

Cygwin/X Frequently Asked Questions

Questions and Answers

1. General Information

1.1. What is Cygwin/X?

Cygwin/X is a port of the X Window System to Cygwin. Cygwin provides a UNIX-like API on the Win32 platform.

1.2. What is Cygwin?

Cygwin tools are, in the words of the Cygwin homepage (<http://cygwin.com/>), “ports of the popular GNU development tools and utilities for Windows 95, 98, and NT. They function by using the Cygwin library which provides a UNIX-like API on top of the Win32 API.” Cygwin provides the compiler (gcc), libraries, headers, and other utilities which build and support the operation of Cygwin/X.

1.3. What is the X Window System?

[ScheiflerGettys92]

The X Window System, or X, is a network-transparent window system. With X, multiple applications can run simultaneously in windows, generating text and graphics in monochrome or color on a bitmap display. Network transparency means that application programs can run on machines scattered through the network.

1.4. What is an X Server?

An X Server is a program that provides display and user input services to other programs. In comparison, a file server provides other programs with access to file storage devices. File servers are typically located in a remote location and you use the services of a file server from the machine that you are located at. In contrast, an X Server is typically running on the machine that you are located at; display and user input services may be requested by programs running on your machine, as well as by programs running on remote machines.

1.5. What is an X client?

An X client is a program that utilizes the display and user input services provided by an X Server. X clients may run on the same or disparate machine as the X Server that is providing display and user input services.

1.6. What does :0.0 mean?

The `:0.0` part of the `DISPLAY` variable denote the display and the screen of an X server.

The display is the first number and equals to a running instance of an X server. If it is using TCP/IP for communication it listens on port 6000 + *display-number* for connections. With local (UNIX domain sockets) it uses the socket `/tmp/.X11-unix/Xdisplay-number`

The screen denotes different output devices of the X server. You could start `xwin.exe` with two `-screen` options and would end up with two X11 windows. Each of them is a different screen. Other X servers open different screens for different monitors connected to the computer.

Cygwin/X supports different formats of the `DISPLAY` variable

- `:0.0` or `unix:0.0`

This names a local X server and the communication uses the UNIX domain sockets.

- `hostname:0.0`

This names a remote X server and the communication uses the TCP/IP network.

1.7. Why port the X Window System to Microsoft Windows?

Porting X Window System to Microsoft Windows benefits many people and projects in many ways:

- Prior to Cygwin/X only commercial, closed source X Servers were available for Microsoft Windows.
- An X Server on Windows may be used to display the output of programs running on remote UNIX machines.
- Cygwin/X, in conjunction with Cygwin, provides a complete compatibility layer for compiling and running UNIX applications on Microsoft Windows.

1.8. Is there a Cygwin/X newsgroup?

No, Cygwin/X does not have a newsgroup; however, we do have a mailing list. See Q: 1.9.

1.9. Is there a Cygwin/X mailing list?

Yes, Cygwin/X has a mailing list, namely, `cygwin-xfree@cygwin.com`. Visit the Cygwin Mailing Lists (<http://cygwin.com/lists.html>) page to subscribe to `cygwin-xfree@cygwin.com` as well as to read and search an online archive of the mailing list traffic.

Tip: Post your X-related inquires to `cygwin-xfree@cygwin.com` only; do not post nor cross post your inquires to the `cygwin@cygwin.com` mailing list. Cygwin's mailing list is only for Cygwin related inquires that are not handled by another more-specific list.

2. Installation

2.1. What versions of Windows does Cygwin/X run on?

Cygwin/X aims to support all versions of Windows supported by Cygwin. However, Cygwin/X has not been tested on older versions of Windows and is believed to be broken. Problem reports are welcomed.

Cygwin/X requires Cygwin to compile and run. Cygwin is not, as of 2003-12-29, available on Microsoft Windows CE, therefore Cygwin/X is not currently available on Microsoft Windows CE.

2.2. How is Cygwin/X installed?

The Cygwin/X User's Guide (<http://x.cygwin.com/docs/ug/cygwin-x-ug.html>) thoroughly documents the installation process. Installation is performed through Cygwin's **setup.exe** program.

3. Upgrade

3.1. What happened to my X server? Where did `/usr/X11R6/ go?`

The upgrade from X.Org R6.8 to modular X.Org R7.4 makes a lot of changes. Please read the announce email (<http://cygwin.com/ml/cygwin-xfree-announce/2008-11/msg00000.html>) and pay attention to the upgrade instructions

3.2. I upgraded my X server and now I can't type anything into any X application

Launch the X server via the shortcut under "Cygwin-X" on the start menu.

Technical details: The **startxwin.bat** script used to set several environment variables used by the X server to specify the location of files it needs to access. Specifically this batch file would set `XKEYSYMDB` to `/usr/X11R6/lib/X11/XKeysymDB`. This file is now at `/usr/share/X11/XKeysymDB`, and without it the keyboard won't work.

If you are (perhaps unintentionally) using a copy of the old **startxwin.bat** (perhaps under another name) to start the X server, remove the environment variables `XAPPLRESDIR`, `XOMSDB`, `XNLSPATH` and `XKEYSYMDB` from it, or (preferably) use the updated **startxwin.bat**.

If `echo $XKEYSYMDB` outputs something, you have something else setting `XKEYSYMDB` in your environment. Find it and remove it.

These variables were always being set to the defaults, so they can simply be removed. See Q: 8.8. for the reason why you might need to set them.

3.3. I can't find **startxwin.bat** to start the X server

X.Org now uses the prefix `/usr` not `/usr/X11R6`. So **startxwin.bat** has moved from `/usr/X11R6/bin/startxwin.bat` to `/usr/bin/startxwin.bat`.

A "XWin Server" shortcut to this batch file is created on the Start menu, under "Cygwin-X" **startxwin.bat** and the Start menu link to it are now installed by the `xinit` package.

3.4. Fatal server error: Can't read lock file /tmp/.X0-lock

The cause of this problem is not well understood at present. Possible causes:

1. /tmp resides on a FAT filesystem
2. Bad permissions on /tmp
3. Not having administrator rights

Possible workarounds:

1. Try starting the server with `-nolock` (e.g. if you use `startxwin.bat` or `startxwin.sh` to start the server, add `-nolock` to the **XWin** line in that script; if you use **xinit** or **startx**, run it as `xinit -- -nolock` or `startx -- -nolock`)
2. Try `rm -rf /tmp; mkdir /tmp; chmod 1777 /tmp`

Technical details: The X server attempts to create a lock file in /tmp by creating the file under a temporary name, then renaming it to the proper name (by hard linking it under the correct name, then unlinking it from the temporary name). If this rename fails it attempts to read the existing lock file to determine the pid of an already running server. The failure case appears to be that lock file was created successfully, but the rename failed, despite the fact that no old lock file exists, which we then fail to read (hence the error message).

3.5. My favourite font has gone! The font Emacs uses is just boxes

Only minimal fonts will be installed after the upgrade.

Font packages are now named `font-<author/class>-<fonttype>`

Some packages dependencies have not yet been updated for the fonts they require, so you may need to manually install the needed fonts. For example, to provide the font emacs wants to use by default you will probably want to install `font-adobe-dpi75` (or `font-adobe-dpi100` if you like large fonts). This package provides the *courier*, *helvetica*, *new century schoolbook* and *times* font families.

The *lucida* font family is provided by the package `font-bh-dpi75` (or `font-bh-dpi100`). The monospaced version, *lucida typewriter* is provided by the package `font-bh-lucidatypewriter-dpi75` (or `font-bh-lucidatypewriter-dpi100`).

Note that after installing fonts you will need to restart the X server or run `xset fp default; xset fp rehash` to make the new fonts available

3.6. Where has xhost/xlsfonts/etc. gone?

Previously all the X utility programs were contained in a single package, `xorg-x11-bin`, which needed to be updated when any of the programs it contained was updated. In modular X each of these programs can be found in a separate package, usually named `xhost/xlsfont/etc.`

3.7. How do I get rid of that menu at the top of my xterm?

Run it as `xterm +tb`, or add `XTerm *toolBar: false` to `~/.Xdefaults`

3.8. ssh -X now says "Warning: untrusted X11 forwarding setup failed: xauth key data not generated"

See Q: 6.1.. See point 3 in this mail

(<http://cygwin.com/ml/cygwin-xfree/2008-11/msg00154.html>). Use ssh -Y.

Technical details: ssh tried to run **xauth generate** to create an untrusted cookie for the session, which failed because the server isn't compiled with the XCSECURITY extension built-in.

3.9. nedit fails to start with an error message

```
$ nedit
X Error of failed request: BadMatch (invalid parameter attributes)
Major opcode of failed request: 70 (X_PolyFillRectangle)
Serial number of failed request: some number
Current serial number in output stream: some other number
```

nedit needs rebuilding with a patch to work around an issue `lesstif` has with current X servers.

Until this happens, you can work around the issue by adding `XLIB_SKIP_ARGB_VISUALS` to your environment, e.g.

```
$ export XLIB_SKIP_ARGB_VISUALS=1
$ nedit
```

4. Configuration

4.1. Is there an `xorg.conf` or `XF86Config` file?

No. But most of the options which were configurable in the configfile are now available as command line options. For more information on configuring other keyboard layouts see Q: 5.1.1.

4.2. What are the command line arguments for `xwin.exe`?

The Cygwin/X User's Guide (<http://x.cygwin.com/docs/ug/cygwin-x-ug.html>) documents the command line arguments for `XWin.exe`.

4.3. Why does `xwin.exe` ignore the display depth that I pass on the command line?

When running in windowed mode or GDI-based fullscreen mode, `xwin.exe` must run the X Server at whatever display depth Windows is currently using; in these cases the display depth passed on the command line is ignored. `xwin.exe` only uses the display depth parameter when running in a DirectDraw-based fullscreen mode, as DirectDraw allows applications to change the display resolution and depth when running in fullscreen mode.

4.4. I have a two button mouse, can I emulate a three button mouse?

Yes. Pass the `-emulate3buttons` `timeout_in_milliseconds` parameter to `XWin.exe`, where `timeout_in_milliseconds` is the, optional, maximum number of milliseconds between a button release and opposite button press that will trigger an emulated third button press.

4.5. Is there a Focus-Follows-Mouse feature (Auto-Focus)?

This is a setting of the windowmanager used. The default windowmanager `twm` has no such feature. But with `fvwm2` this can be achieved with the this configuration entry:

```
Focus FocusFollowsMouse
```

Other windowmanagers (eg. `windowmaker`) have similar features too.

If you are using the `-multiwindow` mode you can not set this behaviour in the windowmanager but you can use the `TweakUI` tool to enable this feature for all windows, not limited to Cygwin/X windows.

4.6. The option `-nounixkill` has no effect. How can i prevent the server shutdown an `Ctrl-Alt-BackSpace`?

There is a keybinding to `Ctrl-Alt-BackSpace` which is named `TerminateServer`. Remove this binding and `Ctrl-Alt-BackSpace` will have no effect.

```
xmodmap -e "keycode 22 = BackSpace"
```

4.7. I have a multihead system. Do I need special options to make it work? I have a multihead system. Why are my X-application windows white?

You should start `XWin.exe` with the `-multiplemonitors` options

4.8. I have a firewall. Is there anything I have to take care of?

`XWin.exe` uses port 6000/TCP by default. You will have to allow incoming and outgoing traffic on this port even if you are only using local clients. `XWin.exe` has a builtin access control so you won't have to worry about opening the port. If you are still concerned about security, you may limit the allowed hosts to 127.0.0.1 (localhost) and the local IP addresses.

If you use a different `DISPLAY` variable check section Q: 1.6. for details about which ports are used. For additional information about firewalls and XDMCP connections check Q: 7.4..

5. Internationalization**5.1. Keyboard support**

5.1.1. How do I use a non-U.S. keyboard layout?

Some keyboard layouts are autodetected from the Windows keyboard settings. For these layouts no special change is needed. For all other layouts there is the possibility to configure the layout via commandline options.

The mainoption for changing the layout is `-xkblayout countrycode` where *countrycode* is in most cases the 2 character code which also represents the country in internet addresses (e.g. Australia = au, Deutschland = de, France = fr, Japan = jp)

Other options for tweaking the XKB layout are `-xkbmodel`, `-xkbvariant`, `-xkboptions` and `-xkbrules`. These are the counterparts for the similar named options known from the `xorg.conf` file.

If the loading fails, check Q: 5.1.6.

5.1.2. I there a way to add a layout to the list of autodetected?

If your keyboard layout is not automatically detected you can send the required information for including it into Cygwin/X to cygwin-xfree@cygwin.com. Please include the following information in your mail:

- The windows keyboard layout code and the layout name

You will find it in `/var/log/XWin.0.log` in lines similar to these:

```
(--) winConfigKeyboard - Layout: "00001809" (00001809)
(EE) KeyboardLayout "Irish" (00001809) is unknown
```

- The XKB layout code for this layout if you know it. Please experiment with `setxkbmap` or `-xkblayout` (as described in Q: 5.1.1.) to find a XKB layout code which works for you, otherwise the maintainers will have to guess it.
- A description how the layout looks like. This makes it easy to identify the matching XKB layout code. Many layouts are available from the Microsoft Global Dev (<http://www.microsoft.com/globaldev/reference/keyboards.mspx>) website. Just add a link to your layout.

5.1.3. Where can I find an xmodmap for my non-U.S. keyboard layout?

This question should be obsolete The package `xkeyboard-config` should contain just about any needed layout

Or, you can use `xkeycaps` to automatically generate a modmap for one of over 208 different layouts. See the `xkeycaps` home page (<http://www.jwz.org/xkeycaps/>) to download and for more information.

5.1.4. How do I get my non-U.S. keyboard modmap to be installed when using `xdmcp`?

See Q: 5.1.1.

5.1.5. Logging into AIX via XDMCP causes the keyboard to function as if **AltGr** is permanently pressed.

[Pavel Rybnicek] The X Keyboard Extension doesn't work with AIX. The X Keyboard Extension is enabled by default, so you must disable it with the `-kb` parameter. An example command line follows.

```
XWin.exe -kb -query aix_hostname_or_ip_address
```

5.1.6. Loading XKB keymaps fails

First check if you are able to change the server to another layout via XKB. The german layout will be good for testing:

```
setxkbmap de -model pc105
```

This worked if pressing "Shift" and "8" produces "(" instead of "*". If it worked then you can skip the next paragraph.

There is currently a problem with the /tmp directory mounted in textmode. You can change the setting to binmode with:

```
mount -b "$(cygpath -m /tmp)" /tmp
```

If this fails with an error message stating insufficient rights, try

```
mount -b -u "$(cygpath -m /tmp)" /tmp
```

Not all keyboard layouts are tested very well and some contain errors or do not work at all. To test if the compiling of your layout works start

```
setxkbmap de -print | xkbcomp -w3 -xkm - localhost:0.0
```

(replace the "de" with your layout code). This may produce warnings, but must not produce errors. If there are errors then please report them to the mailinglist.

XXX: This answer needs updating

5.1.7. I have Windows XP with Powertoy installed and AltGr does not work. What can I do?

This problem is solved in recent Cygwin/X releases. Use cygwin setup to upgrade the xorg-server package.

5.1.8. AltGr does not work properly when connecting to other unices or to old XFree86.

The older X11 releases on the various commercial unices define the AltGr key as ModeSwitch, MetaR, AltR or similar. Cygwin/X expects it to be ISO_Level3_Switch. For reasons unknown to us this is reset when logging into the remote host. As far as we don't have access to such a machine we are unable to track this down and find a reason.

Sometimes it does help to run

```
DISPLAY=:0.0 setxkbmap languagecode
```

from a cygwin shell. For more information see Q: 5.1.1..

5.2. Display problems

5.2.1. How do I get **bash** to display accents and/or umlauts?

(Heinz Peter Hippenstiel) Add the following lines to `.inputrc` in your Cygwin home directory (e.g. `/home/harold/`):

```
set meta-flag on
set output-meta on # to show 8-bit characters
set convert-meta off # to show it as character, not the octal representation

# Mapping for German umlauts
"\M-a": "ä"
"\M-A": "Ä"
"\M-o": "ö"
"\M-O": "Ö"
"\M-u": "ü"
"\M-U": "Ü"
"\M-s": "ß"
# (TODO: Mapping for accents?)
```

5.2.2. How do I put **bash** into “8 bit” mode?

See Q: 5.2.1.

6. Remote connections

6.1. X11Forwarding does not work with OpenSSH under Cygwin

A1:

OpenSSH 3.8 enables untrusted X11 forwarding by default when connecting to an ssh server that supports untrusted *X11Forwarding*. Most ssh servers for GNU/Linux are versions of OpenSSH that do support untrusted X11Forwarding, so using OpenSSH 3.8 from Cygwin will result in a connection that uses untrusted X11Forwarding by default. You will quickly notice that this is the case if most of your X applications are now killed when you try to copy and paste or if **xdpyinfo** returns only a fraction of the supported extensions that it does if run locally.

It is easiest to just override untrusted X11Forwarding by passing `-Y` to **ssh** in place of `-X`. The `-Y` does the same thing as `-X`, but it enables trusted X11Forwarding for the current connection.

A2:

Before establishing the ssh connection the xserver must be started and the environment variable `DISPLAY` must be set for ssh.

```
$ DISPLAY=localhost:0.0
$ export DISPLAY
$ ssh -Y remotehost
```

or

```
$ DISPLAY=localhost:0.0 ssh -Y remotehost
```

The parameter `-Y` enables trusted X11Forwarding. This is available since OpenSSH 3.8. If you have an older version of ssh you will have to use `-X`.

A3:

Make sure you're not starting ssh with the parameter `-x` (lowercase). This disables X11Forwarding.

A4:

Check that X11Forwarding is not disabled in the openssh client configuration.

The configfiles are by default `~/.ssh/config` and `/etc/ssh_config`. The file in the home directory overrides settings in the global one.

The configfile is split into various sections starting with "Host *wildcard*". The section applies to all hosts where *wildcard* matches the hostname.

If this section contains an entry "ForwardX11 no" then X11Forwarding is disabled. To enable it change the entry to:

```
ForwardX11 yes
```

Starting with OpenSSH 3.8 you will need the switch "ForwardX11Trusted yes" in the client configuration to allow remote clients full access to the xserver. Without it some clients will fail with a similar error:

```
X Error of failed request: BadAtom (invalid Atom parameter)
Major opcode of failed request: 18 (X_ChangeProperty)
Atom id in failed request: 0x114
Serial number of failed request: 370
Current serial number in output stream: 372
```

The commandline switch `-Y` does the same.

A5:

Check that X11Forwarding is not disabled in the ssh server configuration.

The configfile is by default `/etc/ssh/sshd_config`. If there is an entry “X11Forwarding no” then X11Forwarding is disabled.

If you have write access to the config file then change it to

```
X11Forwarding yes
```

Otherwise ask your you admin to change this for you.

A6:

[Frederick W. Wheeler] If the *remote* machine is a Windows machine using Cygwin OpenSSH server, make sure the Cygwin **xauth** package is installed on the *remote* machine. The OpenSSH server needs to be able to run **xauth** to do X11 Forwarding.

6.2. Why do remote programs crash with X Error of failed request: BadAtom?

Starting with OpenSSH 3.8 you will need to set “ForwardX11Trusted yes” in the client configuration to allow remote clients full access to the xserver. Without it some clients will fail with a similar error:

```
X Error of failed request: BadAtom (invalid Atom parameter)
Major opcode of failed request: 18 (X_ChangeProperty)
Atom id in failed request: 0x114
Serial number of failed request: 370
Current serial number in output stream: 372
```

The commandline switch `-Y` does the same. See also Q: 6.1.

7. XDMCP connections

7.1. XDMCP fatal error: Session declined No valid address

Cygwin/X is sometimes unable to determine which local network interface’s address should be reported to the *XDMCP* server; in these cases you need to pass `-from`

`local_host_name_or_ip_address` to `XWin.exe` to specify which interface address to report.

7.2. Why does Cygwin/X report AUDIT: client 1 rejected from IP *remotehost* ?

The problem is most likely a wrong DNS (Network name resolution). Make sure your windows host has a hostname which is valid from linux too and an IP address which linux can resolve to that hostname.

If you add a line

```
192.168.26.1 myhost
```

to `/etc/hosts` on the *XDMCP* server with the IP address and the hostname of your windows host the name resolution should work.

7.3. I get no login screen when using `-query`

Disabled XDMCP on servers

[Mika Laitio] For security reasons, *XDMCP* is not enabled by default on most Linux/UNIX/*NIX/*BSD distributions (RedHat, Mandrake, SuSE, FreeBSD, NetBSD, etc.) by default. You have to manually enable remote logins to your X Display Manager (**x**dm, **k**dm, or **g**dm). The location of the proper config file is distribution/OS dependent, but a short list of known config file locations is given in Table 1. You must change the line:

```
[Xdmcp]
Enable=false
```

to:

```
[Xdmcp]
Enable=true
```

or for xdm style configuration:

```
DisplayManager.requestPort: 0
```

to:

```
!DisplayManager.requestPort: 0
```

Table 1. Known XDM Configuration File Locations

Distribution/OS	Version	Display Manager	Location
Linux Mandrake	8.1	kdm	/usr/share/config/kdm/kdmrc
Debian GNU/Linux	Unstable	kdm	/etc/kde3/kdm/kdmrc
Debian GNU/Linux	Unstable	gdm	/etc/X11/gdm/gdm.conf
Debian GNU/Linux	Unstable	xdm	/etc/X11/xdm/xdm-config
Debian GNU/Linux	Unstable	wdm	/etc/X11/wdm/wdm-config

XDMCP and firewalls

XDMCP will not work correctly if you have a personal firewall installed or the built-in firewall of Windows is activated.

The XDMCP protocol will send and receive data on port 177/UDP. But the actual connections will be made to the local port 6000/TCP. It is safe to allow connections since the xserver has an own security layer. An overview of used ports is given in Table 2.

Table 2. Ports used with XDMCP connections

Port	Protocol	Direction	Comment
177	UDP	Incoming/Outgoing	Actual XDMCP connection
6000+ <i>display</i>	TCP	Incoming	Connection for X11 clients. <i>display</i> is usually 0 except you specify it on the commandline.

7.4. XDMCP does not work with Mandrake 8.1

See Q: 7.3.

7.5. Why does GDM not work with `-clipboard`

Newer versions of GDM have a more complex startup mechanism than the other display manager have. This can interfere with the way the clipboard integration client is started.

Workaround: add (or modify) this section in the `gdm.conf` (or `/etc/gdm/custom.conf`) file.

```
[daemon]
KillInitClients=false
```

7.6. I get no login screen for Solaris

See also Q: 7.7. and Q: 7.8.

[David Dawson] For whatever reason, certain versions of Solaris need fonts that are not provided by Cygwin/X; the result is that you may see the Solaris background tile and the hourglass cursor, but the XDM login prompt will never appear. The simplest solution is to point Cygwin/X at the font server that is usually running on the Solaris machine. You'll need a command line similar to the following to start your *XDMCP* session and to connect to the Solaris font server:

```
XWin.exe -query solaris_hostname_or_ip_address -fp
tcp/ solaris_hostname_or_ip_address :7100
```

Note: The `-fp` parameter is a general X Server parameter, it is not specific to Cygwin/X; therefore, the `-fp` is documented in the X Server manual page (<http://freedesktop.org/~xorg/X11R6.7.0/doc/Xserver.1.html>). For additional information about fonts, see Fonts in X11R6.7 (<http://freedesktop.org/~xorg/X11R6.7.0/doc/fonts.html>).

The standard port number for a font server is 7100, however, you may need to ask your system administrator what the font server port number is if you cannot connect to a font server on port 7100. It is also possible that your Solaris machine is not running a font server, in which case you will need to consult your Solaris documentation for instructions on how to run a font server.

7.7. XDMCP freezes with remote Solaris machine!

See also Q: 7.6. and Q: 7.8.

Solaris appears to not support certain display bit depths, such as 24 bits per pixel. Change your Windows display bit depth to 8, 16, or 32 and try logging in again. File a complaint with Sun if this issue is important to you, or change your Solaris machines to use XFree86 instead of the Solaris X Window System.

7.8. Login to CDE on Solaris via XDMCP hangs Cygwin/X.

See also Q: 7.6. and Q: 7.7.

Install the recommended set of patches (<http://www.sun.com/bigadmin/patches/indexRec.html>) for your version of Solaris.

7.9. Where can I find more information about XDMCP.

See the Linux XDMCP HOWTO (<http://en.tldp.org/HOWTO/XDMCP-HOWTO/>) for more information about XDMCP.

8. Troubleshooting

8.1. Cygwin/X failed with "Fatal Error". What does this mean?

The Fatal Error is a general error message. More specific information what caused this is available in `/var/log/xwin.0.log`. Please check the common error messages in the Section called *Error and Warning Messages*. If your error is not mentioned proceed with Q: 8.4.

8.2. Is there a log file that I can look at for diagnostic information and error messages?

Yes. The Cygwin/X log file is located at `/var/log/xwin.0.log`. You will find solutions to the most common error messages in the Section called *Error and Warning Messages*.

8.3. I have a specific error message, what does it mean?

See the Error and Warning Messages section for help with specific error messages. Return to this section if you do not find a specific answer for the error message that you have.

8.4. I have a specific error message that is not addressed in the Error and Warning Messages section.

Search the Cygwin/X mailing list archives (<http://cygwin.com/ml/cygwin-xfree/>) to see if the error message has already been reported and/or addressed. Report the error message to the Cygwin/X mailing list (cygwin-xfree@cygwin.com), how the error message was caused, and the behavior of the X Server after the error message was generated (exit, freeze, etc.), only if the error message has not been reported, if the circumstances that produced the error message are significantly different from other reports, or if you have additional information regarding the error message to contribute. Please include `/var/log/XWin.0.log` in your mail. This may help us identify the cause of your problem quicker.

8.5. My bug report the Cygwin/X mailing list was ignored. What do I do now?

Some bug reports are deliberately ignored by project members if the bug in question was recently dealt with; did you search the mailing list archives ([project-url-ml-search](#);) for a solution to your problem before submitting your bug report? Some bug reports are ignored if they do not contain sufficient information to understand the situation that produces the bug; did your bug report have enough information? Some bug reports are missed or forgotten, thus some valid bug reports do not receive a reply; simply resubmit such bug reports that have not received a response within 7 days of submission.

8.6. Why does Cygwin/X freeze right after startup?

Zone Alarm 5 is known to break Cygwin/X. As a result you'll see this line (or a similar) as last output in `/var/log/XWin.0.log`

```
Rules = "xorg" Model = "pc101" Layout = "us" Variant = "(null)" Options = "(null)"
```

Disabling Zone Alarm will not solve this problem. You can only uninstall Zone Alarm 5 and switch to an earlier version (4.5 is known to work) or use a different personal firewall.

Another reason is `/tmp` mounted in textmode. This does only happen with the `-multiwindow` and `-clipboard` switches because of the extra threads within Cygwin/X.

You can remount `/tmp` to binmode with these commands:

```
mount -b "$(cygpath -m /tmp)" /tmp
```

If this fails with an error message stating insufficient rights, try

```
mount -b -u "$(cygpath -m /tmp)" /tmp
```

8.7. Cygwin/X has very poor performance. What's the reason?

Most likely you have installed some kind of personal firewall, VPN software or any other software that modifies the TCP/IP stack of Windows. Especially Webwasher and some other filtering software are known to slow down the network traffic.

Some online virus scanners like Symantec Antivirus do slowdown Cygwin/X a lot. They scan every file access and network traffic which causes serious processing overhead beyond that from the X11 protocol and the unix emulation layer.

So far there is no know solution but to disable the virus scanner completely.

[Dr. Edward Wornar] Certain programs that are installed by various drivers and software packages can consume an incredible amount of system resources and processing time. One known example of such a program is `ATI2evxx.exe`, a utility installed with some ATI Technologies graphics card drivers. Answers That Work (<http://www.answersthatwork.com/>) has information on `ATI2evxx.exe` on their Task List Programs - A (http://www.answersthatwork.com/Tasklist_pages/tasklist_a.htm) page. You may want to try disabling, one-by-one, `ATI2evxx.exe` and other such programs until you find the program that is causing the slowdown.

8.8. I have Microsoft Services for Unix installed and can't type anything. Help me!!!

Microsoft Services for Unix set some environment variables which points Cygwin/X to outdated or not existing files. These variables are

```
XAPPLRESDIR
XCMSDB
XKEYSYMDB
XNLSPATH
```

To have Cygwin/X work correctly you have to unset at least `XKEYSYMDB`.

Reported by Juan Medina, Pavel Rozenboim

8.9. Cygwin/X is extremely slow, especially when using XDMCP to connect to remote machines.

see Q: 8.7..

8.10. IBM ThinkPad's with a TrackPoint mouse doesn't allow simulated mouse wheel scrolling.

[Gerald S. Williams] The TrackPoint driver tries to send scroll up/down messages to the default scrollbar in a window. Cygwin/X does not use Windows scrollbars for X Client windows, so we must configure the TrackPoint driver to send standard `WM_MOUSEWHEEL` messages to the Cygwin/X window. This can be done by editing the TrackPoint configuration file that can be found either in `%SYSTEM_ROOT%\System32\tp4table.dat` or `%SYSTEM_ROOT%\System32\tp4scrol.dat`. Add the following to the "Pass 0 rules" section:

```
; X Windows
*,*,XWin.exe,*,*,Cygwin/X,WheelStd,0,9
```

8.11. Why is the root window not shown in normal mode?

This is a small problem with `run.exe`. If you start `XWin.exe` with `-n-decoration`, `-multiwindow` or `-fullscreen` the window will come up normally.

8.12. Why is the cross the default cursor in multiwindow mode?

To workaroud this add the command

```
run xsetroot -cursor_name left_ptr -fg white -bg black  
to startxwin.bat
```

8.13. How can I adjust the linewidth in bash after resizing XTerm?

Try starting `resize`.

8.14. Why do some menus not work if Num-Lock is on?

The problem are programs which treat Num-Lock as modifier similar to Control. The programs expect a plain click but received some strange Num-Lock-Click combination and can't associate this with the action "open menu".

9. Error and Warning Messages

9.1. `_XSERVTransmkdir: Owner of /tmp/.X11-unix should be set to root`

```
_XSERVTransmkdir: ERROR: euid != 0,directory /tmp/.X11-unix will not be created
```

This warning message can be ignored; it does not cause any known problems.

9.2. `error opening security policy file /usr/X11R6/lib/X11/xserver/SecurityPolicy`

This error is harmless.

9.3. `Duplicate invocation on display number: 0. Exiting.`

Most likely you have started `XWin.exe` twice with `startxwin.bat` or `startx` or a similar script.

if you start multiple instances of `XWin.exe` you have to start to number them

```
XWin.exe -query foo  
XWin.exe :1 -query bar  
XWin.exe :2 -query blubb
```

Specifying no number is the same as using `:0`

If you want another terminal window (which in fact is just a convenient side effect of running `startxwin.bat`) you should do this by starting `xterm` from the cygwin shell or from the `startmenu` entries.

9.4. `Fatal server error: could not open default font 'fixed'`

This error occurs for one of three reasons:

1. You do not have a font package which provides the default font ('fixed') installed. This is rarely the problem; but in the event that it is the problem, just rerun Cygwin's **setup.exe**, select the `font-misc-misc` package and install it.

2. The mount point for `/usr/share/fonts/` was either invalid (does not point to a valid folder on your system) or is a text-mode mount. You can confirm that this is the problem by running **mount** from a Cygwin shell and checking the disk path returned for the `/usr/share/fonts/` mount point.

Note: You cannot reliably fix this problem by deleting your Cygwin installation and reinstalling it. The mount points that Cygwin was using will be left in your system settings and the invalid mount point for `/usr/share/fonts/` will be used again when you perform the reinstallation. You SHOULD follow the instructions below to fix the problem.

To fix the problem, perform the following steps:

- a. Open a Cygwin shell and run **umount /usr/share/fonts/**.
 - b. Close the Cygwin shell.
 - c. Run Cygwin's **setup.exe**.
 - d. For each of the font packages, if they are marked Keep, then select Reinstall, otherwise leave them as they are:
 - e. Allow Cygwin's **setup.exe** to download and reinstall the fonts packages. The key to fixing this problem is that the files were previously untarred into an invalid location; removing the mount point for the fonts directory should result in the files being untarred to a valid location.
3. You chose "DOS/text" as the "Default Text File type" during Cygwin setup, ignoring the advice that the Default Text File Type should be left on Unix/binary unless you have a very good reason to switch it to DOS/text.

Open a Cygwin shell and run.

```
umount /usr/share/fonts/  
mount -f -s -b "C:/cygwin/usr/share/fonts" "/usr/share/fonts"
```

Reinstall your fonts

9.5. Could not init font path element `/usr/share/fonts/*/`, removing from list!

These warnings are generally harmless since they indicate that default search paths for fonts do not actually contain fonts; this is only a problem if the `misc` path does not contain fonts and/or all of the paths do not contain fonts.

If you are getting these message and the X Server is also failing to start, then see Q: 9.4. for information on how to fix your fonts.

9.6. The procedure entry point `_check_for_executable` could not be located

Programs that you are attempting to use were compiled against a newer version of Cygwin than is currently on your system. Run Cygwin's setup program to update your installation to the latest version.

9.7. cygX11-6.dll not found after installation or upgrade

Obsolete question

9.8. Exception: STATUS_ACCESS_VIOLATION

`cygwin1.dll` uses a shared memory section amongst all loaded copies of `cygwin1.dll`; unfortunately, the layout and usage of the shared memory section changes between versions of `cygwin1.dll`. Loading two different versions of `cygwin1.dll` will cause the shared memory section to become corrupted, which almost always results in an Exception: `STATUS_ACCESS_VIOLATION`. You must search your filesystem(s) and remove all copies of `cygwin1.dll` except the copy in `/bin`. You must remove the different versions of `cygwin1.dll` even if they are not in your path, as programs that depend on `cygwin1.dll` attempt to load the file from the local directory before searching other paths; thus, it is rather easy, and common, for multiple versions of `cygwin1.dll` to become loaded at the same time if they exist on a particular system.

9.9. Xlib: connection to "*local_host_name_or_ip_address* :0.0" refused by server Xlib: Maximum number of clients reached

Cygwin/X queries `getdtablesize ()` for the maximum number of client connections allowed; by default Cygwin returns 32 from `getdtablesize ()`. Cygwin/X Server Test Series (<http://x.cygwin.com/devel/server/>) release Test44 (<http://x.cygwin.com/devel/server/changelog.html>), released on 2001-08-15, changes the maximum number of clients from 32 to 1024 by passing the square of `getdtablesize ()` to `setdtablesize ()`.

9.10. XIO: fatal IO error 104 (Connection reset by peer) on X server "127.0.0.1:0.0"

See Q: 9.9.

9.11. Cannot Open Display: 127.0.0.1:0.0

Certain classes of software, such as that used for *Virtual Private Networking* and *fire-walling* may cause the IP address 127.0.0.1, or other local adapter addresses, to be redirected, to become inoperable in some way, or to be operated in a manner that violates the defined operation of IP address.

As a potential remedy, try removing all instances of such software; this may not always fix the problem though, as some software may leave artifacts even after uninstallation is completed. The only way to be sure that you have not found a Cygwin/X bug is to install Windows on a freshly formatted hard drive, followed by Cygwin and Cygwin/X, and finally add your other software one application at a time until Cygwin/X stops working.

Some products that have been reported to cause problems:

Note: These products may not cause problems in all configurations. However, the Cygwin/X project has neither the time, ability, nor resources to help you correctly configure your third-party software.

- Aventail Connect

- Zonealarm PC Firewall from Zonelab

9.12. Out of environment space

Increase your Windows environment space by following the instructions provided by Microsoft (<http://support.microsoft.com/support/kb/articles/Q230/2/05.ASP>).

9.13. Too many parameters

See Q: 9.12.

9.14. "xcb_xlib_lock: Assertion '!c->xlib.lock' failed." or "xcb_xlib_unlock: Assertion 'c->xlib.lock' failed."

Both of these represent bugs in a caller of libX11, and *not* in libX11 or libxcb. The first assertion means that a caller attempted to lock the display while already locked. The second assertion means that a caller attempted to unlock the display without having it locked.

If you encounter such bugs, please report a bug against the offending software (which is *not* libX11 or libxcb)

This error can be worked around by using **export LIBXCB_ALLOW_SLOPPY_LOCK=1**

10. Porting Software

10.1. Is there a list of software that has been ported to Cygwin/X?

Yes, see the Cygwin/X - Ported Software (<http://x.cygwin.com/ported-software.html>) page.

10.2. How do I start porting software to Cygwin/X?

Cygwin/X provides a software interface that is very similar to the software interface provided by GNU/Linux and other UNIX systems. Most software packages will compile on Cygwin/X without any changes at all. To begin with, try to compile a given software package following that package's compilation instructions for GNU/Linux.

10.3. Are there common problems encountered when porting software to Cygwin/X?

One common problem encountered when porting software to Cygwin/X is due to Cygwin's inability to distinguish between files with the same name but different capitalization (e.g. XvMC.h and xvmc.h), which is due to a Windows' limitation.

Example 1. Include Problems

This example is based off an error that actually occurred in the source code tree in `xc/programs/Xserver/Xext/xvnc.c`. `xvnc.c` included `XvMC.h`, as shown below:

```
#include "XvMC.h"
```

The intention was to include the file `xc/include/extensions/XvMC.h`. Unfortunately, there was a file named `xc/programs/Xserver/Xext/xvnc.h` that ended up getting included instead

of the desired file, because the precompiler searched the local directory, `xc/programs/Xserver/Xext/`, before searching the rest of the include path. Cygwin can't distinguish between `XvMC.h` and `xvmc.h`, so `xvmc.h` ended up being included in `xvmc.c`. The build process on Cygwin broke because the contents of `XvMC.h` were entirely different than the contents of `xvmc.h`.

The solution was to change the include to specifically reference the desired header:

```
#include "../../include/extensions/XvMC.h"
```

11. Contributing

11.1. Are there step-by-step instructions for contributing to Cygwin/X?

Yes. The Cygwin/X Contributor's Guide (<http://x.cygwin.com/docs/cg/cygwin-x-cg.html>) has step-by-step instructions for obtaining the source, building the source, building debug versions of the source, and even cross-compiling under Linux.

11.2. Are there editors for Windows that understand and preserve UNIX end of line characters?

Yes. Emacs and XEmacs are available for Windows; they both understand and preserve UNIX end of line characters.

11.3. How should I generate patches for Cygwin/X?

Only submit patches that have UNIX end of line characters. See Q: 11.2. for information on editors for Windows that are aware of UNIX end of line characters.

11.4. Where do I submit patches for Cygwin/X?

Submit patches for Cygwin/X to the cygwin-xfree@cygwin.com mailing list.

See Q: 11.3. for more information on generating patches.

11.5. Why doesn't the X Window System use GNU's **autoconf**?

It does! Thanks to the excellent efforts of the X.Org community, the X Window System has been autotoolized since X.Org R7.0.

Anyone who despaired of touching the monolithic tree will find things much easier now with modular packages.

11.6. What compiler does Cygwin/X use, and which compilers are supported?

Cygwin/X uses the gcc compiler from the Free Software Foundation. Cygwin/X source code is mostly ANSI C compliant, but we cannot guarantee that Cygwin/X will compile with any other compiler, nor can we afford the time to support compilers other than gcc.

See the GCC Home Page (<http://gcc.gnu.org>) for more information on gcc.

11.7. Is cross-compiling from a non-Cygwin platform supported?

Cross-compiling from a non-Cygwin platform is described in the Cygwin/X Contributor's Guide (<http://x.cygwin.com/docs/cg/cygwin-x-cg.html>)

11.8. Where can I get help for installing DocBook on Cygwin?

See SGML for Windows NT: Setting up a free SGML editing and publishing system on Windows NT/Cygwin

(http://web.archive.org/web/20050320030737/http://ourworld.compuserve.com/homepages/hoenicka_markus/cygwin) by Markus Hoenicka.

12. Licenses, Patents, Trademarks, and Copyrights

12.1. What licenses apply to Cygwin/X source code?

Cygwin/X proper isn't covered by a single license, as Cygwin/X is made up of two parts that are covered by distinct licenses: Cygwin and the X Window System.

See Q: 12.2. and Q: 12.3. for more information regarding the licenses that apply to Cygwin/X.

12.2. What licenses apply to the X Window System source code?

X Window System source code is generally licensed under an X11 style license (<http://www.x.org/terms.htm>), which is certified by the Free Software Foundation (<http://www.fsf.org/philosophy/license-list.html#GPLCompatibleLicenses>) as compatible with the GNU GPL.

12.3. What license applies to Cygwin source code?

Cygwin source code is licensed under a modified version of the GNU GPL. Cygwin's license modification specifically allows third-party software under an open source license to be linked with Cygwin without requiring that the source code for the third-party software be distributed under the terms of the GNU GPL. Cygwin's developers went to great trouble to obtain this modification and should be thanked for doing so, as without it the modification, Cygwin/X linking to Cygwin would be the subject of endless discussion.

12.4. Who holds the copyright on the Cygwin/X source code?

Cygwin/X proper doesn't have a single copyright holder, as Cygwin/X is made up of two parts, namely Cygwin and the X Window System; each part follows a different scheme in regards to who will hold the copyright on source code.

See Q: 12.5. and Q: 12.6. for more information regarding who holds the copyright on Cygwin/X source code.

12.5. Who holds the copyright on the X Window System source code?

Each source code file in the X Window System typically has its own license and copyright statement. Therefore, there is not a general rule for determining who holds the copyright on a particular X Window System source file, as each author is free to assign the copyright to someone

else, to some group, or to keep the copyright themselves. You must inspect the source code file in question to determine who holds the copyright for that file.

12.6. Who holds the copyright on the Cygwin source code?

RedHat (<http://redhat.com/>) owns the copyright on the Cygwin source code. RedHat requires that copyright be assigned to RedHat for non-trivial changes to Cygwin. You must fill out a copyright transfer form if you are going to contribute substantial changes to Cygwin.

12.7. What license applies to Motif?

Motif is a closed source product produced by The Open Group (<http://www.opengroup.org/>). However, The Open Group released Open Motif (<http://www.opengroup.org/openmotif/>) on 2000-05-15 under a public license, The Open Group Public License (<http://www.opengroup.org/openmotif/license>), that allows Open Motif to be distributed with and used on Open Source platforms. As of 2001-07-10, Cygwin/X does not qualify as a platform that Open Motif can be distributed with and used on. However, the Open Motif FAQ (<http://www.opengroup.org/openmotif/faq.html>) states, "[...] we hope to be able to make a distribution under a license complying with the Open Source guidelines sometime in the future. For now this is as close as to Open Source as we could get."

12.8. Isn't "XWin" trademarked by StarNet Communications?

No. A quick search at the United States Patent and Trademark Office (<http://www.uspto.gov/>) for "XWin" turns up one dead record and one live record. The live record is for a logo belonging to a rock crusher manufacturer based out of Belgium. Neither trademark affects Cygwin/X, as the dead record is no longer enforceable, while the live record is in an unrelated and distinct industry; there cannot be confusion between rock crushers and computer programs.

Bibliography

Books

- [ScheiflerGettys92] Robert W. Scheifler, James Gettys, Jim Flowers, and David Rosenthal, 1992, 1-55558-088-2, Butterworth-Heinemann, *X Window System: The Complete Reference to Xlib, X Protocol, ICCCM, and XLFD*.
- [Richter99] Jeffrey Richter, 1999, 1-57231-996-8, Microsoft Press, *Programming Applications for Microsoft Windows: Mastering the critical building blocks of 32-bit and 64-bit Windows-based applications*.
- [Petzold99] Charles Petzold, 1999, 1-57231-995-X, Microsoft Press, *Programming Windows: The definitive guide to the Win32 API*.
- [McKay99] Everett N. McKay, 1999, 0-7356-0586-6, Microsoft Press, *Developing User Interfaces for Microsoft Windows: Practical and effective methods for improving the user experience*.

- [JonesOhlund99] Anthony Jones and Jim Ohlund, 1999, 0-7356-0560-2, Microsoft Press, *Network Programming for Microsoft Windows: Clear, practical guide to Microsoft's networking APIs*.
- [Yuan01] Feng Yuan, 2001, 0-13-086985-6, Prentice Hall PTR, *Windows Graphics Programming: Win32 GDI and DirectDraw*.
- [CohenWoodring98] Aaron Cohen and Mike Woodring, 1998, 1-56592-296-4, O'Reilly & Associates, Inc., *Win32 Multithreaded Programming: Building Thread-Safe Applications*.
- [CameronRosenblattRaymond96] Debra Cameron, Bill Rosenblatt, and Eric Raymond, 1996, 1991, 1-56592-152-6, O'Reilly & Associates, Inc., *Learning GNU Emacs: UNIX Text Processing*.
- [Lewine91] Edited by Dale Dougherty, Donald A. Lewine, 1991, 0-937175-73-0, O'Reilly & Associates, Inc., *POSIX Programmer's Guide: Writing Portable UNIX Programs*.
- [KernighanRitchie88] Brian W. Kernighan and Dennis M. Ritchie, 1988, 1978, 0-13-110370-9, Prentice Hall PTR, *The C Programming Language: ANSI C*.

Glossary

F

firewall

Firewall software attempts to protect an internal network from intrusions originating from an external network.

V

Virtual Private Network

Virtual Private Networks are encrypted tunnels through which private data can be safely transmitted over a private network (e.g. the Internet).

X

X Display Manager

An X Display Manager presents a graphical login screen to X users. Often an XDM will allow the user to select a desktop environment or window manager to be for their login session. Some X Display Managers are xdm, gdm (Gnome Display Manager), and kdm (KDE Display Manager).

X Display Manager Control Protocol

XDMCP allows XDM to process logins for users remote to the machine that XDM is running on; login sessions will be run on the machine running XDM. For example, at a university you may use XDMCP to login to an X session running on an engineering department computer from your dorm room.

See Also: X Display Manager.

X11 Forwarding

Some SSH programs like OpenSSH provide a feature where in addition to the normal text channel opened between the local and the remote host another encrypted channel is opened for the communication between the X11 client and the X11 server. The SSH server will act as proxy-server for the X11 clients and will forward all communication to the X11 server.

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