

Cross Platform Development for Raspberry

Cross-development means developing and compiling programs on another platform than it intended to run upon. It is a common approach for Pi, since it's also how Raspbian is built. For quite some time I did compile Pi applications on the Pi itself. Which works quite well, but has one large drawback: performance. Being able to compile these programs on my 8 core 16GB desktop, improved compilation time enorm. And it is quite simple.

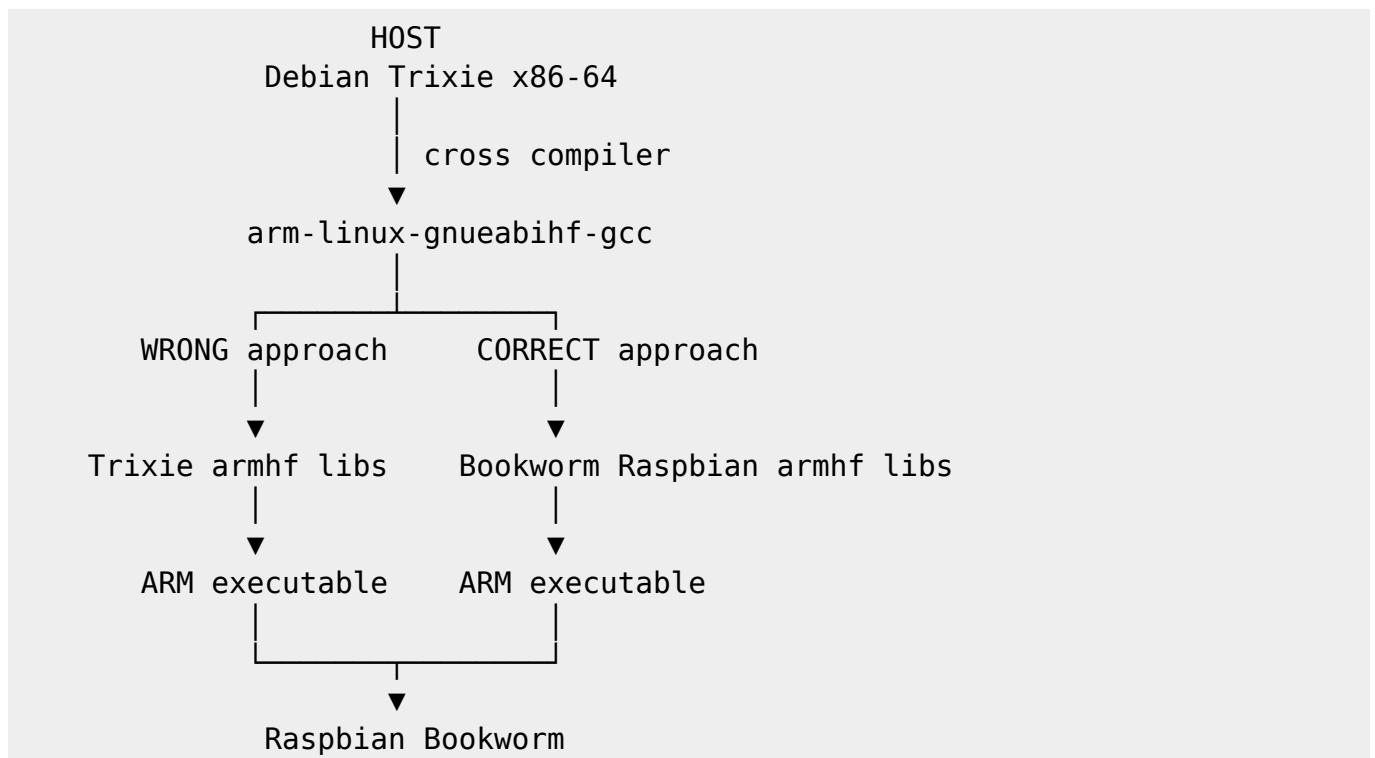
There are multiple approaches to setup a cross-compile environment. The most essential aspect is the following:

1. Exact **identical Linux/Debian versions** on X86 build host and Raspberry runtime target
 2. **Different Linux/Debian versions** on X86 build host and Raspberry runtime target
1. [Setup for Identical Debian versions](#)
 2. [Setup for Different Debian versions](#)

[crossbuild-essential-armhf](#)

The problem with different host and target ARM libraries

The important guideline is that **the target system's ABI, headers, libraries and library versions vs. what you build against**. For example:



Suppose your **x86 host is Debian Trixie**, and you install **libc6:armhf** from Trixie. Your compiler might then build against something like **glibc 2.41** while your Raspberry Pi's Raspbian Bookworm has **glibc 2.36**. Your executable may therefore acquire a dependency on a newer GLIBC symbol. For

example, conceptually:

```
program
└─ was linked against and requires GLIBC_2.41
    │
    ▼
    Raspbian Bookworm only has GLIBC_2.36
    │
    x
    program won't run, with errors like:
    ".../lib/arm-linux-gnueabihf/libc.so.6: version `GLIBC_2.41' not
    found..."
```

This is one of the most common reasons why **building on a newer distribution for an older target** causes trouble.

But the reverse is usually fine

Suppose:

```
Host:   Debian Trixie
Target: Raspbian Bookworm
```

and you use the **Raspbian Bookworm sysroot**.

Then:

```
Trixie GCC
    │
    ▼
Raspbian Bookworm headers
    +
Raspbian Bookworm libraries
    │
    ▼
Raspbian Bookworm executable
```

The host's distribution version becomes much less important. You are essentially saying:

“Use this compiler, but pretend the target filesystem is this Raspbian Bookworm system.”

That's exactly what `--sysroot` is for.

There's another subtle reason

It isn't only the **libraries** that matter. The headers matter too. Suppose you compile against Trixie's

headers:

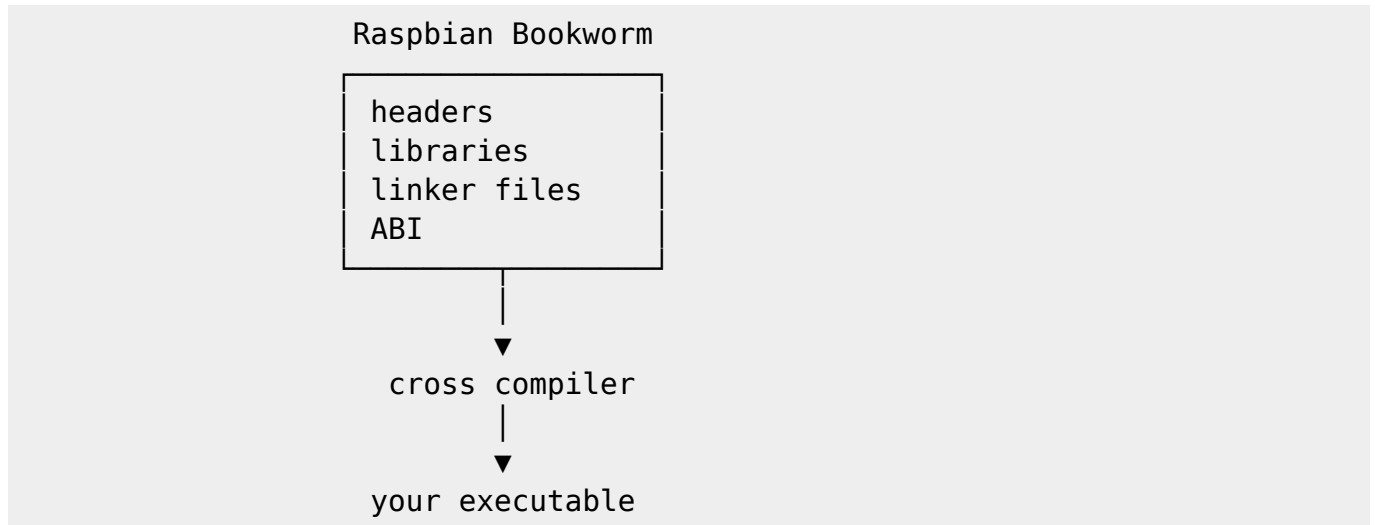
```
/usr/include
```

but run on Bookworm.

You can potentially get differences in:

* API definitions * feature macros * structure definitions * constants * kernel interfaces * glibc interfaces * library-specific APIs

So the ideal relationship is:



That's why a **target-specific sysroot** is the clean solution.

One important exception

If you deliberately want to require a newer target system, that's perfectly legitimate.

For example:

```
Build against Trixie armhf
      ↓
Deploy only to Trixie armhf
```

No problem.

The rule is simply:

Don't build against a newer userspace than the oldest target you intend to support.

This is particularly important for glibc.

This distinction matters:

Target = Debian armhf

```
Debian Bookworm x86-64
    ↓
Debian Bookworm armhf
```

Excellent fit for: crossbuild-essential-armhf

Target = Raspberry Pi OS 32-bit

```
Debian Bookworm x86-64
    ↓
Raspberry Pi OS armhf
```

You should ideally use the **actual Raspberry Pi OS sysroot/libraries**. This becomes particularly important if you're linking against anything beyond libc. you want the headers and libraries corresponding to the **actual target system**. Otherwise you can end up with:

```
compile successfully
    ↓
link successfully
    ↓
copy to Pi
    ↓
runtime/library incompatibility
```

Raspberry Pi OS vs Debian armhf

One important distinction: Raspberry Pi OS vs Debian armhf

There is, however, a **very important caveat** for Raspberry Pi.

If your target is **Raspberry Pi OS 32-bit**, don't blindly assume that Debian Bookworm's armhf libraries are an exact match.

Debian itself points this out:

Raspberry Pi OS armhf can be subtly incompatible with Debian armhf.

In particular, Raspberry Pi OS/Raspbian has historically had differences in its ARM ABI/build configuration. Debian recommends using a target-specific chroot when cross-compiling packages for Raspberry Pi OS armhf. ([Debian Wiki][2])

Links

- <https://developer.arm.com/downloads/-/arm-gnu-toolchain-downloads>
- https://www.acmesystems.it/arm9_toolchain
- <https://jensd.be/1126/linux/cross-compiling-for-arm-or-aarch64-on-debian-or-ubuntu>
- <https://learn.arm.com/install-guides/gcc/cross/>
- <https://packages.debian.org/search?keywords=crossbuild-essential>
- <https://www.get-edi.io/assets/pdfs/DebianCross.pdf>
- <https://prashanth.entertolearn.in/debian-arm-architecture-and-emulation/using-debian-arm-cross-compiler-for-bare-metal-programming>

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