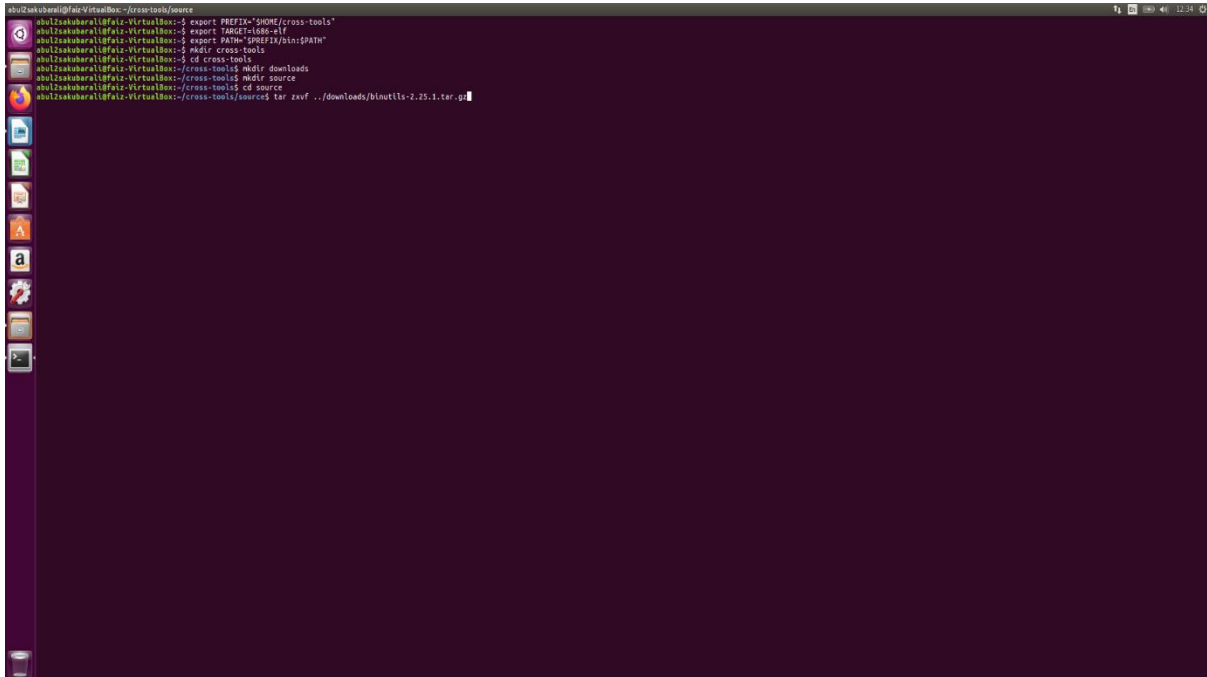


Operating systems

Worksheet – 2



First we settled up environmental variables PREFIX is set to \$HOME/cross-tools, TARGET is set to 1686-elf, PATH is updated to include the bin directory of the cross-tools: \$PREFIX/bin:\$PATH. Then we created a directory called cross-tools after that we made two directories inside directory cross-tools named source and downloads after we downloaded the binutils-2.25.1.tar.gz file from ftp.gnu.org using wget -m command as shown in the above image. After that we extracted the binutils-2.25.1 within source using tar zxvf ../downloads/binutils-2.25.1.tar.gz command.

```

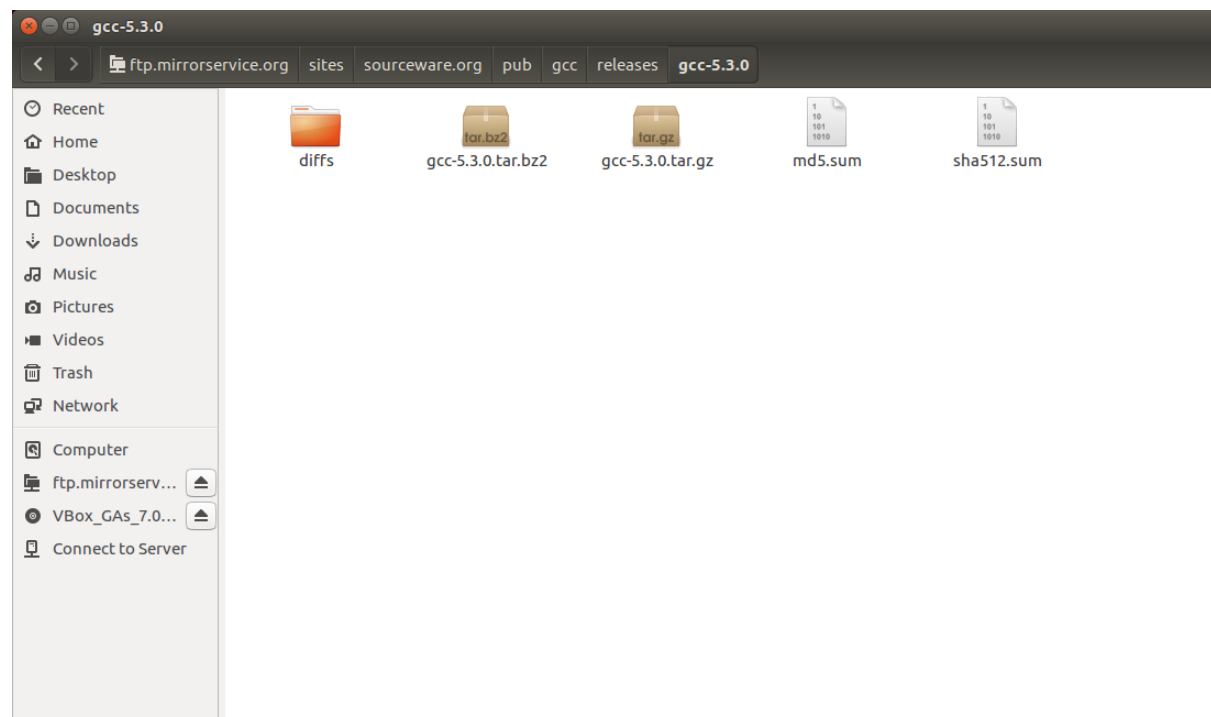
abul@ABULFAIZ:~/cross-tools/source$ configure --target=$TARGET --prefix=$PREFIX --with-sysroot --
bash: /configure: No such file or directory
abul@ABULFAIZ:~/cross-tools/source$ disable-nls --disable-werror
disable-nls: command not found
abul@ABULFAIZ:~/cross-tools/source$ cd binutils-2.25.1
abul@ABULFAIZ:~/cross-tools/source/binutils-2.25.1$ ./configure --target=$TARGET --prefix=$PREFIX --with-sysroot --disable-nls --disable-werror
checking build system type... x86_64-unknown-linux-gnu
checking host system type... x86_64-unknown-linux-gnu
checking target system type... i686-pc-elf
checking for a BSD-compatible install... /usr/bin/install -c
checking whether ln works... yes
checking whether ln -s works... yes
checking for a sed that does not truncate output... /bin/sed
checking for awk... no
checking for mawk... mawk
checking for gcc... gcc
checking for C compiler default output file name... a.out
checking whether the C compiler works... yes
checking whether we are cross compiling... no
checking for suffix of executables...
checking for suffix of object files... o
checking whether we are using the GNU C compiler... yes
checking whether gcc accepts -g... yes
checking for gcc option to accept ISO C89... none needed
checking for g++... g++
checking whether we are using the GNU C++ compiler... yes
checking whether g++ accepts -g... yes
checking whether g++ accepts -static-libstdc++ -static-libgcc... yes
checking for gnatbind... no
checking for gnatmake... no
checking whether compiler driver understands Ada... no
checking how to compare bootstrapped objects... cmp --ignore-initial=16 $f1 $f2
checking for objdir... .libs
checking for version 0.10 of ISL... no
checking for version 0.11 of ISL... no
checking for version 0.12 of ISL... no
checking for default BUILD_CONFIG...
checking for --enable-verify... no
checking for bison... no
checking for byacc... no
checking for yacc... no
checking for bison... no
checking for gm4... no

```

After we extracted the file we lead into the binutils-2.25.1 file and then we configured the Binutils source so it can be built on the particular Linux distro. Using `./configure --target=$TARGET --prefix="$PREFIX" --with-sysroot disable-nls --disable-werror` Like shown in the above image .

```
abul@ABULFAIZ:~/cross-tools/source/binutils-2.25.1$ make
make[1]: Entering directory '/home/abul/cross-tools/source/binutils-2.25.1'
Configuring in ./libiberty
configure: creating cache ./config.cache
checking whether to enable maintainer-specific portions of Makefiles... no
checking for makeinfo... /home/abul/cross-tools/source/binutils-2.25.1/missing makeinfo --split-size=5000000
configure: WARNING:
*** Makeinfo is missing. Info documentation will not be built.
checking for perl... perl
checking build system type... x86_64-unknown-linux-gnu
checking host system type... x86_64-unknown-linux-gnu
checking for x86_64-unknown-linux-gnu-ar... ar
checking for x86_64-unknown-linux-gnu-ranlib... ranlib
checking whether to install libiberty headers and static library... no
configure: target_header_dir =
checking for x86_64-unknown-linux-gnu-gcc... gcc
checking for C compiler default output file name... a.out
checking whether the C compiler works... yes
checking whether we are cross compiling... no
checking for suffix of executables...
checking for suffix of object files... o
checking whether we are using the GNU C compiler... yes
checking whether gcc accepts -g... yes
checking for gcc option to accept ISO C89... none needed
checking for special C compiler options needed for large files... no
checking for _FILE_OFFSET_BITS value needed for large files... no
checking how to run the C preprocessor... gcc -E
checking whether gcc supports -W... yes
checking whether gcc supports -Wall... yes
checking whether gcc supports -Wwrite-strings... yes
checking whether gcc supports -Wc++-compat... yes
checking whether gcc supports -Wstrict-prototypes... yes
checking whether gcc supports -pedantic... yes
checking whether gcc and cc understand -c and -o together... yes
checking for an ANSI C-conforming const... yes
checking for inline... inline
checking for grep that handles long lines and -e... /bin/grep
checking for egrep... /bin/grep -E
checking for ANSI C header files... yes
checking for sys/types.h... yes
checking for sys/stat.h... yes
checking for stdlib.h... yes
checking for string.h... yes
checking for memory.h... yes
```

After configured the binutils source we built and installed the binutils with commands `make` and `make install` as shown above.



And then we downloaded `gcc-5.3.0.tar.gz` file in our downloads directory in cross-tools and then we extracted it to our source directory in the same cross-tools with `tar zxvf ../downloads/gcc-5.3.0.tar.gz` command .

```

gcc-5.3.0/gcc/c/c-decl.c
gcc-5.3.0/gcc/c/c-objc-common.c
gcc-5.3.0/gcc/c/c-parser.c
gcc-5.3.0/gcc/c/c-aux-info.c
gcc-5.3.0/gcc/c/c-array-notation.c
gcc-5.3.0/ltsugar.m4
abu@ABULFAIZ:~/cross-tools/source$ cd gcc-5.3.0
abu@ABULFAIZ:~/cross-tools/source/gcc-5.3.0$ ./contrib/download_prerequisites
--2024-07-19 00:41:30-- ftp://gcc.gnu.org/pub/gcc/infrastructure/mpfr-2.4.2.tar.bz2
=> 'mpfr-2.4.2.tar.bz2'
Resolving gcc.gnu.org (gcc.gnu.org)... 8.43.85.97, 2620:52:3:1:0:246e:9693:128c
Connecting to gcc.gnu.org (gcc.gnu.org)[8.43.85.97]:21... connected.
Logging in as anonymous ... Logged in!
=> SYST ... done.      ==> PWD ... done.
=> TYPE I ... done.    ==> CWD (1) /pub/gcc/infrastructure ... done.
=> SIZE mpfr-2.4.2.tar.bz2 ... 1077886
=> PASV ... done.      ==> RETR mpfr-2.4.2.tar.bz2 ... done.
Length: 1077886 (1.0M) (unauthoritative)

mpfr-2.4.2.tar.bz2          100%[=====] 1.03M  454KB/s  in 2.3s

2024-07-19 00:41:37 (454 KB/s) - 'mpfr-2.4.2.tar.bz2' saved [1077886]

--2024-07-19 00:41:37-- ftp://gcc.gnu.org/pub/gcc/infrastructure/gmp-4.3.2.tar.bz2
=> 'gmp-4.3.2.tar.bz2'
Resolving gcc.gnu.org (gcc.gnu.org)... 8.43.85.97, 2620:52:3:1:0:246e:9693:128c
Connecting to gcc.gnu.org (gcc.gnu.org)[8.43.85.97]:21... connected.
Logging in as anonymous ... Logged in!
=> SYST ... done.      ==> PWD ... done.
=> TYPE I ... done.    ==> CWD (1) /pub/gcc/infrastructure ... done.
=> SIZE gmp-4.3.2.tar.bz2 ... 1897483
=> PASV ... done.      ==> RETR gmp-4.3.2.tar.bz2 ... done.
Length: 1897483 (1.8M) (unauthoritative)

gmp-4.3.2.tar.bz2          100%[=====] 1.81M  692KB/s  in 2.7s

2024-07-19 00:41:44 (692 KB/s) - 'gmp-4.3.2.tar.bz2' saved [1897483]

--2024-07-19 00:41:44-- ftp://gcc.gnu.org/pub/gcc/infrastructure/mpc-0.8.1.tar.gz
=> 'mpc-0.8.1.tar.gz'
Resolving gcc.gnu.org (gcc.gnu.org)... 8.43.85.97, 2620:52:3:1:0:246e:9693:128c
Connecting to gcc.gnu.org (gcc.gnu.org)[8.43.85.97]:21... connected.
Logging in as anonymous ... Logged in!
=> SYST ... done.      ==> PWD ... done.
=> TYPE I ... done.    ==> CWD (1) /pub/gcc/infrastructure ... done.
=> SIZE mpc-0.8.1.tar.gz ... 544950
=> PASV ... done.      ==> RETR mpc-0.8.1.tar.gz ... done.
Length: 544950 (532K) (unauthoritative)

mpc-0.8.1.tar.gz           100%[=====] 532.18K  82.7KB/s  in 8.8s

```

Then we used the third party script given to install the necessary dependencies with `./contrib/download_prerequisites` command as shown in the above image.

```

abu@ABULFAIZ:~/cross-tools/source/gcc-5.3.0/gcc_build$ ../configure --target=$TARGET --prefix="$PREFIX" --disable-nls --enable-languages=c,c++ --without-headers
checking build system type... x86_64-unknown-linux-gnu
checking host system type... x86_64-unknown-linux-gnu
checking target system type... i686-pc-elf
checking for a BSD-compatible install... /usr/bin/install -c
checking whether ln works... yes
checking whether ln -s works... yes
checking for a sed that does not truncate output... /bin/sed
checking for gawk... no
checking for mawk... mawk
checking for libatomic support... no
checking for libcilkrts support... no
checking for libitm support... no
checking for libsanitizer support... no
checking for libvtv support... no
checking for gcc... gcc
checking for C compiler default output file name... a.out
checking whether the C compiler works... yes
checking whether we are cross compiling... no
checking for suffix of executables...
checking for suffix of object files... o
checking whether we are using the GNU C compiler... yes
checking whether gcc accepts -g... yes
checking for gcc option to accept ISO C89... none needed
checking for g++... g++
checking whether we are using the GNU C++ compiler... yes
checking whether g++ accepts -g... yes
checking whether g++ accepts -static-libstdc++ -static-libgcc... yes
checking for gnatbind... no
checking for gnatmake... no
checking whether compiler driver understands Ada... no
checking how to compare bootstrapped objects... cmp --ignore-initial=16 $Sf1 $Sf2
checking for objdir... .libs
configure: WARNING: using in-tree ISL, disabling version check
*** This configuration is not supported in the following subdirectories:
    target-libgomp target-libatomic target-libcilkrts target-libitm target-libsanitizer target-libvtv target-libmpx gnattools gotools target-libada target-libgfortran target-libgo target-libffi target-libbacktrace target-zlib target-libjava target-libobjc target-liboffloadmhc target-boehm-gc
    (Any other directories should still work fine.)
checking for default BUILD_CONFIG...
checking for --enable-vtable-verify... no
checking for bison... no

```

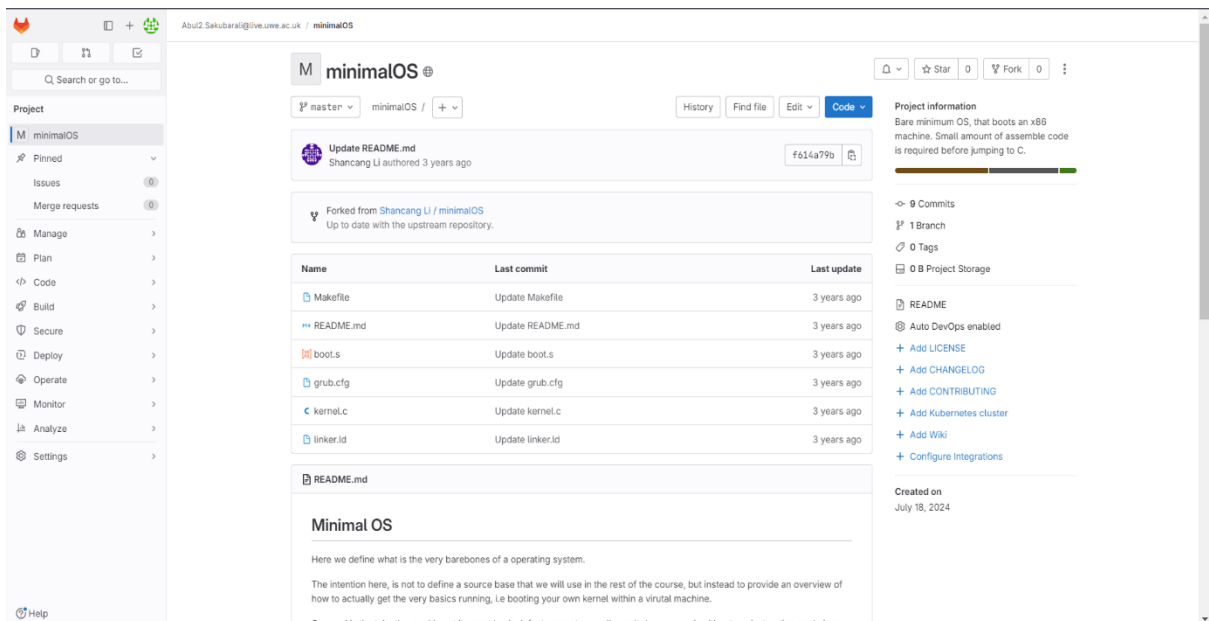
Then we configure the gcc source base by creating a directory inside the same gcc-5.3.0 called `gcc_build` and then we configured the file `gcc_build` with `../configure --target=$TARGET --prefix="$PREFIX" --disable-nls --enable-languages=c,c++ --withoutheaders` command.

```

abul@ABULFAIZ: ~/cross-tools/source/gcc-5.3.0/gcc_build
perl ../../gcc/./contrib/text2pod.pl ../../gcc/doc/include/gpl_v3.texti > gpl.pod
Unescaped left brace in regex is deprecated, passed through in regex; marked by <-- HERE in m/^\@strong{ <-- HERE (.*)}$ / at ../../gcc/./contrib/text2
pod.pl line 319.
echo timestamp > doc/gpl.7
(pod2man --center="GNU" --release="gcc-5.3.0" --date=2015-12-04 --section=7 gpl.pod > doc/gpl.7.TS$ && \
mv -f doc/gpl.7.TS$ doc/gpl.7) || \
{ rm -f doc/gpl.7.TS$ && exit 1 }
cp doc/gcc.1 doc/g++.1
rm gcc.pod
make[1]: Leaving directory '/home/abul/cross-tools/source/gcc-5.3.0/gcc_build/gcc'
abul@ABULFAIZ:~/cross-tools/source/gcc-5.3.0/gcc_build$ make all-target-libgcc
make[1]: Entering directory '/home/abul/cross-tools/source/gcc-5.3.0/gcc_build/gmp'
make all-recursive
make[2]: Entering directory '/home/abul/cross-tools/source/gcc-5.3.0/gcc_build/gmp'
Making all in tests
make[3]: Entering directory '/home/abul/cross-tools/source/gcc-5.3.0/gcc_build/gmp/tests'
Making all in .
make[4]: Entering directory '/home/abul/cross-tools/source/gcc-5.3.0/gcc_build/gmp/tests'
make[4]: Nothing to be done for 'all-am'.
make[4]: Leaving directory '/home/abul/cross-tools/source/gcc-5.3.0/gcc_build/gmp/tests'
Making all in devel
make[4]: Entering directory '/home/abul/cross-tools/source/gcc-5.3.0/gcc_build/gmp/tests/devel'
make[4]: Nothing to be done for 'all'.
make[4]: Leaving directory '/home/abul/cross-tools/source/gcc-5.3.0/gcc_build/gmp/tests/devel'
Making all in mpn
make[4]: Entering directory '/home/abul/cross-tools/source/gcc-5.3.0/gcc_build/gmp/tests/mpn'
make[4]: Nothing to be done for 'all'.
make[4]: Leaving directory '/home/abul/cross-tools/source/gcc-5.3.0/gcc_build/gmp/tests/mpn'
Making all in mpz
make[4]: Entering directory '/home/abul/cross-tools/source/gcc-5.3.0/gcc_build/gmp/tests/mpz'
make[4]: Nothing to be done for 'all'.
make[4]: Leaving directory '/home/abul/cross-tools/source/gcc-5.3.0/gcc_build/gmp/tests/mpz'
Making all in mpq
make[4]: Entering directory '/home/abul/cross-tools/source/gcc-5.3.0/gcc_build/gmp/tests/mpq'
make[4]: Nothing to be done for 'all'.
make[4]: Leaving directory '/home/abul/cross-tools/source/gcc-5.3.0/gcc_build/gmp/tests/mpq'
Making all in mpf
make[4]: Entering directory '/home/abul/cross-tools/source/gcc-5.3.0/gcc_build/gmp/tests/mpf'
make[4]: Nothing to be done for 'all'.
make[4]: Leaving directory '/home/abul/cross-tools/source/gcc-5.3.0/gcc_build/gmp/tests/mpf'
Making all in rand
make[4]: Entering directory '/home/abul/cross-tools/source/gcc-5.3.0/gcc_build/gmp/tests/rand'
make[4]: Nothing to be done for 'all'.
make[4]: Leaving directory '/home/abul/cross-tools/source/gcc-5.3.0/gcc_build/gmp/tests/rand'
Making all in misc
make[4]: Entering directory '/home/abul/cross-tools/source/gcc-5.3.0/gcc_build/gmp/tests/misc'
make[4]: Nothing to be done for 'all'.
make[4]: Leaving directory '/home/abul/cross-tools/source/gcc-5.3.0/gcc_build/gmp/tests/misc'
Making all in cxx
make[4]: Entering directory '/home/abul/cross-tools/source/gcc-5.3.0/gcc_build/gmp/tests/cxx'
make[4]: Nothing to be done for 'all'.

```

And then we built and installed GCC and associate libraries with make all-gcc , make alltarget-libgcc , make install-gcc , make install-target-libgcc one by one as s hown in the above image.



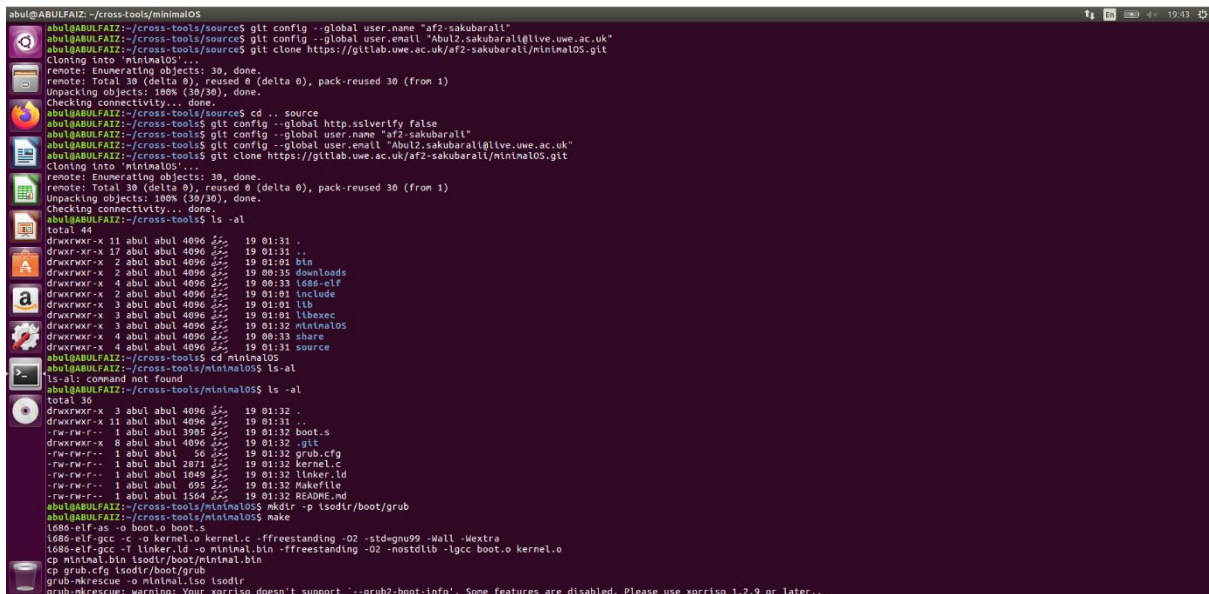
Then forked with the given Uwe gitlab account with this link <https://gitlab.uwe.ac.uk/s23-li/minimalOS>

```

abul@ABULFAIZ:~/cross-tools/source$ cd .. source
abul@ABULFAIZ:~/cross-tools$ git config --global http.sslverify false
abul@ABULFAIZ:~/cross-tools$ git config --global user.name "af2-sakubarali"
abul@ABULFAIZ:~/cross-tools$ git config --global user.email "Abul2.sakubarali@live.uwe.ac.uk"
abul@ABULFAIZ:~/cross-tools$ git clone https://gitlab.uwe.ac.uk/af2-sakubarali/minimalOS.git
Cloning into 'minimalOS'...
remote: Enumerating objects: 30, done.
remote: Total 30 (delta 0), reused 0 (delta 0), pack-reused 30 (from 1)
Unpacking objects: 100% (30/30), done.
Checking connectivity... done.
abul@ABULFAIZ:~/cross-tools$ ls -al
total 44
drwxrwxr-x 11 abul abul 4096 19 01:31 .
drwxr-xr-x 17 abul abul 4096 19 01:31 ..
drwxrwxr-x 2 abul abul 4096 19 01:01 bin
drwxrwxr-x 2 abul abul 4096 19 00:35 downloads
drwxrwxr-x 4 abul abul 4096 19 00:33 i686-elf
drwxrwxr-x 2 abul abul 4096 19 01:01 include
drwxrwxr-x 3 abul abul 4096 19 01:01 lib
drwxrwxr-x 3 abul abul 4096 19 01:01 libexec
drwxrwxr-x 3 abul abul 4096 19 01:32 minimalOS
drwxrwxr-x 4 abul abul 4096 19 00:33 share
drwxrwxr-x 4 abul abul 4096 19 01:31 source
abul@ABULFAIZ:~/cross-tools$ cd minimalOS
abul@ABULFAIZ:~/cross-tools/minimalOS$ ls -al
ls-al: command not found
abul@ABULFAIZ:~/cross-tools/minimalOS$ ls -al
total 36
drwxrwxr-x 3 abul abul 4096 19 01:32 .
drwxrwxr-x 11 abul abul 4096 19 01:31 ..
-rw-rw-r-- 1 abul abul 3905 19 01:32 boot.s
drwxrwxr-x 8 abul abul 4096 19 01:32 .git
-rw-rw-r-- 1 abul abul 56 19 01:32 grub.cfg
-rw-rw-r-- 1 abul abul 2871 19 01:32 kernel.c
-rw-rw-r-- 1 abul abul 1049 19 01:32 linker.ld
-rw-rw-r-- 1 abul abul 695 19 01:32 Makefile
-rw-rw-r-- 1 abul abul 1564 19 01:32 README.md
abul@ABULFAIZ:~/cross-tools/minimalOS$

```

After that we created a directory under cross-tools named minimalOS and clone it to our forked gitlab account with `git clone https://gitlab.uwe.ac.uk/af2-sakubarali/minimalOS` command as shown in the above image.



```

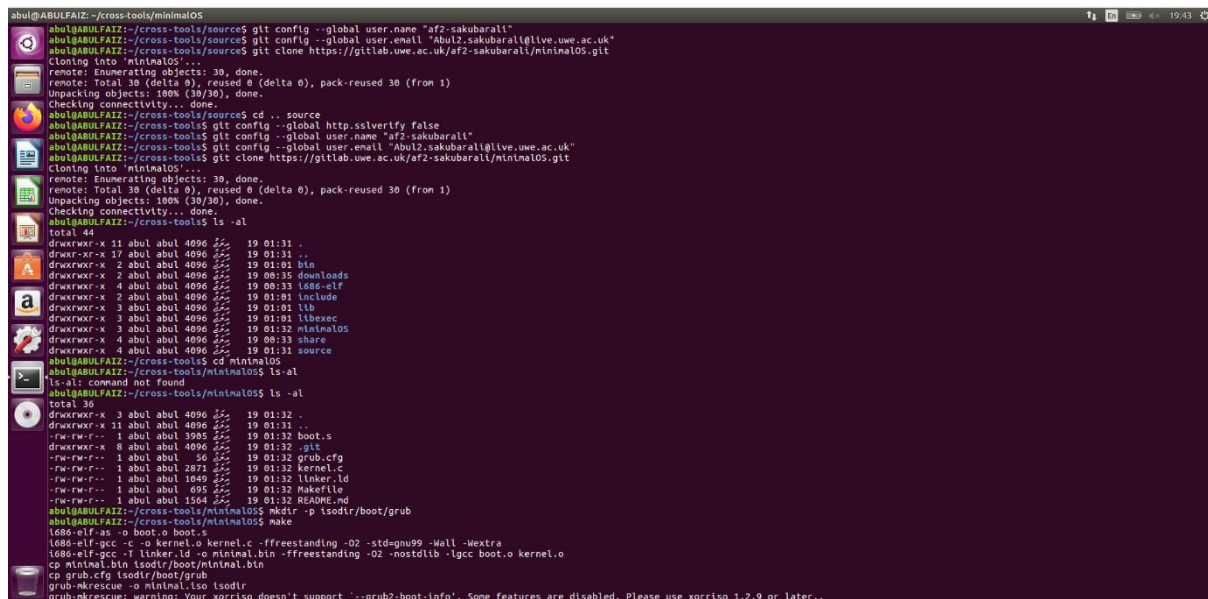
abul@ABULFAIZ:~/cross-tools/minimalOS$
abul@ABULFAIZ:~/cross-tools/source$ git config --global user.name "af2-sakubarali"
abul@ABULFAIZ:~/cross-tools/source$ git config --global user.email "Abul2.sakubarali@live.uwe.ac.uk"
abul@ABULFAIZ:~/cross-tools/source$ git clone https://gitlab.uwe.ac.uk/af2-sakubarali/minimalOS.git
Cloning into 'minimalOS'...
remote: Enumerating objects: 30, done.
remote: Total 30 (delta 0), reused 0 (delta 0), pack-reused 30 (from 1)
Unpacking objects: 100% (30/30), done.
Checking connectivity... done.
abul@ABULFAIZ:~/cross-tools/source$ cd .. source
abul@ABULFAIZ:~/cross-tools$ git config --global http.sslverify false
abul@ABULFAIZ:~/cross-tools$ git config --global user.name "af2-sakubarali"
abul@ABULFAIZ:~/cross-tools$ git config --global user.email "Abul2.sakubarali@live.uwe.ac.uk"
abul@ABULFAIZ:~/cross-tools$ git clone https://gitlab.uwe.ac.uk/af2-sakubarali/minimalOS.git
Cloning into 'minimalOS'...
remote: Enumerating objects: 30, done.
remote: Total 30 (delta 0), reused 0 (delta 0), pack-reused 30 (from 1)
Unpacking objects: 100% (30/30), done.
Checking connectivity... done.
abul@ABULFAIZ:~/cross-tools$ ls -al
total 44
drwxrwxr-x 11 abul abul 4096 19 01:31 .
drwxr-xr-x 17 abul abul 4096 19 01:31 ..
drwxrwxr-x 2 abul abul 4096 19 01:01 bin
drwxrwxr-x 2 abul abul 4096 19 00:35 downloads
drwxrwxr-x 4 abul abul 4096 19 00:33 i686-elf
drwxrwxr-x 2 abul abul 4096 19 01:01 include
drwxrwxr-x 3 abul abul 4096 19 01:01 lib
drwxrwxr-x 3 abul abul 4096 19 01:01 libexec
drwxrwxr-x 3 abul abul 4096 19 01:32 minimalOS
drwxrwxr-x 4 abul abul 4096 19 00:33 share
drwxrwxr-x 4 abul abul 4096 19 01:31 source
abul@ABULFAIZ:~/cross-tools$ cd minimalOS
abul@ABULFAIZ:~/cross-tools/minimalOS$ ls -al
ls-al: command not found
abul@ABULFAIZ:~/cross-tools/minimalOS$ ls -al
total 36
drwxrwxr-x 3 abul abul 4096 19 01:32 .
drwxrwxr-x 11 abul abul 4096 19 01:31 ..
-rw-rw-r-- 1 abul abul 3905 19 01:32 boot.s
drwxrwxr-x 8 abul abul 4096 19 01:32 .git
-rw-rw-r-- 1 abul abul 56 19 01:32 grub.cfg
-rw-rw-r-- 1 abul abul 2871 19 01:32 kernel.c
-rw-rw-r-- 1 abul abul 1049 19 01:32 linker.ld
-rw-rw-r-- 1 abul abul 695 19 01:32 Makefile
-rw-rw-r-- 1 abul abul 1564 19 01:32 README.md
abul@ABULFAIZ:~/cross-tools/minimalOS$ make
i686-elf-as -o boot.o boot.s
i686-elf-gcc -c -o kernel.o kernel.c -ffreestanding -O2 -stdgnu99 -Wall -Wextra
i686-elf-gcc -i linker.ld -o minimal.bin -ffreestanding -O2 -nostdlib -lgcc boot.o kernel.o
cp minimal.bin isodir/boot/minimal.bin
cp grub.cfg isodir/boot/grub
grub-mkrescue -o minimal.iso isodir
grub-mkrescue: warning: Your xorriso doesn't support '--grub2-boot-info'. Some features are disabled. Please use xorriso 1.2.9 or later..

```

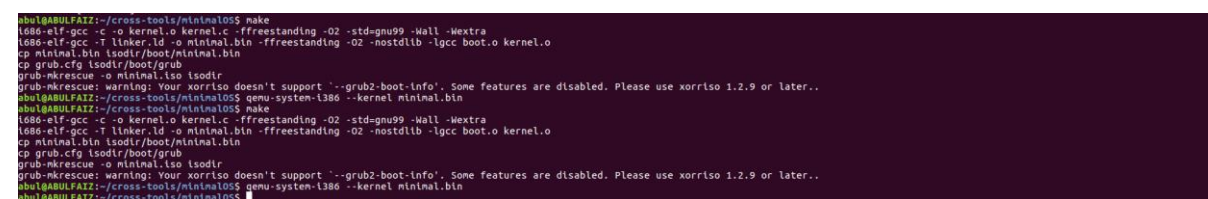
After we cloned our git we created bootable ISO images and for that grub expects an directory containing image loaded with a grub.cfg description, under grub/boot with a structural command which is `mkdir -p isodir/boot/grub`.



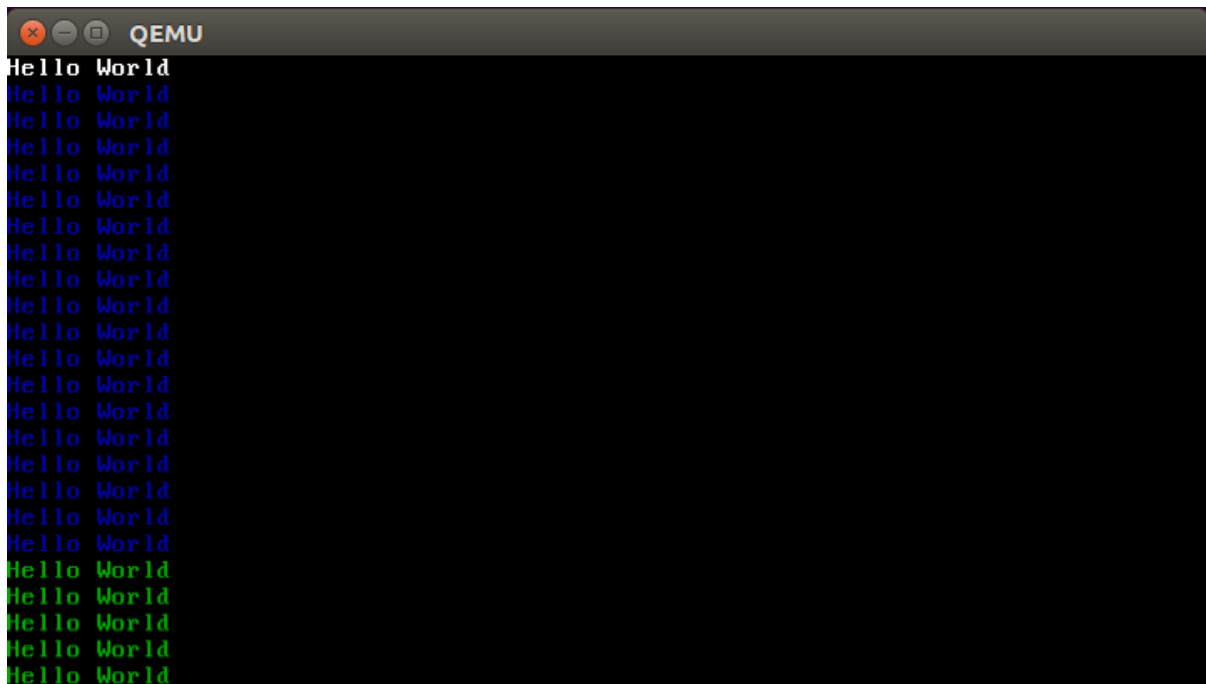
Then in our OS directory's file we open the kernel.c file and edited it according to the same as mentioned in the worksheet and after that we saved it as shown in the above image.



After we saved the kernel.c in the terminal we use make command to make the changes as shown the above image.



Then we use qemu -system-i386 -kernel minimal.bin to see our respected output



this new tab views automatically named as QEMUas shown in the image

```
abul@ABULFAIZ:~/cross-tools/minimalOS$ git push
warning: push.default is unset; its implicit value has changed in
Git 2.0 from 'matching' to 'simple'. To squelch this message
and maintain the traditional behavior, use:

  git config --global push.default matching

To squelch this message and adopt the new behavior now, use:

  git config --global push.default simple

When push.default is set to 'matching', git will push local branches
to the remote branches that already exist with the same name.

Since Git 2.0, Git defaults to the more conservative 'simple'
behavior, which only pushes the current branch to the corresponding
remote branch that 'git pull' uses to update the current branch.

See 'git help config' and search for 'push.default' for further information.
(the 'simple' mode was introduced in Git 1.7.11. Use the similar mode
'current' instead of 'simple' if you sometimes use older versions of Git)

Username for 'https://gitlab.uwe.ac.uk': af2-sakubarali
Password for 'https://af2-sakubarali@gitlab.uwe.ac.uk':
Everything up-to-date
abul@ABULFAIZ:~/cross-tools/minimalOS$
```

And finally we pushed our changes to git and saved the changes commit in local with git push command.

completed the Worksheet – 2.

Thank you.