# Cross Compiling For Perl Hackers

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# Motivation

## Clarify some use-cases

- Cross-Compiling
- Cross-Building
- Canadian Cross
- Foreign builds

## Sensibilize beyond developer environments

- How can I enable other people using my code?
- What else beside specs, tests and documentation can be provided?
- Why should I care?

# Cross Compiler

- Compiles source into binary objects for another platform than the current host
- Platform? What is such a platform?
- A platform is defined by
  - Architecture
  - Vendor
  - Operating System / ABI
    - i486-pc-linux-gnu
    - x86_64-apple-darwin64
    - arm926ejse-poky-linux-gnueabi
    - cortexa9hf-vfp-neon-mx6qdl-poky-linux-gnueabi
    - sparcv9-sun-solaris

# API vs. ABI

## size_t-size.c

```
#include <stdio.h>
#include <stdlib.h>

int main(int argc, char *argv[]) {
    printf("%zd\n", sizeof(size_t));
    return 0;
}
```

## 32-bit mode size_t-size

```
$ cc -O -m32 -o size_t-size size_t-size.c
$ ./size_t-size
4
```

## 64-bit mode size_t-size

```
$ cc -O -m64 -o size_t-size size_t-size.c
$ ./size_t-size
8
```

# API

- abbreviation for "Application Programming Interface"
- defines compatibility on source level

## snprintf declaration

```
#include <stdio.h>
int snprintf(char * restrict str,
             size_t size,
             const char * restrict format,
             ...);
```

- every STD C conforming C program can call snprintf

## snprintf invocation

```
#include <stdio.h>
int main(int argc, char *argv[]) {
    char buf[_PATH_MAX];
    snprintf(buf, sizeof buf, "%s", argv[0]);
    return 0;
}
```

# ABI

- abbreviation for "Application Binary Interface"
- defines compatibility on compiled code level

## snprintf declaration

```
#include <stdio.h>
int snprintf(char * restrict str,
             size_t size,
             const char * restrict format,
             ...);
```

- sizes of pointers depend on memory model (segmented, flat, address width, ...)
- size of buffer size depends just on a subset of the memory model: the address width

# ABI influencers

- CPU register sizes
- alignment
- packing of enums/structs
- memory model (flat vs. segmented, address width, . . . )
- calling convention (stack vs. register based, order of arguments, how many registers, . . . )
- byte order

# Cross Compiling "Hello world"

What does such a compiler do?
Compiles source.

## hello.c

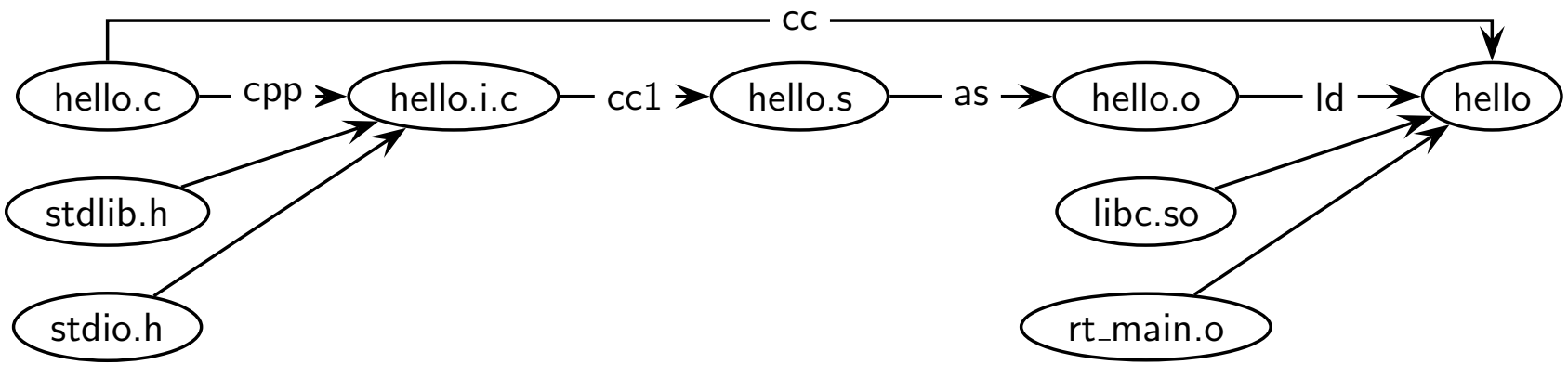
```
#include <stdio.h>
#include <stdlib.h>

int main(int argc, char *argv[]) {
    printf("Hello world\n");
    return 0;
}
```

# Cross Compiling II

## compiler invocation

```
$ ${CC} -o hello hello.c
```



# Cross Development Kit

## What is this . . . you're talking about?

| | |
|---|---|
| cpp | C PreProcessor |
| cc1 | C Compiler |
| as | Assembler |
| ld | Linker |

# Cross Development Kit Location

## Which stdlib.h,... is used

```
# locate stdlib.h
...
/foo-bsp/w/tmp/sysroots/arm926ejse-poky-linux-gnueabi/usr/include/stdlib.h
/foo-bsp/w/tmp/sysroots/cortexa9hf-vfp-neon-poky-li.../usr/include/stdlib.h
...
/opt/SolarisStudio12.3-linux-x86-bin/solstudio12.3/prod/include/cc/stdlib.h
...
/usr/include/stdio.h
```

Similar picture for stdio.h, stdint.h, libc.so, rt_main.o, ...

# Convinced

## Where can I download it?

Which one?

# Build Yourself a Cross-SDK

## Use the source, Luke

There're several ways:

- the hard way: do it yourself as described at
  Building Cross Toolchains with gcc or
  Build a GCC-based cross compiler for Linux
- Toolchain build helper like crosstool-NG or Scratchbox
- Full flavoured - Yocto or T2 SDE

# Vendor Cross-SDK

## Typical cases

- Bare Metal SDK
- Accelerator Libraries (typically not Open-Source)
- Early Adopter
- Enterprise Support

# And now

## Which way I ought to go from here?

That depends . . . on where you want to get to.

## Topic was . . .

Cross compiling for Perl Hackers
we didn't define an audience, reasonable possibilities are

- Perl Porters
- Perl Module Maintainers

Perl Porters probably have to care for more than Perl Module Maintainers . . .

# Build here, run there

## Host vs. Target

- Which 'cc' to use to compile bootstrap tools (as miniperl)?
  mind HOSTCC vs. CC
- ...and which *stdlib.h*/*libc.so*?
  modern toolchains know `--sysroot` argument - prior lot's on replacements in `-I...` and `-L...` were required
- pick right CFLAGS, BUILD_CFLAGS, HOST_CFLAGS or TARGET_CFLAGS for the right job, likewise for LDFLAGS, CCLDFLAGS, LDDLFLAGS, CXXFLAGS and whatever additional tool is used
- do not mix build and target configuration
- do not run target artifacts locally

# Build here, run there II

## Build vs. Run

- during build, several development kits are involved (at least host and target, sometimes host, build and multiple targets)
- PATHs vary, eg. `-L/foo-bsp/w/tmp/sysroots/arm926ejse-poky-linux-gnueabi/usr/lib` vs. `-Wl,-R/usr/lib`

# Build here, run there III

mind those differences when invoking wrapper-scripts

## Build vs. Run

```
rakudo-star % make install
# This is a post-compile task, unfortunately placed into install stage
./perl6-j tools/build/install-core-dist.pl /foo-bsp/w/tmp/work/...
    cortexa9hf-vfp-neon-poky-linux-gnueabi/rakudo-star/2016.01-r0/...
    image/usr/share/nqp
Error: Could not find or load main class perl6
```

## perl6-j

```
#!/bin/sh
: ${NQP_DIR:="/usr/share/nqp"}
: ${NQP_JARS:="${NQP_DIR}/runtime/asm-4.1.jar:${NQP_DIR}/runtime/asm-tree-4.1.jar:\
              ${NQP_DIR}/runtime/jline-1.0.jar:${NQP_DIR}/runtime/jna.jar:\
              ${NQP_DIR}/runtime/nqp-runtime.jar:${NQP_DIR}/lib/nqp.jar"}
: ${PERL6_DIR:="/usr/share/perl6"}
: ${PERL6_JARS:="${NQP_JARS}:${PERL6_DIR}/runtime/rakudo-runtime.jar:${PERL6_DIR}/runtime/perl6.jar"}
exec java -noverify -Xms100m -Xbootclasspath/a:${NQP_JARS}:${PERL6_DIR}/runtime/rakudo-runtime.jar:\
        ${PERL6_DIR}/runtime/perl6.jar -cp $CLASSPATH:${PERL6_DIR}/runtime:${PERL6_DIR}/lib:\
        ${NQP_DIR}/lib -Dperl6.prefix=/usr -Djna.library.path=/usr/share/perl6/site/lib \
        -Dperl6.execname="$0" perl6 "$@"
```

# Build here, run there IV

## Build vs. Run

- guess why running that script from `/foo-bsp/w/tmp/work/cortexa9hf-vfp-neon-poky-linux-gnueabi/...rakudo-star/2016.01-r0/rakudo-star-2016.01/` fails ...
- remember `sdkroot` (build libraries, can be executed in build evironment) and `sysroot` (target runtime chroot, used for linking etc.)
- all path's in `sysroot` are as if the files were already on `target`

# Configure Stage

## Prerequisites ...

- nowadays Perl Toolchain doesn't support cross compile dependcy checks
- neither external resources (mind wrapper modules as RRDTool::OO), so configure stage has to prove on it's own (compile and link test in *Makefile.PL*)
- `x_prereqs` was an idea but never completed
- workaround in Yocto for module prerequisites: DEPENDS (configure stage) contain host packages, RDEPENDS (install stage) contain target packages
  - ☞ it's slightly more complicated for external libraries when *Makefile.PL* doesn't know about cross compiling

# Conclusion

- stay as close as possible to existing standards - reinventing the wheel will almost always fail
- use ExtUtils::MakeMaker for building
- use Config::AutoConf when it is really necessary to have configure time checks (as which API is supported by wrapped library)
- prefer pkgconf (or pkg-config) over compile and link testing
- always allow every check being overwritten by environment variables

# Resources

## Cross Compile Perl

[P5P] Remodeling the cross-compilation model
http://grokbase.com/t/perl/perl5-porters/141gz52519/remo

## Cross Compile Guides

Building Cross Toolchains with gcc
https://gcc.gnu.org/wiki/Building_Cross_Toolchains_with_

Build a GCC-based cross compiler for Linux
https://www6.software.ibm.com/developerworks/education/l

# Resources

## Cross Compile Helper

crosstool-NG http://crosstool-ng.org/

Scratchbox http://www.scratchbox.org/

## Cross Compile Distribution Builder

Yocto http://yoctoproject.org/

T2 SDE http://t2-project.org/

# Thank You For Listening

## Questions?

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