Installing and Configuring *Cygwin* for my lectures "Operating Systems" and "Parallel Programming" on top of *Microsoft Windows 8.1* with *NTFS*

(Cygwin 2.0.x with X11R7.7, June 2015 or later)

1) Login as Administrator on your Windows system.

2) Create a new directory (e.g., *c:\cygwin* or *c:\cygwin64*), download *setup-x86.exe* (32-bit) or *setup-x86_64.exe* (64-bit) from *http://www.cygwin.com* or any mirror site, and store it into the new directory. You should not create that directory within Windows directories (e.g., *c:\Programme\cygwin* or *c:\Program Files\cygwin*) because you may run into trouble with security rules from Windows if you are using the NTFS file system. The following text describes the installation of a 32-bit version of Cygwin.

3) Start *setup-x86.exe*. Choose "Weiter" or "Next" and select if you want to "Install from the Internet", "Download without Installing" (if you want to install Cygwin on many computers), or "Install from Local Directory" on the next screen. On the following screen you can choose a "Root directory" for Cygwin and if you want to install Cygwin for all users. Normally you will not change any options on the next screens until you get to the screen "Choose A Download Site", where you have to choose a mirror site (e.g., *ftp://ftp.inf.tu-dresden.de*). If you "Install from the Internet" *setup-x86.exe* will create a new directory in the "Local Package Directory" with the name of the download address (e.g., ftp%3a%2f%2fftp.inf.tu-dresden.de%2fsoftware%2fwindows %2fcygwin32) and download the packages into that directory before it starts the real installation process.

4) At first install only the default packages. When the installation terminates successfully, you can restart *setup-x86.exe*. Click on *View* when the "Select Packages" screen appears, so that you see all packages in an alphabetical order. If you select a package, the packages needed from that package will be later selected automatically. Don't select too many packages at a time because the connection to the server often times out and you have to select the packages once more in that case (you must restart *setup-x86.exe* in that case and it doesn't remember your old choices). You should install at least the following additional packages (click on *skip* if necessary to get a package installed) if you want to have a development environment for my lectures and a X11 GUI:

   autoconf (wrapper script for *autoconf* commands),
   automake (wrapper script for *automake* and *aclocal*),
   autossh,
   binutils,
   bison,
   cygrunsrv (normally already selected/installed),
   emacs (at least the packages "emacs", "emacs-el", and "emacs-X11"),
   flex,
   font-* (all packages, some are already selected/installed),
   fontconfig (normally already selected/installed),
   fontsproto,
   fonttosfnt,
   fvwm,
   gcc-core,

gcc-fortran,
gcc-c++,
gcc-java,
grep (normally already selected/installed),
libtool,
libXm-devel,
libXt-devel,
make,
motif,
openmpi (doesn't support the Java API),
openssh (normally already selected/installed),
openssl (normally already selected/installed),
tcsh,
unzip,
util-linux,
vim,
xclock,
xemacs (all five packages; only available for 32-bit Cygwin),
xhost,
xman,
xmodmap,
xorg-cf-files,
xorg-server,
xrdb,
xset,
xsetroot,
xterm,
zip.

Later you can run *setup-x86.exe* for an automatic update of the installed packages or you can examine which files belong to the different packages (for each installed package setup-x86.exe stores a file in the directory "/etc/setup" with that information).

5) Start Cygwin with the Cygwin-icon on the desktop and execute the command *cygcheck -c*. If the installation of a package is incomplete, try to install the faulty package once more. Run *setup-x86.exe* and click through the different screens until you get the "Select Packages" screen. Click on "View" and choose the package. Now you can click on the version number of the package until you get "Reinstall". Close the Cygwin window.

6) Right-click on the Cygwin-icon on the desktop and choose "Als Administrator ausführen" or "Run as Administrator". If you just double-click on the Cygwin-icon, you will not have Administrator privileges and cannot execute the following command successfully due to permission problems. Execute the command */usr/bin/cygserver-config*.

```
Generating /etc/cygserver.conf file

Warning: The following function requires administrator privileges!

Do you want to install cygserver as service?
(Say "no" if it's already installed as service) (yes/no) yes

The service has been installed under LocalSystem account.
To start it, call `net start cygserver' or `cygrunsrv -S cygserver'.

Further configuration options are available by editing the configuration
file /etc/cygserver.conf.  Please read the inline information in that
file carefully. The best option for the start is to just leave it alone.
```

```
Basic Cygserver configuration finished. Have fun!
```

You can read more about *cygserver* in */usr/share/doc/Cygwin/cygserver.README*. This server is necessary for programs using *System V interprocess communication* functions (like semaphores). It is also necessary for MPI (message passing interface libraries).

7) Modify the configuration file */etc/cygserver.conf* if necessary. I have changed *kern.srv.request_threads* to 32 and removed the comment character from that line.

8) Configure the service *cygserver*.

   a) Move the mouse pointer to the left bottom corner, click the right mouse button, and choose "Systemsteuerung" or "Control Panel". Click on the following items in the screens which follow.

      Verwaltung → *Dienste* or

      Administrative Tools → *Services*

   b) Right click on service *Cygwin cygserver* and choose *Eigenschaften* or *Properties*.

   c) Choose *Wiederherstellung* or *Recovery*.

   d) Set the values of *Erster Fehlschlag*, *Zweiter Fehlschlag*, and *Weitere Fehlschläge* to *Dienst neu starten* or the values of *First failure*, *Second failure*, and *Subsequent failures* to *Restart the service*. Set *Dienst nach **0** Minuten starten* or *Restart service after **0** minutes*.

   e) Right click on field *Status* of *Cygwin cygserver* and start the service.

9) Now we want to configure the "secure shell" package. Execute the command "/usr/bin/ssh-host-config " in a Cygwin window which you opened with a right-click on the Cygwin-icon on the desktop and choosing "Als Administrator ausführen" or "Run as Administrator". Remember that you will not have Administrator privileges and can't execute the command successfully due to permission problems, if you just double-clicked on the Cygwin-icon.

```
*** Info: Generating missing SSH host keys
          ssh-keygen: generating new host keys: RSA1 RSA DSA ECDSA ED25519
*** Info: Creating default /etc/ssh_config file
*** Info: Creating default /etc/sshd_config file

*** Info: StrictModes is set to 'yes' by default.
*** Info: This is the recommended setting, but it requires that the POSIX
*** Info: permissions of the user's home directory, the user's .ssh
*** Info: directory, and the user's ssh key files are tight so that
*** Info: only the user has write permissions.
*** Info: On the other hand, StrictModes don't work well with default
*** Info: Windows permissions of a home directory mounted with the
*** Info: 'noacl' option, and they don't work at all if the home
*** Info: directory is on a FAT or FAT32 partition.
*** Query: Should StrictModes be used? (yes/no) yes

*** Info: Privilege separation is set to 'sandbox' by default since
*** Info: OpenSSH 6.1.  This is unsupported by Cygwin and has to be set
*** Info: to 'yes' or 'no'.
*** Info: However, using privilege separation requires a non-privileged account
*** Info: called 'sshd'.
*** Info: For more info on privilege separation read
          /usr/share/doc/openssh/README.privsep.
```

*** **Query**: Should privilege separation be used? (yes/no) **yes**
*** Info: Note that creating a new user requires that the current account have
*** Info: Administrator privileges. Should this script attempt to create a
*** **Query**: new local account 'sshd'? (yes/no) **yes**
*** Info: Updating /etc/sshd_config file

*** Query: Do you want to install sshd as a service?
*** **Query**: (Say "no" if it is already installed as a service) (yes/no) **yes**
*** **Query**: Enter the value of CYGWIN for the daemon: **[ ]**
*** Info: On Windows Server 2003, Windows Vista, and above, the
*** Info: SYSTEM account cannot setuid to other users -- a capability
*** Info: sshd requires. You need to have or to create a privileged
*** Info: account. This script will help you do so.

*** Info: It's not possible to use the LocalSystem account for services
*** Info: that can change the user id without an explicit password
*** Info: (such as passwordless logins [e.g. public key authentication]
*** Info: via sshd) when having to create the user token from scratch.
*** Info: For more information on this requirement, see
*** Info: https://cygwin.com/cygwin-ug-net/ntsec.html#ntsec-nopasswd1

*** Info: If you want to enable that functionality, it's required to create
*** Info: a new account with special privileges (unless such an account
*** Info: already exists). This account is then used to run these special
*** Info: servers.

*** Info: Note that creating a new user requires that the current account
*** Info: have Administrator privileges itself.

*** Info: No privileged account could be found.

*** Info: This script plans to use 'cyg_server'.
*** Info: 'cyg_server' will only be used by registered services.
*** **Query**: Do you want to use a different name? (yes/no) **no**
*** **Query**: Create new privileged user account 'EIGER\cyg_server' (Cygwin name: 'cyg_server')? (yes/no) **yes**
*** Info: Please enter a password for new user cyg_server. Please be sure
*** Info: that this password matches the password rules given on your system.
*** Info: Entering no password will exit the configuration.
*** **Query**: Please enter the password: **<your password>**
*** **Query**: Reenter: **<your password>**

*** Info: User 'cyg_server' has been created with password 'xxxxxxxxxx.'.
*** Info: If you change the password, please remember also to change the
*** Info: password for the installed services which use (or will soon use)
*** Info: the 'cyg_server' account.

*** Info: The sshd service has been installed under the 'cyg_server'
*** Info: account. To start the service now, call `net start sshd' or
*** Info: `cygrunsrv -S sshd'. Otherwise, it will start automatically
*** Info: after the next reboot.

*** Info: Host configuration finished. Have fun!

You can read more about OpenSSH in */usr/share/doc/Cygwin/openssh.README*.

10) Configure the service *sshd* in a similar way as described above for *cygserver*.

11) Now you should be able to use secure shell in your Cygwin window. "*ssh*" works only for password protected accounts!
    a) "ssh Admin@localhost" should work. Answer the question "Are you sure you want to continue connecting?" with "yes". Type "exit" to logout.
    b) Try also: "ssh Admin@127.0.0.1", "ssh <user name>@localhost", or "ssh <user name>@127.0.0.1". You can also login to your machine from another system now.
    c) You can use *sftp* in the same way as *ssh*, if you want to transfer files.
12) If you want to use my user environment you have to use *tcsh* instead of *bash*.
    a) Copy */Cygwin.bat* to */Cygwin_tcsh.bat*. and edit the new file.
    b) Comment the line "`bash --login -i`" out (`rem bash --login -i`).
    c) Add the line `tcsh –l`
    d) Add a new Cygwin-icon to the Windows desktop. Right-click on the Windows desktop and choose *Neu → Verknüpfung* or *New → Shortcut*. Browse for the file *c:\cygwin\Cygwin_tcsh.bat* and click through the menus until you can finish. Now you can right-click on the new icon and choose *Eigenschaften → Anderes Symbol ...* or *Properties → Change Icon ...* and browse for the file *c:\cygwin\Cygwin.ico*.
    e) Change access permissions: "`chmod 755 /*.bat`".
13) Create home directories (if necessary) for all users and unpack my environment. You find the compressed tar file on my web page (store it in */home*). Execute c) and d) for all directories in "/home".
    a) cd /home
    b) mkdir <user name> (normally not necessary)
    c) (cd <user name>; tar zxvf ../cygwin-env.tar.gz) ("(" and ")" are important)
    d) chown -Rh <user name> <user name>
14) Modify the configuration files */etc/ssh*_config* if necessary. If you like you can start with my configuration files (my file *etc-ssh-config.tar.gz* is available on my web page).
    a) cd /etc
    b) cp ssh_config ssh_config.orig
       cp sshd_config sshd_config.orig
       (these files are also available in */etc/defaults/etc*)
    c) You must change the permissions of both files with "chmod 664 ssh*_config" before you can modify them.
    d) Modify the files.
    e) Change the permissions back to original values so that no normal user can make changes: *chmod 644 ssh*_config*.

    Restart the secure shell daemon so that it learns the settings of the new configuration file.
    a) net stop sshd
    b) net start sshd
15) If you want to use *ssh* without being prompted for a password (necessary for MPI) you can for example setup public-key authentication. Execute the command */usr/bin/ssh-user-config* in a Cygwin window (every user must do that). You get the following output.

```
*** Query: Shall I create a SSH2 RSA identity file for you? (yes/no) no
*** Query: Shall I create a SSH2 DSA identity file for you? (yes/no) no
```

```
*** Query: Shall I create a SSH2 ECDSA identity file for you? (yes/no)
    yes
*** Info: Generating /home/Admin/.ssh/id_ecdsa
Enter passphrase (empty for no passphrase): <your passphrase>
Enter same passphrase again: <your passphrase>
*** Query: Do you want to use this identity to login to this machine?
   (yes/no) yes
*** Info: Adding to /home/Admin/.ssh/authorized_keys
*** Query: Shall I create a (deprecated) SSH1 RSA identity file for you?
(yes/no) no
*** Info: Configuration finished. Have fun!
```

If you do not enter a passphrase, your private key can be used without authentication (insecure). Therefore you should type a passphrase. Public-key authentication does not work if *group* or *other* have write permissions on your home directory. Whenever your private key will be used you will be asked for your passphrase. To avoid typing the passphrase every time it is needed, an agent will be set up at login time which answers that question automatically (you have to type your passphrase only once when you login). You can change your passphrase later with the command "ssh-keygen -t dsa -p". When you do not remember your passphrase you can simply create new keys with a new passphrase.

16) Now you can use *ssh* with public-key authentication.

```
eiger Admin 17 ssh eiger
The authenticity of host 'eiger (194.47.94.220)' can't be established.
RSA key fingerprint is 1a:d8:d8:eb:ec:e8:a9:e2:4b:f7:44:c6:c1:7a:d7:a4.
Are you sure you want to continue connecting (yes/no)? yes
Enter passphrase for key '/home/Admin/.ssh/id_ecdsa': <your passphrase>
eiger Admin 1 exit
eiger Admin 18 ssh eiger
Enter passphrase for key '/home/Admin/.ssh/id_ecdsa': <your passphrase>
eiger Admin 1 exit
```

The question "Are you sure …" will only be asked the first time you connect to a host. The passphrase question disappears when the *ssh agent* is running after your next login.

17) Close Cygwin, right-click on the Cygwin-icon once more, and choose "Als Administrator ausführen" or "Run as Administrator". Now you get a Cygwin terminal first and after a few seconds a graphical user interface. Sometimes you must change access permissions so that different users can start a graphical user interface. Execute the following commands.

    a) cd /var/log/xwin

    b) getfacl XWin0.log

       (Everything is fine if you see the permissions from c) for corresponding entries.)

    c) setfacl -m u::rw-
       setfacl -m g::r--
       setfacl -m o::r--
       setfacl -m d:u::rw-
       setfacl -m d:g::r--
       setfacl -m d:o::r--

18) Close Cygwin, logout as Administrator, and repeat steps 15) and 16) for all other users.

19) If you do not need a *ssh login* without being prompted for a password, you can put a comment character in front of the line "*set USESSH* = userbased" in file *$HOME/.cshrc*.

20) Download e. g. http://www2.hs-fulda.de/~gross/betriebssysteme/prog.tar.gz, unpack the archive, change into the new directory *prog*, run "make" and "rehash". If your installation

of Cygwin was successful, you have now created all example programs for the lecture operating systems in the directory *$HOME/Cygwin/x86/bin* (*$HOME/Cygwin/x86_64/bin* for 64-bit Cygwin). In the past it happened that the service *cygserver* crashed if you terminated a program which used semaphores with <Strg-c>, <Ctrl-c>, or <Control-c>. When that happened you got the error message "Bad system call" if you started the program the next time (you get the same error message when you have not installed and configured the service as described above). A normal user is not allowed to start the service with one of the commands *cygrunsrv -S cygserver*, *net start cygserver*, or via Windows as described above. Even if you have configured the service as described, it may happen from time to time that the service stops and you have to restart it manually as Administrator.

21) If you want to use Java within Cygwin, you have to download the necessary files from http://www.oracle.com/technetwork/java/javase/documentation/jdk8-doc-downloads-2133158.html and http://www.oracle.com/technetwork/java. Download for example the following files (June 2015).

jdk-8u45-windows-i586.exe (32 bit operating system),
jdk-8u45-nb-8_0_2-windows-x64.exe (64 bit operating system),
jdk-8u45-docs-all.zip,
javafx-8u45-apidocs.zip,
jdk-8u45-windows-i586-demos.zip,
jdk-8u45-windows-x64-demos.zip.

Only one of the first two files is necessary for Java and all others are optional. You can download Java with or without *NetBeans*. If you want to use my environment, you must perhaps modify and/or enlarge the files "~/.jdk.csh" and "~/.cshrc" if you download a different version or use a different installation directory.

a) Login as Administrator on your Windows system.

b) Start "jdk-8u45-windows-i586.exe" and/or "jdk-8u45-nb-8_0_2-windows-x64.exe" within *Windows Explorer*. The 32-bit version will be installed into directory "c:\Programme (x86)\Java\..." or "c:\Program Files (x86)\Java\..." and the 64-bit version into directory "c:\Programme\Java\..." or "c:\Program Files\Java\...".

c) Change into the installation directory and unpack the files "jdk-8u45-docs-all.zip", "javafx-8u45-apidocs.zip", and the file "jdk-8u45-windows-i586-demos.zip" or "jdk-8u45-windows-x64-demos.zip" using *Windows Explorer*. If you want to use "unzip" in a Cygwin window, you must once more right-click on the Cygwin-icon on the desktop and choose "Als Administrator ausführen" or "Run as Administrator" to get proper permissions.

d) If you want to have manual pages for all Java commands, you can copy them from a Linux distribution of Java, because the Windows distribution doesn't contain manual pages (Windows has no "man"-command).

e) Now you can set and/or modify some environment variables in Windows (PATH, CLASSPATH, …) so that you can use Java in a *Windows* command shell window (powershell.exe, cmd.exe). Move the mouse pointer to the left bottom corner, click the right mouse button, and choose "Systemsteuerung" or "Control Panel". Click on the following items in the screens which follow.

System → Erweiterte Systemeinstellungen → Umgebungsvariablen… or

System → Advanced system settings → Environment Variables…

Add or modify the following "Systemvariablen" or "System Variables" in the bottom part of the screen with the following values for a 32-bit Java version:

```
DERBY_HOME    c:\Program Files (x86)\Java\jdk1.8.0_45\db
JAVA_HOME     c:\Program Files (x86)\Java\jdk1.8.0_45
CLASSPATH     %DERBY_HOME%\lib\derby.jar;%DERBY_HOME%\lib\derbytools.jar;
              %DERBY_HOME%\lib\derbyrun.jar;.
PATH          ...;%JAVA_HOME%\bin;%DERBY_HOME%\bin
```

f) You can use "`.jdk.csh`" from my user environment stored in *cygwin-env.tar.gz* to set up the Java environment for Cygwin. Perhaps you have to modify some or all path names before you execute "`source .jdk.csh`".

Remarks:

1) You can "clone" a Cygwin installation in one or another way if you want to install Cygwin on several machines. I always install Cygwin with default packages first so that I get all necessary entries in the Windows registry. Next I copy the file "/etc/setup/installed.db" from my "master" installation (which contains all installed packages of that installation) into "/etc/setup" of the new installation. Now I run "setup-x86.exe" or "setup-x86_64.exe" once more and click myself through the different screens until I get the "Select packages" screen. Here I click twice on "All Default" on the upper left side so that I get "Reinstall" for all packages. All packages will be reinstalled or installed if they didn't belong to the default packages, if you continue with a click on "Weiter" or "Next".

2) Stop all Cygwin services (sshd, cygserver) before you update Cygwin (otherwise *setup* cannot update e.g. */bin/cygwin1.dll*).

3) If you start Cygwin with a right-click on the Cygwin-icon on the desktop and choose "Als Administrator ausführen" or "Run as Administrator", you can manually **install** a Windows service with *cygrunsrv -I <service>*, **remove** a service with *cygrunsrv -R <service>*, **start** a service with *cygrunsrv -S <service>*, and **stop** a service with *cygrunsrv -E <service>*. Try *cygrunsrv -h* for more information.

4) Starting with *Cygwin 1.7.34* the files */etc/passwd* and */etc/group* are dispensable, because the account information for users will be fetched directly from the *Windows account database* and can be cached for all Cygwin processes started after *cygserver*. You can take advantage of this mechanism if you start *cygserver* first when you automatically start Cygwin processes as *Windows services* at system startup. *Cygserver* should wait for *Windows TCP/IP* and *AFD* (ancillary function driver for winsock) services before it starts. You can use the following commands to accomplish this if the services already exist.

   a) Choose the *Windows* command shell "cmd.exe", right-click on it and choose "Als Administrator ausführen" or "Run as Administrator".

   b) Now you can query the details of a service with the command "sc qc".

```
C:\cygwin>sc qc cygserver
[SC] QueryServiceConfig ERFOLG

SERVICE_NAME: cygserver
        TYPE               : 10  WIN32_OWN_PROCESS
        START_TYPE         : 2   AUTO_START
        ERROR_CONTROL      : 1   NORMAL
        BINARY_PATH_NAME   : C:\cygwin\bin\cygrunsrv.exe
        LOAD_ORDER_GROUP   :
        TAG                : 0
        DISPLAY_NAME       : CYGWIN cygserver
        DEPENDENCIES       :
        SERVICE_START_NAME : LocalSystem
```

```
C:\cygwin>sc qc sshd
[SC] QueryServiceConfig ERFOLG

SERVICE_NAME: sshd
        TYPE               : 10  WIN32_OWN_PROCESS
        START_TYPE         : 2   AUTO_START
        ERROR_CONTROL      : 1   NORMAL
        BINARY_PATH_NAME   : C:\cygwin\bin\cygrunsrv.exe
        LOAD_ORDER_GROUP   :
        TAG                : 0
        DISPLAY_NAME       : CYGWIN sshd
        DEPENDENCIES       : tcpip
        SERVICE_START_NAME : .\cyg_server

C:\cygwin>
```

c) Set new dependencies with the command “sc config”. Notice that the space character after “depend= “ is required and that the command *replaces* any existing dependencies! The changes affect only future instances and not the running ones.

```
sc config cygserver depend= tcpip/afd
sc config sshd depend= cygserver
```

d) You can remove all dependencies from a service with the following command.

```
sc config <service name> depend= /
```

5) If you install a newer version of Java you must “upgrade” the files .cshrc and .jdk.csh in all home directories as well.

6) If you cannot start *Xwin* after a crash (some message like “Xwin already running” appears in a popup window although you are sure it does not run), you must remove /tmp/.X11/X0 manually.

7) If “chown” shows something like “Permission denied” if you try to change the ownership of a file in a NTFS partition outside of the Cygwin tree, although you have logged in as Administrator, you have forgotten to right-click on the Cygwin-icon and to use “Als Administrator ausführen” or “Run as Administrator”.

8) A normal user cannot run “ping” from Cygwin because it uses “raw ip” which is only available for “Administrator”. “$HOME/.mycshrc” contains an alias so that normal users will use “ping” from windows.

9) You can remove the Cygwin package directory (e. g., c:\cygwin\ftp%3a%2f%2fftp.inf.tu-dresden.de%2fsoftware%2fwindows%2fcygwin32) when the installation is complete and you are short of disk space.

10) You can customize a few things in “~/.cshrc”, “~/.login”, and “~/.mycshrc”. Change system specific items in the first two files and user specific things in the last file.

11) Please let me know if you find any errors in this description or have any improvements.