KernelNumber	0
UnconnectedTimeout	15000
KernelTimeout	0
KernelInactiveTimeout	0
KernelInitialization	\$_ProcessID
LicenseState	invalid:secured
MathId	5110-19024-47763
Hostname	jfkleinmac.wri.wolfram.com
VersionNumber	7.0
Platform	Mac OS X x86 (64-bit)

You would make a change here if, for example, you wanted to switch the location of *Mathematica* that was being launched, or to give special command-line options when launching. The details of the parameters are given in the "Kernel Settings" section.

In order to save changes to the configuration you need to be logged in as the server administrator.

The configuration form has several buttons at the bottom:

Save - Save the changes made in the form. If there are problems with any of the changed settings, none of the changes will be saved and you will see messages identifying the issues. Saved changes will take immediate effect for anyone launching kernels from the selected service, and the saved changes are also saved to disk.

Reset - Reset changes made in the form input fields to the values they had when the web page was loaded.

Reset to Defaults - Change all editable fields (except `name`) to their default settings; this is the same as typing in the defaults and clicking **Save**.

Save and Test Kernel - Save the changes made in the form and do a test launch of the kernel described by `kernelCommand`. You would do this in order to verify that the kernel can be launched and that it has a valid license.

Under **Kernel Settings** there is also a **Services** link which shows this page:

Actions

New Service

Services		
Name	# Kernels	Actions
General (default)	0	Open Kernel Close All Kernels Clone Delete Configure

The Services page shows you the services that the server provides and provides functions for managing them. Each service is a group of identically configured kernels. When you install the server, a default General Service is created. There is always at least one service, and one of the services is marked as the default service.

Manual Launching

Another use of the Services page is to launch kernels manually. This is useful for testing that they can be launched and inspecting the name of the link that is produced. Clicking the **Open Kernel** link will launch a kernel and display information as shown below.

Opened kernel with service "General":

29826@10.10.160.43,29827@10.10.160.43

Linkname	29826@10.10.160.43,29827@10.10.160.43
Process ID	6448
Protocol	TCP/IP
Launch date	Thu Nov 20 21:38:32 GMT 2008
Mathematica version	7.0
Kernel state	Available

This shows that a kernel can be launched and returns a typical link that it would use. It would be possible to use a manual configuration to connect to this link, but just knowing that the link can be created and seeing its name is often useful enough.

Server Settings

The **Server Settings** tab shows settings for the server. A sample is shown below.

Configuration	
Property	Value
LaunchEnabled	<input type="text" value="true"/>
DefaultKernelCommand	<input type="text" value="C:\Program Files\Wolfram Research\grid\Mathematica7.0\math.exe -mathlink"/>
DefaultService	<input type="text" value="General"/>
DNSSDRegistrationEnabled	<input type="text" value="true"/>
DNSSDRegistrationInterfaces	<input type="text" value="All"/>
DNSSDImplementation	<input type="text"/>
Port	<input type="text" value="0"/>
ContactURL	<input type="text"/>
IPFilter	<input type="text"/>

You would make a change here if, for example, you wanted to change the URL that is used to contact the server. The details of the parameters are given in the "Server Settings" section.

In order to save changes to the configuration you need to be logged in as the server administrator.

Licensing

The **Licensing** tab allows you to set license data for the *Mathematica* kernels and front ends launched by the Lightweight Grid. To use the **Licensing** tab you will have to be logged as the server administrator (this will be requested if you are not already logged in). The initial page lets you install a license to be used by this server and is an important step in setting up your server. The following shows the **Licensing** tab.

Status | Kernel Settings | Server Settings | **Licensing** | Logging

Tools for working with licenses for Mathematica.

[Install License](#) | [Show License Data](#)

Install License

Timeout: seconds

Enter License:

Examples:
 mathmsrver.example.com
 myhost 6139-70054-09110 L1111-1111 4849-296-565

If you enter the license information into the text field and click **Install License**, this will install the license for the machine running the server. Typically, the license will indicate a network license manager, for example, !mathlmserver.example.com. Note that the license will be installed into the `$UserBaseDirectory` of the user running the service.

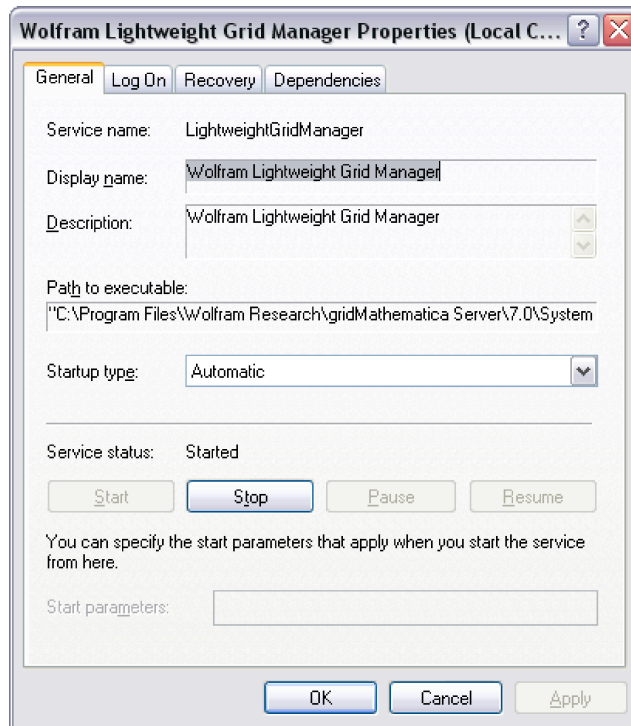
Service Operation

The Wolfram Lightweight Grid Manager runs as a server on each machine that you wish to provide services for the grid. This section describes issues relating to how the server runs on each platform.

If you want to check the server, the web interface is probably more convenient. This section is useful if you want to see details about how the server is launched as a service by the operating system.

Windows

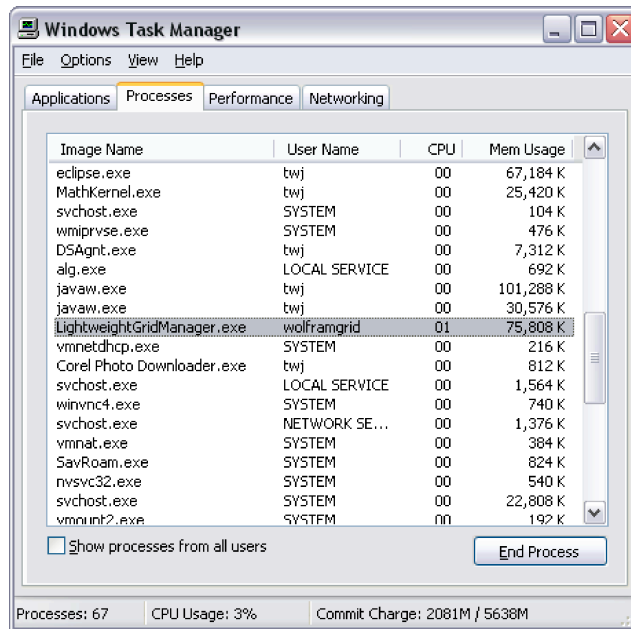
The Lightweight Grid is installed as a service under the Windows operating system. You can review the service by looking at the **Services** control, which is launched from the **Control Panel** by choosing **Administrative Tools** and then **Services**. The Lightweight Grid appears in the service list. Here you can restart or stop the service. Right-click on the service name and select **Properties** to open the dialog window shown below.



Here you can change various parameters for the service, such as whether it is launched automatically when the machine is started or what user should run the service.

When you stop or restart the service, sometimes Windows is slow to get final notification that it has stopped and puts up a warning dialog, but the service has in fact stopped.

If you want to check that the service is running, you can use the Windows Task Manager, which should show that the server is running.



Linux and Unix

The Lightweight Grid runs as a background process or daemon under Linux and Unix. Typically, this is set up by a script for starting and stopping the server located in the directory `/etc/init.d`. The script is invoked at boot time by files in the runlevel directories, such as `/etc/rc3.d`, `/etc/rc4.d`, and `/etc/rc5.d`. The actual meaning of the runlevel directories differs between Unix systems. On many Linux distributions runlevel 3 is used for multi-user startup and 5 for multi-user startup with an X interface.

Once the Lightweight Grid has been set up you can manually shut it down or start it up by executing the file `/etc/init.d/wolframlightweightgrid`, typically as root. A sample session that starts the server is shown below.

```

linux> sudo /etc/init.d/wolframlightweightgrid start
Starting tomcat: Starting Tomcat
Using CATALINA_BASE:
/usr/local/Wolfram/gridMathematicaServer/7.0/SystemFiles/RemoteServices/tom
cat
Using CATALINA_HOME:
/usr/local/Wolfram/gridMathematicaServer/7.0/SystemFiles/RemoteServices/tom
cat
Using CATALINA_TMPDIR:
/usr/local/Wolfram/gridMathematicaServer/7.0/SystemFiles/RemoteServices/tom
cat/temp
Using JAVA_HOME:
/usr/local/Wolfram/gridMathematicaServer/7.0/SystemFiles/Java/Linux-x86-64
Tomcat running as PID 12062.
linux>

```

In typical operation the daemon is started automatically at boot time, but for administrative reasons the daemon can be controlled directly with these commands:

```

sudo /etc/init.d/wolframlightweightgrid start
sudo /etc/init.d/wolframlightweightgrid stop
sudo /etc/init.d/wolframlightweightgrid restart

```

Here are the runlevel scripts in the rc3.d directory.

```

linux> ls -l /etc/rc3.d/S99wolframlightweightgrid
lrwxrwxrwx 1 root root 16 Dec 25 18:03
/etc/rc3.d/S99wolframlightweightgrid -> ../init.d/wolframlightweightgrid*
linux> ls -l /etc/rc3.d/S99wolframlightweightgrid
lrwxrwxrwx 1 root root 16 Dec 25 18:03
/etc/rc3.d/K99wolframlightweightgrid -> ../init.d/wolframlightweightgrid*
linux>

```

If you do not set up the Lightweight Grid with the installer, as described in the section "Installation: Linux and Unix", you can set it up later. You will need to have run the installer to get the *gridMathematica* Server layout. Change the file ownership for the layout to the user running the web server. From the layout, copy the file `SystemFiles/RemoteServices/SystemFiles/Unix/wolframlightweightgrid` to `/etc/init.d`. Then edit it to set three variables: `GRIDM_HOME`, the path to the *gridMathematica* Server layout; `WEBUSER`, the user running the web server; `WEBUSER_HOME`, the path to the `WEBUSER` home directory; and `SYSTEM_ID`, the value of `$SystemID` used by *Mathematica* on the computer. Then make symlinks from the

runlevel directories to /etc/init.d. Finally, you should set the web administrator password to allow web changes to configuration. You can then start the server and your Lightweight Grid should be operating.

If you want to deactivate the Lightweight Grid, stop the server, remove /etc/init.d/wolframlightweightgrid, and remove any runlevel entries.

Mac OS X

The Lightweight Grid on Mac OS X runs as a Startup Item named WolframLightweightGridManager located in /Library/StartupItems. This contains two files, StartupParameters.plist and WolframLightweightGridManager. A default copy of these files is also found in the application layout in SystemFiles/RemoteServices/SystemFiles/MacOSX.

Once the Lightweight Grid has been set up, you can manually shut it down or start it up by executing the program /sbin/SystemStarter, typically as root. This is demonstrated in the following.

```
sudo /sbin/SystemStarter start "Wolfram Lightweight Grid"  
sudo /sbin/SystemStarter stop "Wolfram Lightweight Grid"  
sudo /sbin/SystemStarter restart "Wolfram Lightweight Grid"
```

If you do not set up the Lightweight Grid with the installer, as described in the section "Installation: Mac OS X", you can set it up later. To do this you should create or identify a user account to run the server. Change the file ownership for the layout to the user running the web server. Then from gridMathematicaServer.app copy SystemFiles/RemoteServices/SystemFiles/MacOSX/WolframLightweightGridManager to /Library/StartupItems. You should also ensure the setting for APP_ROOT, the application root, and WEBUSER, the user running the server in WolframLightweightGridManager, are correct. Finally, you should set the web administrator password to allow web changes to configuration. You can then start the server and your Lightweight Grid should be operating.

If you want to deactivate the Lightweight Grid, stop the server and remove the entry in /Library/StartupItems.

Configuration

The Lightweight Grid consists of a network of servers, each of which knows how to launch *Mathematica* kernels for parallel computation; a description of the technology is given in the "Introduction" section.

This section discusses a number of configuration topics that govern the operation of a Lightweight Grid server: the administrator password allows configuration changes to be made through the web interface, "Kernel Settings" deals with parameters of the copy of *Mathematica* that gets launched, and "Server Settings" deals with settings for the server.

Administrator Password

For some operations of the server, such as changing configuration or shutting down kernels, you need to enter a password that authenticates your right to carry out the operation. The server will ask you to enter the administrator password when you try to carry out one of these operations. The web interface uses a standard session-based login session, so once you authenticate you do not need to enter your password until the session expires (typically after about 30 minutes with no activity).

Note that the administrator password is used in a different way from the password of the account that runs the server. You can read more about this in the "Introduction", which has a summary of the Lightweight Grid technology.

The administrator password is typically set when you install the Lightweight Grid. It can be changed after installation.

Windows

Under Windows to reset the administrator password you should first stop the server.

If you are running Vista with User Account Control turned on, you should use the UAC Elevated Command Prompt shortcut, found in `SystemFiles\RemoteServices\SystemFiles\Windows`. This

runs a command prompt but with administrator privileges. If UAC is not relevant, you should just run a command prompt. Alternatively, you can log in as the user account that runs the server.

After this, on a 64-bit computer you can use the following commands.

```
set INSTALLROOT=C:\Program Files\Wolfram Research\gridMathematica
Server\7.0
set JAVA_HOME=%INSTALLROOT%\SystemFiles\Java\Windows-x86-64
cd %INSTALLROOT%\SystemFiles\RemoteServices\SystemFiles\Windows
.\adminutility.bat passwd admin <password>
```

If you are using a 32-bit computer, you should do the following.

```
set INSTALLROOT=C:\Program Files\Wolfram Research\gridMathematica
Server\7.0
set JAVA_HOME=%INSTALLROOT%\SystemFiles\Java\Windows
cd %INSTALLROOT%\SystemFiles\RemoteServices\SystemFiles\Windows
.\adminutility.bat passwd admin <password>
```

Note that if you installed *gridMathematica* Server into a different location you would have to make a different setting for `INSTALLROOT`.

Finally, you can log out and restart the server.

Linux and Unix

In Linux and Unix the administrator password can be set as follows. First, stop the server. Then issue the following commands.

```
cd /usr/local/Wolfram/gridMathematicaServer/7.0
cd SystemFiles/RemoteServices/SystemFiles/Unix
sudo ./adminutility.sh passwd admin <password>
```

Note that if you installed *gridMathematica* Server into a different location than shown above, you would have to change to the corresponding directory.

Mac OS X

For Mac OS X the administrator password can be set as follows. First, stop the server. Then issue the following commands.

```
cd /Applications/gridMathematicaServer.app
cd SystemFiles/RemoteServices/SystemFiles/MacOSX
sudo ./adminutility.sh passwd admin <password>
```

Note that if you installed *gridMathematica* Server into a different location than shown above, you would have to change to the corresponding directory.

Data Directory

The server collects all its configuration and log files in one place, the data directory. The location of the data directory itself is configurable, but the default location is under the `$UserBaseDirectory` of the user that runs the service, in the subdirectory `ApplicationData/WolframLightweightGridManager`. The data directory has three subdirectories, `conf`, `log`, and `kernel`.

The `conf` directory holds the configuration files. `General.conf` is the file corresponding to the **Kernel Settings** tab. `Agent.properties` is the file corresponding to the **Server Settings** tab. If you create new services or rename the default service from `General`, then there will be one file for each service, named according to the service name with a `.conf` file extension. Each time you save settings, the corresponding file is updated.

The `log` directory holds log files useful for tracking server operation. The `audit.log` file corresponds to the **Audit Log** section of the **Logging** tab. The `wrs.log` file corresponds to the **Details** section of the **Logging** tab. The `jmdns.log` file contains details of the service discovery operation. Each of these log files will be renamed on a daily basis so that no single log file contains more than a day's worth of information. It is recommended to keep log files, but log files can be removed without harming server operation. It is not recommended to modify audit log files.

The `kernel` directory is used as the initial working directory for kernels launched by the server. This area can be used as local scratch space by user programs running on Lightweight Grid kernels.

Kernel Settings

These parameters can be modified to change details of the way that the Lightweight Grid launches *Mathematica* for parallel computation. They can be changed with the **Services** tab of the web interface.

Name

`Name` is the service name. To rename the service, you should modify this parameter. Each service is a group of identically configured kernels. When you install the server a default service named `General` is created.

Enabled

`Enabled` sets whether the server can launch kernels. The default is `true`, which allows kernels to be launched. You can set this to `false`, stopping kernels being launched, when you are making some lengthy configuration changes.

The `LaunchEnabled` server setting takes precedence over this setting; if `LaunchEnabled` is `false`, the `Enabled` property setting is ignored.

KernelCommand

`KernelCommand` gives the command that the server uses to launch the *Mathematica* kernel. Typically it should contain the path to the kernel executable, the `-mathlink` and `-subkernel` flags, and any other flags that are needed.

To change the location of the copy of *Mathematica* used by the server, you should modify this parameter.

LinkHost

`LinkHost` sets the name of the *MathLink* TCP connections that the server sends back to a master *Mathematica* kernel that is connecting to a parallel kernel. Typically it is chosen by default correctly, but sometimes a name is chosen that cannot be seen by the master kernel. This can happen if some special network device, such as for a virtual machine, is installed. Set this property to force the link to be named by a particular IP number such as 12.112.110.16.

FrontEndLaunchName

`FrontEndLaunchName` is the full name of the *Mathematica* notebook front end. The default is to use the name that goes with the *Mathematica* kernel.

FrontEndLaunchFlags

`FrontEndLaunchFlags` are given to the *Mathematica* notebook front end when it is launched. This could be used to set the name of a X display.

KernelNumber

`KernelNumber` sets the maximum number of kernels that the server will allow to run at any given time. The default value is 0, which means that the server will not limit the number of kernels, and these will be limited by license availability.

UnconnectedTimeout

`UnconnectedTimeout` sets the time in milliseconds that a kernel will wait for the master kernel to actually connect to it before terminating. A value of 0 means there is no limit, though this is not generally recommended.

KernelTimeout

`KernelTimeout` sets the maximum time in milliseconds that a kernel will be active. The default value is 0, which means that there is no limit. When the time period expires, the kernel is shut down.

KernelInitialization

`KernelInitialization` is a command that is sent to the kernel being launched. This could be used for special configuration.

Server Settings

These parameters can be modified to change details of the way that the Lightweight Grid server operates. They can be changed with the **Settings** tab of the web interface.

LaunchEnabled

`LaunchEnabled` sets whether the server can launch kernels. The default is true, which allows kernels to be launched. You can set this to false, and stop kernels being launched, when you are making some lengthy configuration changes.

Port

`Port` sets the port number used for constructing the contact URL that the server advertises through the service discovery mechanism. The default is 0, which means that a setting of 3737 will be used. If you have reconfigured the web server to use a different port, you would modify this property. If the `ContactURL` setting is used, the `Port` setting is ignored.

Changes to `Port` do not take effect until you restart the server.

ContactURL

`ContactURL` is the URL used by master *Mathematica* kernels to connect to the server to launch parallel kernels. The default value is a blank field, in which case the server constructs a contact URL automatically from the default hostname and the `Port` property. Sometimes the default hostname is not actually reachable across the desired networks. (This can happen on a computer with multiple network interfaces, or on a machine where the configured hostname differs from its DNS name server entry.) In this case a different name, or IP number, can be set here.

When you set this, the name must be locatable over the network, and the port must match the one used by the server. In addition, you must include the `WolframRemoteServices` path. A possible setting would be `http://12.112.110.16:3737/WolframRemoteServices`, which would refer to the server running on the machine with IP number 12.112.110.16.

Changes to `ContactURL` do not take effect until you restart the server.

IPFilter

`IPFilter` is a filter that controls access by the computers that connect to the server according to their IP numbers. The default value is no filter, which will allow any computer to connect to the server and launch kernels.

The setting for `IPFilter` is a comma separated list of patterns; each pattern is of the form `x.x.x.x/bits`, where `bits` is the length of a bit mask. A setting of `12.112.110.0/24` means that the first 24 bits of the IP number have to match, so IP numbers that start 12.112.110 will be allowed. A setting of `12.112.110.0/24,12.112.116.0/24` means that there are two patterns, and for both the first 24 bits have to match, allowing requests from IP numbers that start with 12.112.110 or 12.112.116. In both cases any IP numbers that do not match will not be allowed to connect to the server and launch kernels.

Note that you can also control connections at the Tomcat level, but `IPFilter` is a quick way to control access.

Use caution when changing this setting. It is possible to cut off access for the computer you are browsing from. If you are cut off, you can connect to the server directly with a remote login or from a computer that is accepted by the `IPFilter` setting.

Licensing

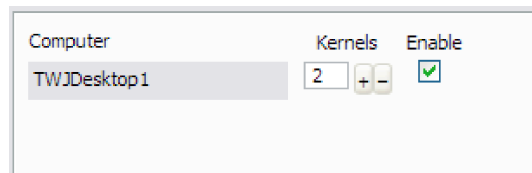
Mathematica needs a license so that it can be launched by the Lightweight Grid. The web interface can install a license, which is described in the "Licensing" section.

Troubleshooting

The section gives some help with common problems that can occur when running the Lightweight Grid.

Cannot Connect to the Server

Suppose that you set up the Lightweight Grid on a server. Then, you launch your master copy of *Mathematica* on a different machine, and open **Parallel Kernel Configuration** from the **Evaluation** menu. You locate your server and set it up to launch two kernels as shown below.



Then you try to connect to these two parallel kernels, but you see error messages. Here is an example.

```
In[1]:= LaunchKernels[]
```

```
LightweightGridClient`RemoteKernelOpen::connect: Unable to connect to  
http://TWJDesktop1.example.com:3737/  
WolframRemoteServices/Manager.  
Check network connectivity and the spelling  
of the hostname or URL of the remote  
computer. Confirm that a Remote Services  
agent is running on the remote computer. >>
```

```
LightweightGridClient`RemoteKernelOpen::connect: Unable to connect to  
http://TWJDesktop1.example.com:3737/  
WolframRemoteServices/Manager.  
Check network connectivity and the spelling  
of the hostname or URL of the remote  
computer. Confirm that a Remote Services  
agent is running on the remote computer. >>
```

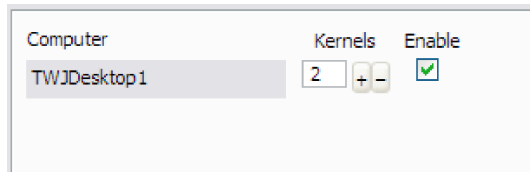
```
Out[1]= {$Failed, $Failed}
```

This suggests that the published name of the machines, `TWJDesktop1`, is not visible across your network. You could confirm this by using a web browser on the machine that runs the master *Mathematica*. If the browser cannot connect to the URL shown in the error message, `http://TWJDesktop1.example.com` in this example, this indicates there is a network host naming issue.

The solution is either to fix your network so that you can find machines by name, or to change the `ContactURL` server configuration parameter, for example using the IP number of the server.

Cannot Connect to the Link

Suppose that you set up the Lightweight Grid on a server. Then, you launch your master *Mathematica* on a different machine, and open **Parallel Kernel Configuration** from the **Evaluation** menu. You locate your server and set it up to launch two kernels as shown below.



Then you try to connect to these two parallel kernels, but after a long time you see error messages. Here is an example.

```
In[1]:= LaunchKernels[]
```

```
LinkConnect::linkc: Unable to connect to LinkObject[
  29778@192.168.70.1,29780@192.168.70.1, 20, 8]. >>
```

```
LinkObject::linkn :
  Argument LinkObject[29778@192.168.70.1,29780@192.168.70.1, 20, 8]
  in LinkRead[LinkObject[
  29778@192.168.70.1,29780@192.168.70.1, 20, 8]] has
  an invalid LinkObject number; the link may be closed. >>
```

```
LinkObject::linkn : Argument LinkObject[
  29778@192.168.70.1,29780@192.168.70.1, 20, 8] in LinkObject[
  29778@192.168.70.1,29780@192.168.70.1, 20, 8] has an
  invalid LinkObject number; the link may be closed. >>
```

```
LinkObject::linkn :
  Argument LinkObject[29778@192.168.70.1,29780@192.168.70.1, 20, 8]
  in LinkWriteHeld[LinkObject[
  29778@192.168.70.1,29780@192.168.70.1, 20, 8], Hold[<<31>>[]
  ]] has an invalid LinkObject
  number; the link may be closed. >>
```

```
General::stop :
  Further output of LinkObject::linkn will be suppressed during this
  calculation. >>
```

This suggests that the server was found, and responded with a link, but that the link could not be used. The clue here is that the name of the link, `192.168.70.1`, is a private network name. This name has been picked by the link system called by the Lightweight Grid, but is a name not visible outside of this machine. You can inspect the link further by using manual launching from the web interface.

The solution is to change the configuration of your system, or to use the `LinkHost` kernel configuration parameter to set the IP number for the link.

