Cross compiling with rust

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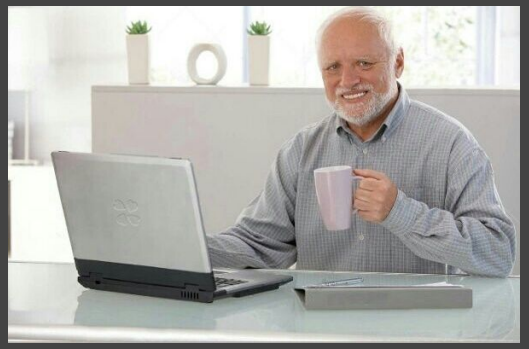
- Definitions
- Cross compiling ?
- Targets
- glibc vs musl
- The main machine
- The other machine
- Cross compiling with rust
- Examples

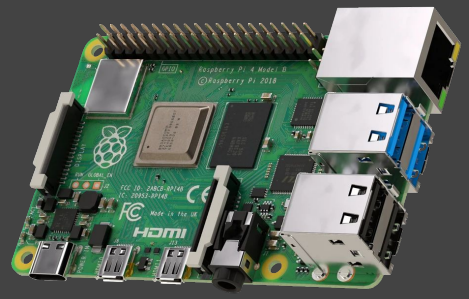
Everything in this talk will be a TLDR version.

Definitions

- **Host**: Your desktop or working environment.



- **Target:** Your embedded device or the machine that will run the code that does **not** uses the same **architecture**.



Definitions

- **Compiling**: Create binaries from the source code.

```
fn main() {
    println!("Hello, world!");
}
```

```
Contents of section .text.main:
 0000 4883ec18 8a050000 00004863 cf488d3d  H.........Hc.H.=
 0010 00000000 48897424 104889ce 488b5424  ....H.t$.H..H.T$
 0020 10884424 0fe80000 00004883 c418c3    ..D$......H....
Contents of section .rodata..L__unnamed_3:
 0000 48656c6c 6f2c2077 6f726c64 210a      Hello, world!.
Contents of section .data.rel.ro..L__unnamed_1:
 0000 00000000 00000000 0e000000 00000000  ................
Contents of section .debug_gdb_scripts:
 0000 01676462 5f6c6f61 645f7275 73745f70  .gdb_load_rust_p
 0010 72657474 795f7072 696e7465 72732e70  retty_printers.p
 0020 7900                                 y.
Contents of section .debug_str:
 0000 636c616e 67204c4c 564d2028 72757374  clang LLVM (rust
```

- Opcode: Operation code or human friendly representation of the CPU instruction.

```
Disassembly of section .interp:

00000000000002e0 <.interp>:
 2e0:   2f                      (bad)
 2e1:   6c                      insb   (%dx),%es:(%rdi)
 2e2:   69 62 36 34 2f 6c 64    imul   $0x646c2f34,0x36(%rdx),%esp
 2e9:   2d 6c 69 6e 75          sub    $0x756e696c,%eax
 2ee:   78 2d                   js     31d <_ZN3std9panicking18update
 2f0:   78 38                   js     32a <_ZN3std9panicking18update
 2f2:   36 2d 36 34 2e 73       ss sub $0x732e3436,%eax
 2f8:   6f                      outsl  %ds:(%rsi),(%dx)
 2f9:   2e 32 00                xor    %cs:(%rax),%al
```

```
Disassembly of section .text:

00010100 <elf_try_debugfile>:
   10100:   e92d 4ff0   stmdb   sp!, {r4, r5, r6, r7, r
   10104:   b08b        sub sp, #44 ; 0x2c
   10106:   4c29        ldr r4, [pc, #164]  ; (101ac <e
   10108:   4680        mov r8, r0
   1010a:   4617        mov r7, r2
   1010c:   4828        ldr r0, [pc, #160]  ; (101b0 <e
   1010e:   9a15        ldr r2, [sp, #84]   ; 0x54
   10110:   447c        add r4, pc
   10112:   9106        str r1, [sp, #24]
   10114:   9307        str r3, [sp, #28]
   10116:   4623        mov r3, r4
   10118:   9204        str r2, [sp, #16]
   1011a:   5822        ldr r2, [r4, r0]
   1011c:   9b14        ldr r3, [sp, #80]   ; 0x50
   1011e:   9804        ldr r0, [sp, #16]
   10120:   18fb        adds    r3, r7, r3
   10122:   9303        str r3, [sp, #12]
```

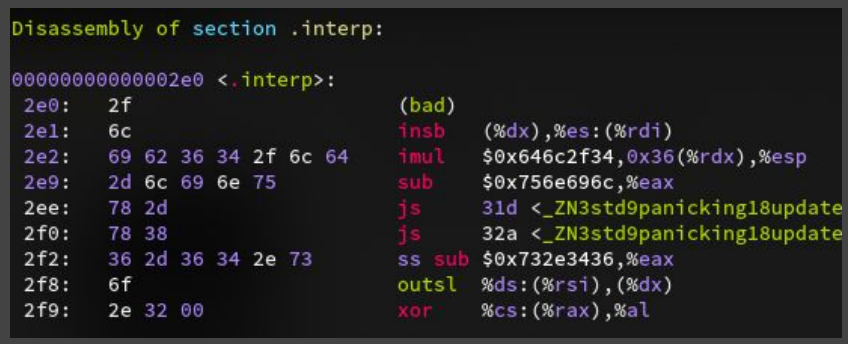
- **objdump**: Display information from object files.

- **strings**: Search printable characters from object files.

- Cross compiling ?

x86_64

GCC



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```
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x86_64

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GCC

ARMv7

```
fn main() {
    println!("Hello, world!");
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```

ARM-GCC

```
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   10100:   e92d 4ff0   stmdb   sp!, {r4, r5, r6, r7, r
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Cross compiling ?

- Why can’t you compile in your target computer ?


```
# AMD Ryzen 7 2700 Eight-Core Processor
# 16 threads, 16GB Ram

cargo build
Finished dev [unoptimized + debuginfo] target(s) in  1m 48s


# ARMv7 Processor rev 4 (v7l)
# 4 threads, 1GB Ram
Finished dev [unoptimized + debuginfo] target(s) in  33m 56s
```

- Targets
  - List of available targets

rustup target list

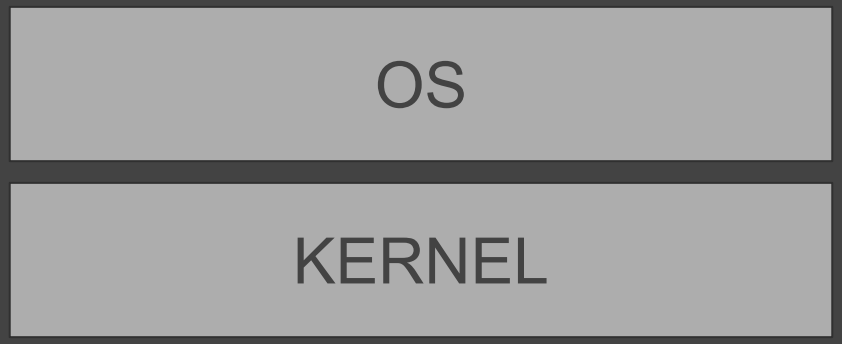
!! | wc -l # 81

glibc vs musl

- Both are low-level libraries

glibc vs musl

- Both are low-level libraries



glibc vs musl

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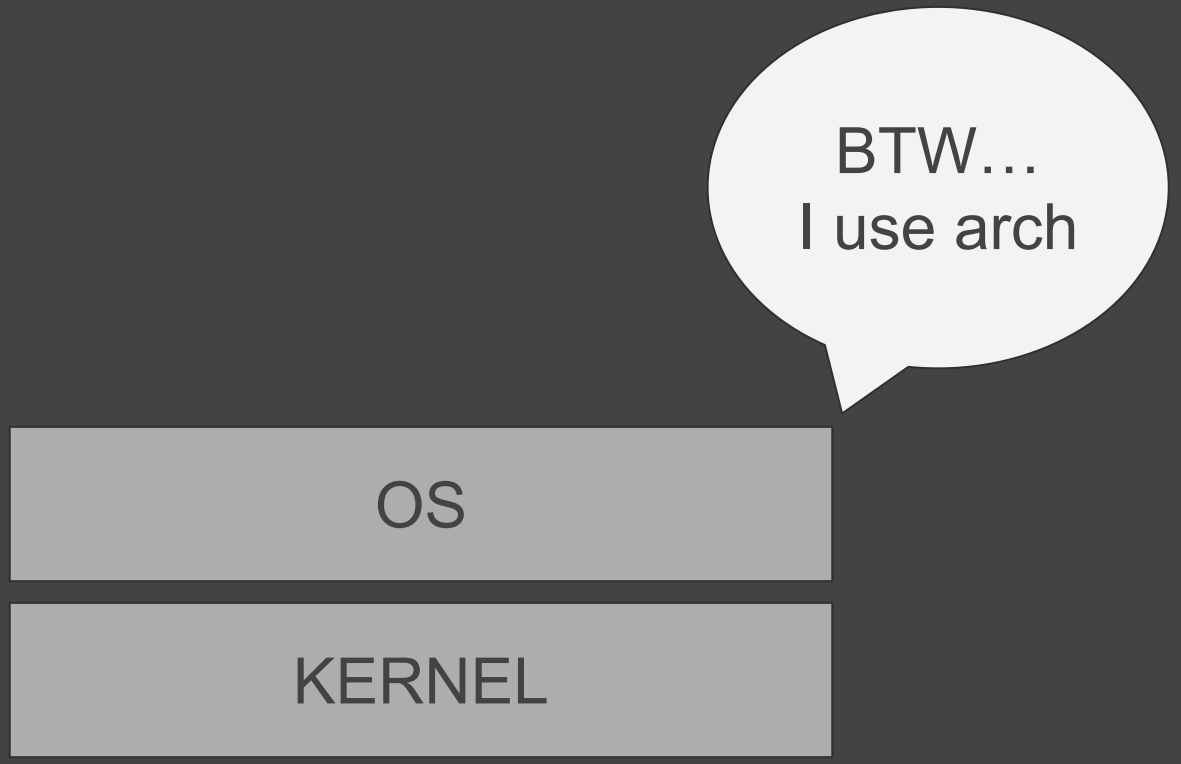

glibc vs musl

- Both are low-level libraries

glibc vs musl

- Both are low-level libraries

glibc vs musl

- Both are low-level libraries

- glibc is backward compatible but not forward compatible
  - If you compile with glibc2 it'll run in a system with glibc6
  - If you compile with glibc6 it'll **not** run in a system with glib2
  - Linux Appimages should be compatible with the standard deployment OS [CentOS 6 (2011)]

glibc vs musl

- Both are low-level libraries

- glibc is backward compatible but not forward compatible
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  - If you compile with glibc6 it'll **not** run in a system with glib2
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- musl is a new standard library
- It's backward and forward compatible
- There is more advantages that you can check here:
  - https://www.musl-libc.org/

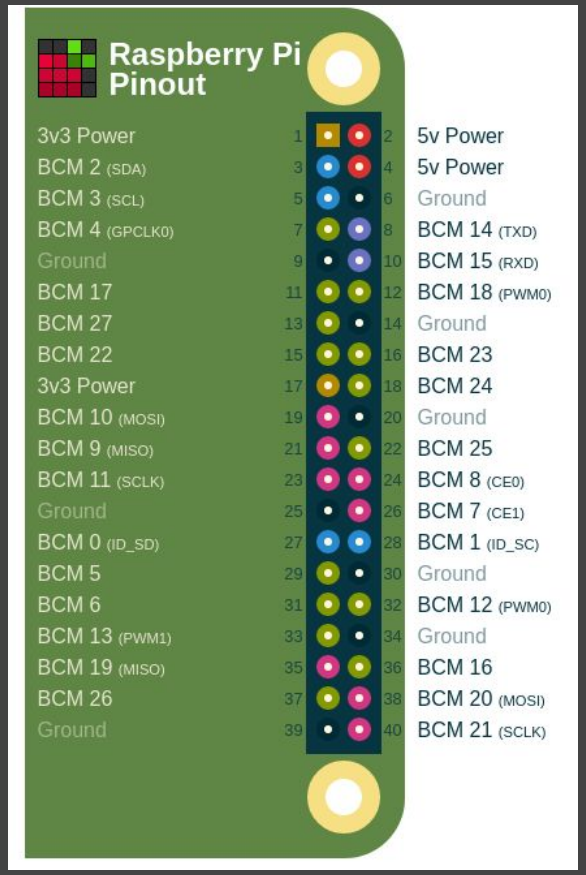
- The main machine

macbook pro 2017

The other machine

- Raspberry Pi 3B

```
✘ alarm@alarmpi ~ uname -m
armv7l
```



Cross compiling with rust

1. Install rust!
   a. https://rustup.rs/
2. Create a new project
   a. cargo new cross
3. Build the project locally
   a. cargo build
4. Run it!
   a. cargo run

HOST MACHINE

Cross compiling with rust

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   a. cargo new cross
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HOST MACHINE

Note: linker not found = no compiler in your machine
Try to install GCC

Cross compiling with rust

1. Install rust-std for our target
   a. rustup target add armv7-unknown-linux-gnueabihf
2. Build the project locally
   a. cargo build --target armv7-unknown-linux-gnueabihf

TARGET MACHINE

• Cross compiling with rust

1. Install rust-std for our target
   a. rustup target add armv7-unknown-linux-gnueabihf
2. Build the project locally
   a. cargo build --target armv7-unknown-linux-gnueabihf

TARGET MACHINE

```
error: linking with `cc` failed: exit code: 1
```

Cross compiling with rust

1. Install rust-std for our target
   a. rustup target add armv7-unknown-linux-gnueabihf
2. Build the project locally
   a. cargo build --target armv7-unknown-linux-gnueabihf
3. Download the compiler
   a. https://www.linaro.org/downloads/-arm-linux-gnueabihf[bin]
4. Make it visible
   a. export PATH=$PATH:BIN_FOLDER
5. Edit cargo configuration file
   a. $EDITOR ~/.cargo/config
      [target.armv7-unknown-linux-gnueabihf]
      linker = "arm-linux-gnueabihf-gcc"
6. Build it 🎶 *one more time* 🎶
   a. cargo build --target armv7-unknown-linux-gnueabihf

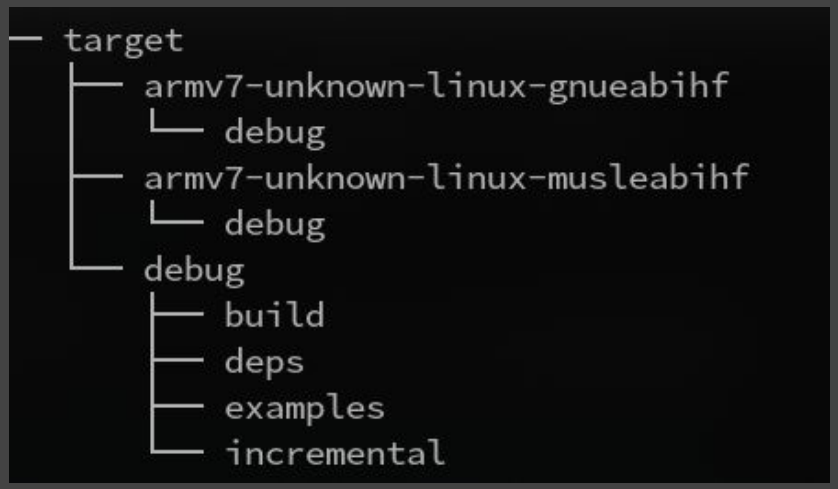
TARGET MACHINE

Cross compiling with rust

1. Install rust-std for our target
   a. rustup target add armv7-unknown-linux-**musleabihf**
2. Download the compiler
   a. https://musl.cc/ - armv7l-linux-musleabihf-cross.tgz
3. Make it visible
   a. export PATH=$PATH:BIN_FOLDER
4. Edit cargo configuration file
   a. $EDITOR ~/.cargo/config
      [target.armv7-unknown-linux-**musleabihf**]
      linker = "armv7l-linux-**musleabihf**-gcc"
5. Build the project locally
   a. cargo build --target armv7-unknown-linux-**musleabihf**

TARGET MACHINE

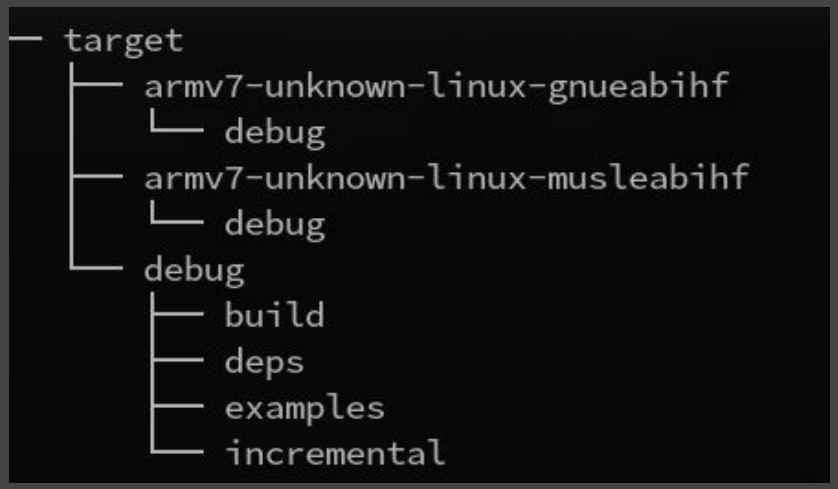
Cross compiling with rust



1. cargo build
   a. file executable:
      i. cross: **ELF 64-bit LSB** pie executable, **x86-64**, version 1 (SYSV), dynamically linked, interpreter…
   b. ldd executable:

```
linux-vdso.so.1 (0x00007ffca0df7000)
libdl.so.2 => /usr/lib/libdl.so.2 (0x00007fe61751b000)
libpthread.so.0 => /usr/lib/libpthread.so.0 (0x00007fe6174f9000)
libgcc_s.so.1 => /usr/lib/libgcc_s.so.1 (0x00007fe6174df000)
libc.so.6 => /usr/lib/libc.so.6 (0x00007fe617318000)
/lib64/ld-linux-x86-64.so.2 => /usr/lib64/ld-linux-x86-64.so.2
(0x00007fe61755d000)
```

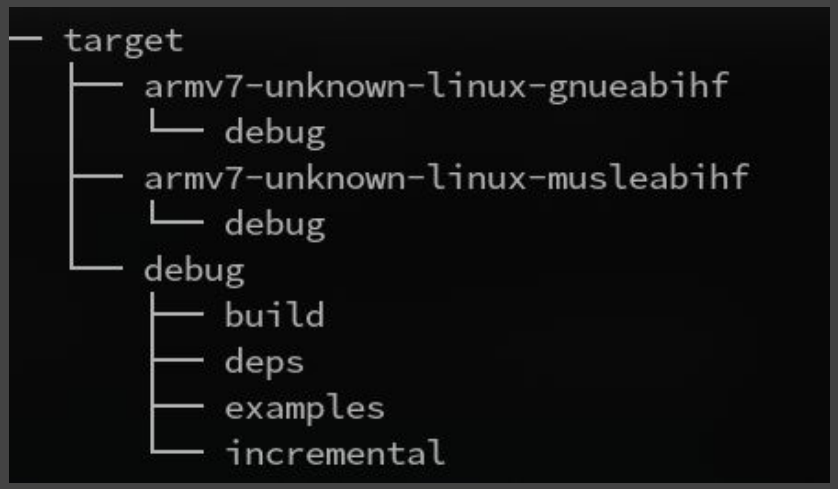
Cross compiling with rust



1. cargo build --target armv7-unknown-linux-gnueabihf
   a. file executable:
      i. cross: **ELF 32-bit LSB** pie executable, **ARM, EABI5** version 1 (SYSV), **dynamically linked**, interpreter ...
   b. ldd executable:

```
linux-vdso.so.1 (0x7eff8000)
libc.so.6 => Not found
/lib/ld-linux-armhf.so.3 => /usr/lib/ld-linux-armhf.so.3 (0x76f49000)
libdl.so.2 => /usr/lib/libdl.so.2 (0x76a66000)
libpthread.so.0 => /usr/lib/libpthread.so.0 (0x76a3c000)
libgcc_s.so.1 => /usr/lib/libgcc_s.so.1 (0x76a0f000)
libm.so.6 => Not found
```

Cross compiling with rust



1. cargo build --target armv7-unknown-linux-gnueabihf
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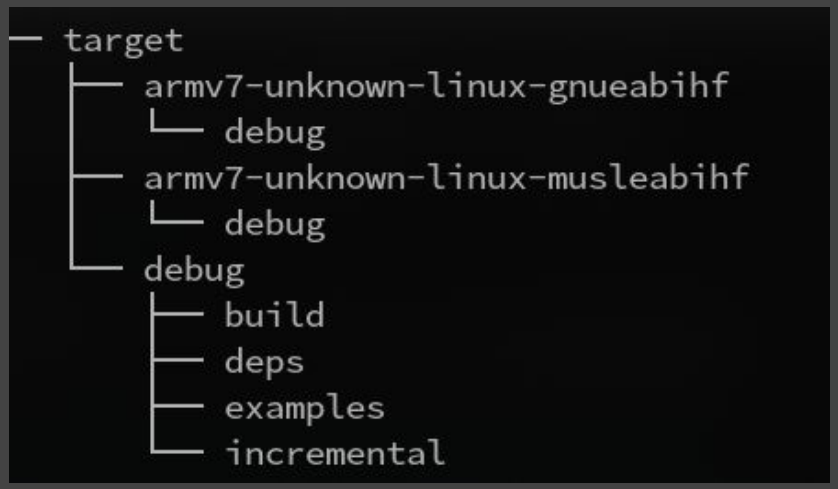
   b. ldd executable:

```
linux-vdso.so.1 (0x7eff8000)
libc.so.6 => /usr/lib/libc.so.6 (0x76a79000)
/lib/ld-linux-armhf.so.3 => /usr/lib/ld-linux-armhf.so.3 (0x76f49000)
libdl.so.2 => /usr/lib/libdl.so.2 (0x76a66000)
libpthread.so.0 => /usr/lib/libpthread.so.0 (0x76a3c000)
libgcc_s.so.1 => /usr/lib/libgcc_s.so.1 (0x76a0f000)
libm.so.6 => /usr/lib/libm.so.6 (0x769a1000)
```

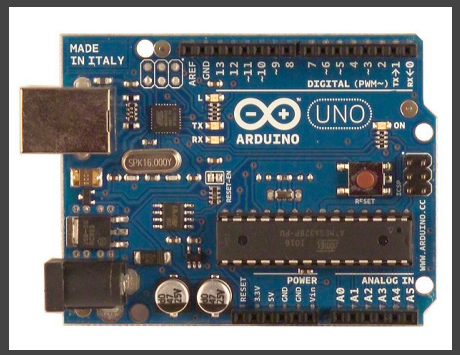
Cross compiling with rust



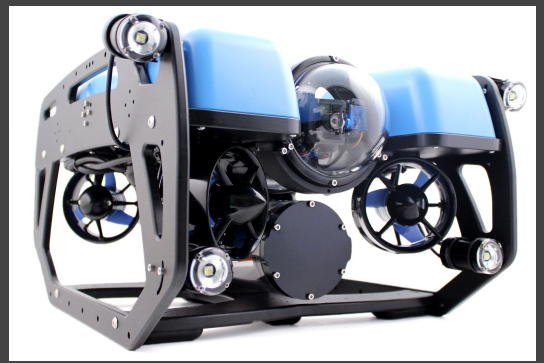
1. cargo build --target armv7-unknown-linux-**musleabihf**
   a. file executable:
      i. cross: **ELF 32-bit LSB** executable, **ARM, EABI5** version 1 (SYSV), **statically linked**, with ...
   b. ldd executable:
      not a dynamic executable

Examples

1. https://github.com/patrickelectric/bridges
   a. A bidirectional Serial-UDP bridge!



2. https://github.com/patrickelectric/mavlink2rest
   a. REST server that provides mavlink information from a mavlink source



- Demo

@patrickelectric

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https://patrickelectric.work

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