Embedded Software

Programming in Linux

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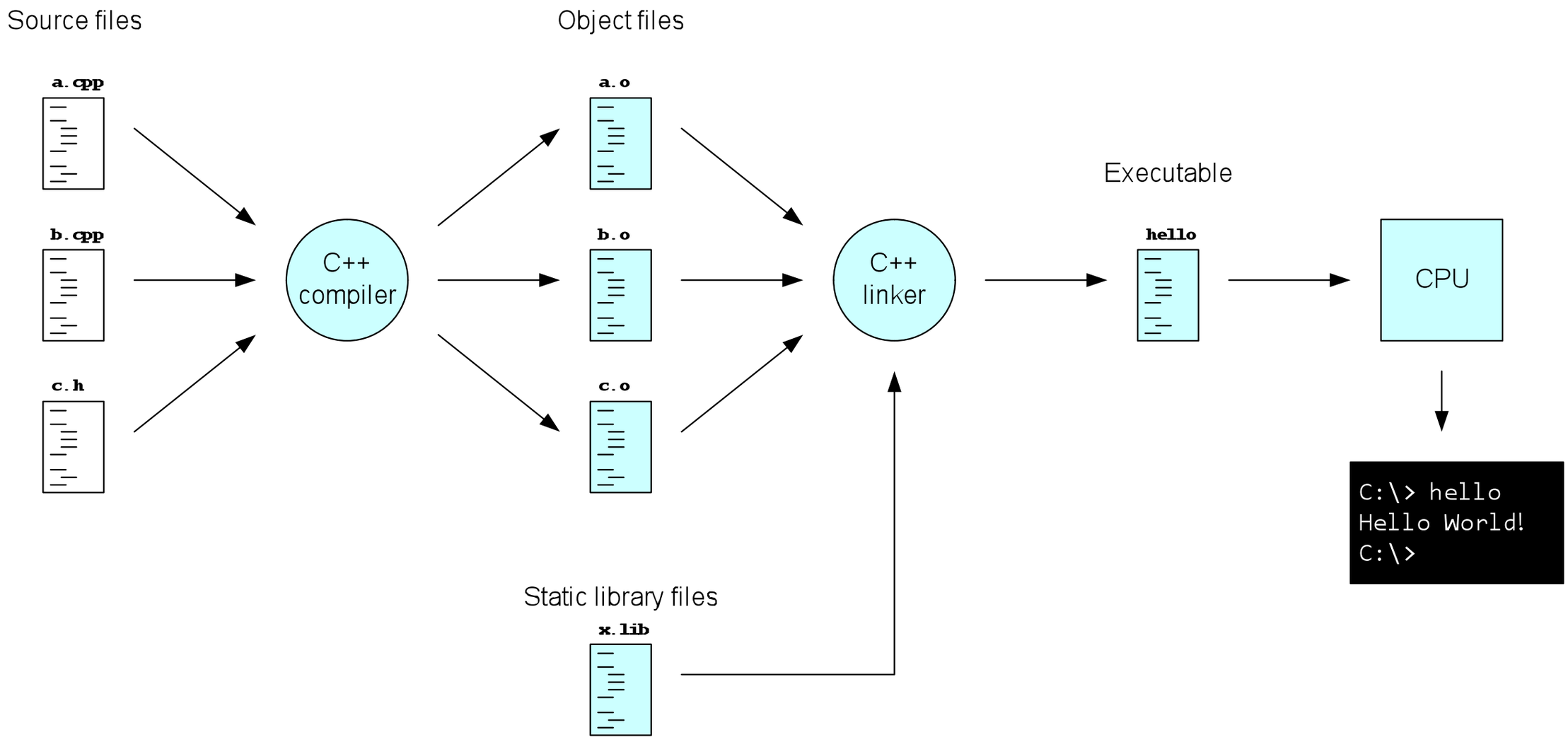
Agenda

- Compilation
- Host and Target
- SW Development for Embedded targets - Howto make it

Compilation



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Host and target

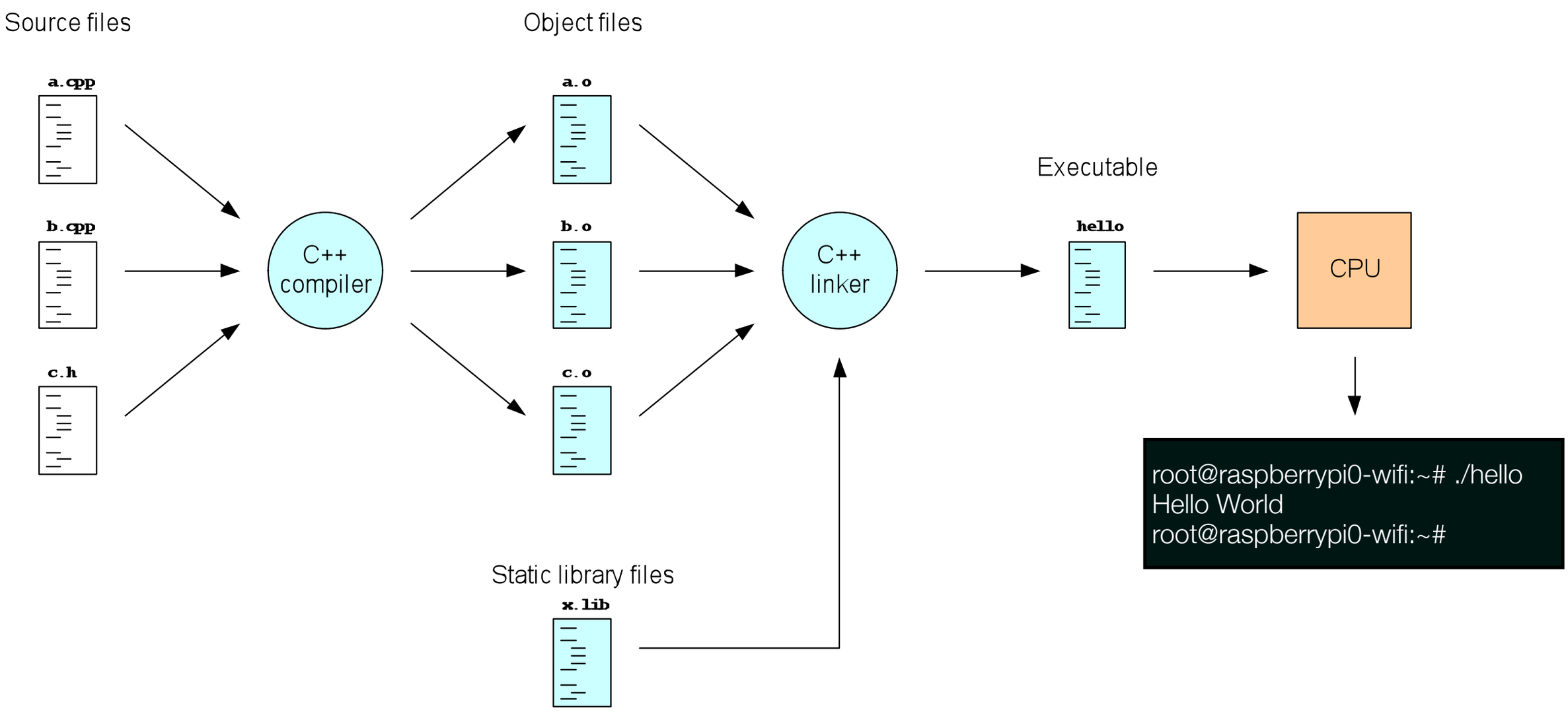
- Any executable (“binary”) is generated on a *host* for a specific *target*

```
stud@ubuntu:~/$ file hello
hello: ELF 64-bit LSB shared object, x86-64, version 1 (SYSV) …
stud@ubuntu:~/$
```

- Until now, host == target

- *What if you wish to generate programs for an **embedded** target, e.g. an ARM processor?*
  - An ARM processor does not understand an x86 binary!

Host and target



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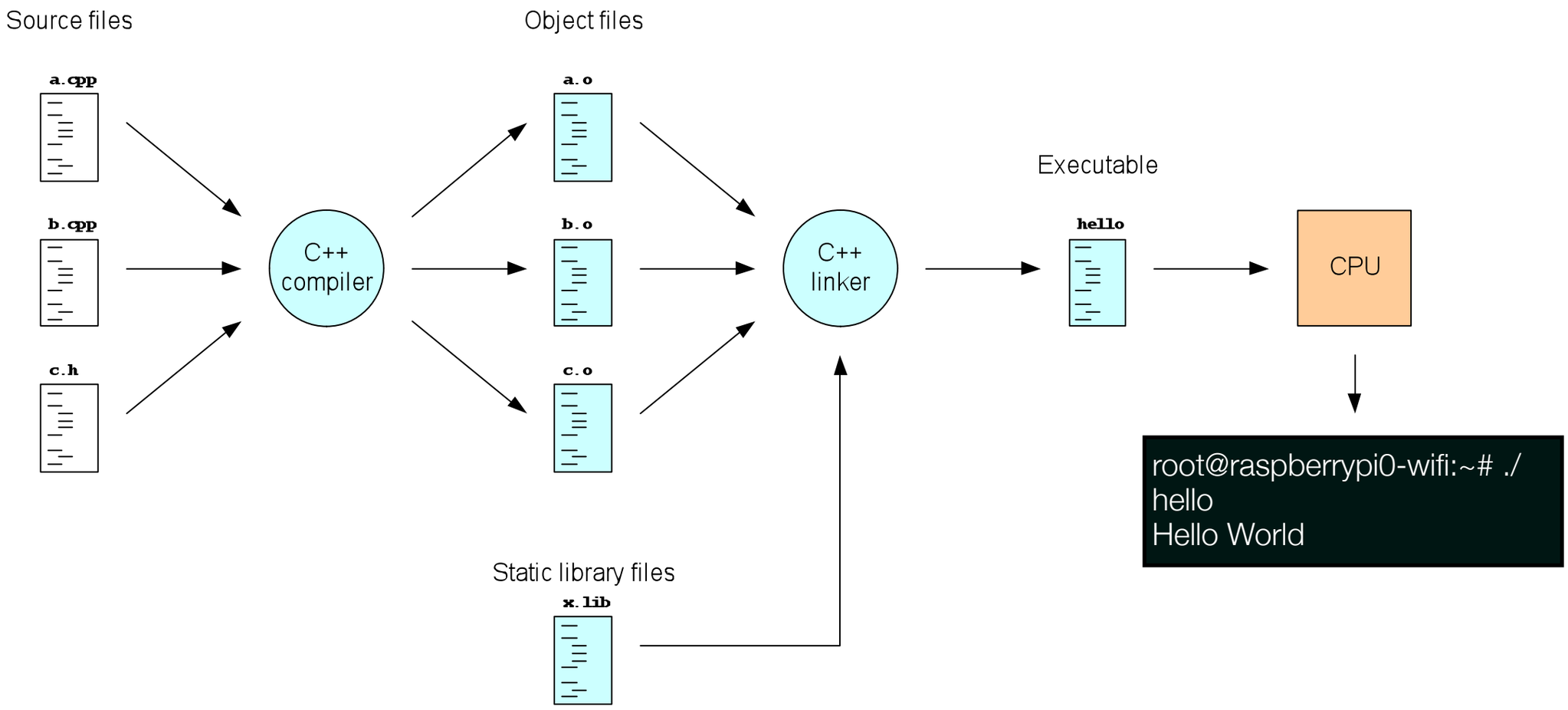
SW development for embedded targets - how to *make* it

- To make SW for an embedded target, you use *cross compilation*
  - You compile the program ***on*** the host, but ***for*** the target



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SW development for embedded targets - how to *make* it

- For the Raspberry Pi Zero Wifi (which is an ARM target) we use the Yocto (Poky) C/C++ compiler suite of tools

```
stud@ubuntu: ls /opt/poky/2.4.1/sysroot/….$
arm-poky-linux-gnueabi-addr2line  arm-poky-linux-gnueabi-gprof
arm-poky-linux-gnueabi-ar         arm-poky-linux-gnueabi-ld
arm-poky-linux-gnueabi-as         arm-poky-linux-gnueabi-nm
arm-poky-linux-gnueabi-c++        arm-poky-linux-gnueabi-objcopy
arm-poky-linux-gnueabi-c++filt    arm-poky-linux-gnueabi-objdump
arm-poky-linux-gnueabi-cpp        arm-poky-linux-gnueabi-ranlib
arm-poky-linux-gnueabi-g++        arm-poky-linux-gnueabi-readelf
arm-poky-linux-gnueabi-gcc        arm-poky-linux-gnueabi-size
arm-poky-linux-gnueabi-gcov       arm-poky-linux-gnueabi-strings
arm-poky-linux-gnueabi-gdb        arm-poky-linux-gnueabi-strip
arm-poky-linux-gnueabi-gdbtui
```

SW development for embedded targets - how to *make* it

- Unfortunately the correct invocation is
- ```
  arm-poky-linux-gnueabi-g++  -march=armv6 -mfpu=vfp -mfloat-abi=hard -
  mtune=arm1176jzf-s -mfpu=vfp —sysroot=$SDKTARGETSYSROOT ……
  ```
- To simply matters a simple alias has been made
  - For C

    ```
    arm-rpizw-gcc ……
    ```
  - For C++

    ```
    arm-rpizw-g++ ……
    ```
    ```

SW development for embedded targets - how to *make* it

- To invoke the compiler we specify the name of the compiler
  - For host:

```
stud@ubuntu:~$ g++ -o hello_host hello.cpp
stud@ubuntu:~$ file hello_host
hello_host: ELF 64-bit LSB shared object, x86-64, version 1 (SYSV), …
stud@ubuntu:~$ ./hello_host
Hello world!
stud@ubuntu:~$
```

  - For target:

```
stud@ubuntu:~$ arm-rpizw-g++ -o hello_tgt hello.cpp
stud@ubuntu:~$ file hello_tgt
hello_tgt: ELF 32-bit LSB executable, ARM, EABI5 version 1 (GNU/Linux), …
stud@ubuntu:~$ ./hello_tgt
bash: ./hello_tgt: cannot execute binary file
stud@ubuntu:~$
```

Native and cross compiler - Include (&lib) handling?

- How does a compiler know which include to use?

```
#include <iostream>

int main(int argc, char* argv[])
{
    std::cout << "Hello World" << std::endl;
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- **Can be discovered by g++ -v (or cross compiler edition -v)**
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*The **sysroot** path is thus responsible for ensuring that the compilers don't miks up files*

SW development for embedded targets - how to *make* it

- Testing embedded SW can be very difficult – ***why?***
  - Very few resources (CPU, memory, keyboard, monitor, …) for testing
- To the extent possible, you can use a simulated environment
  - If your target and host runs Linux, then it is *relatively* easy – compile and test on your host, then recompile for target
- Anything you need to think of in the simulated environment?
  - Time
  - Peripherial
  - Memory and CPU constraints
  - …
- So…what can you test?