Rethinking the core OS in 2015

Are alternatives to gcc, libstdc++ and glibc viable yet?

Presented by

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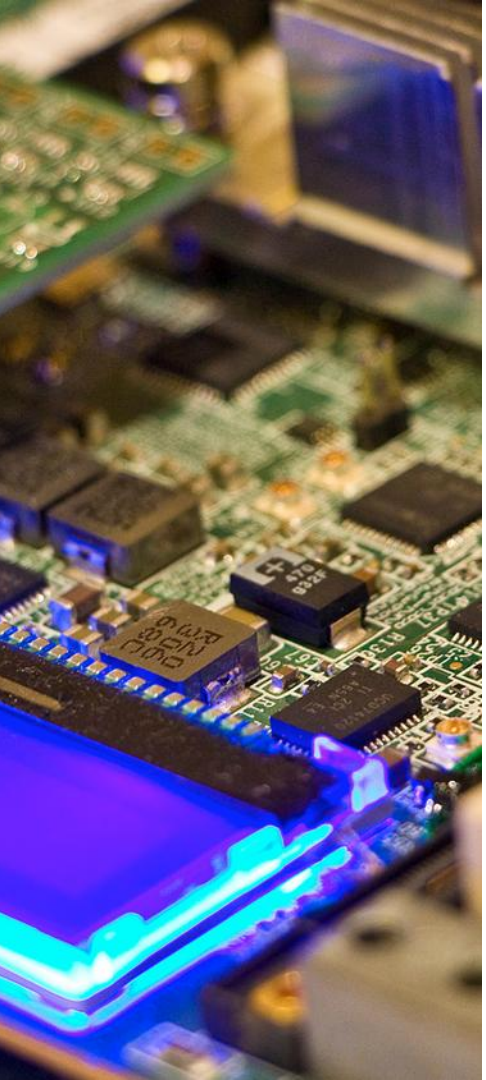
Date

Linux Plumbers Conference 2015



The traditional approach

Building a Linux system traditionally meant starting with building a core consisting of binutils, gcc and glibc (sometimes uClibc).

This is still a very viable approach, but now there are other options...

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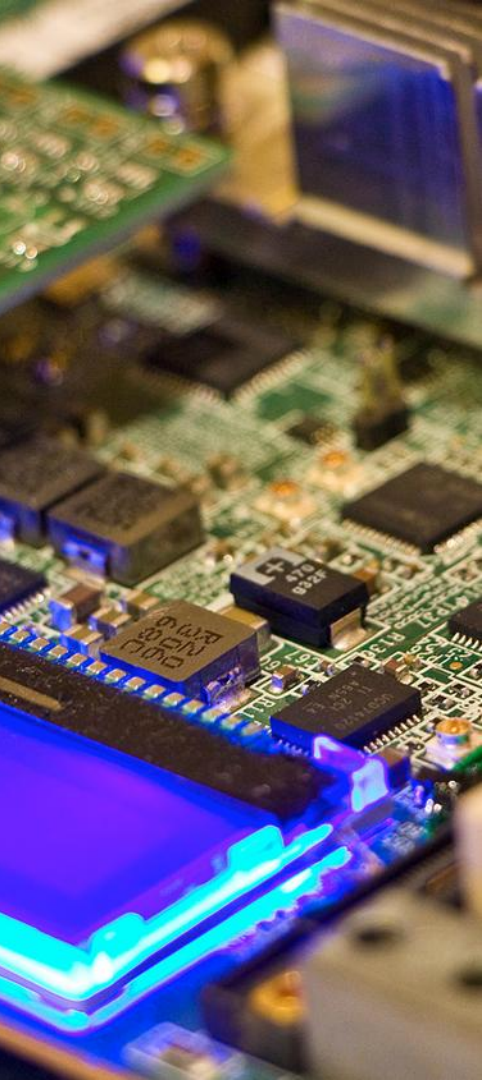

Binutils

Parts of binutils are still needed - in particular, a linker. (The traditional BFD ld can be replaced with gold, also part of binutils).

lld and mclinker are making some progress, but not quite there yet.

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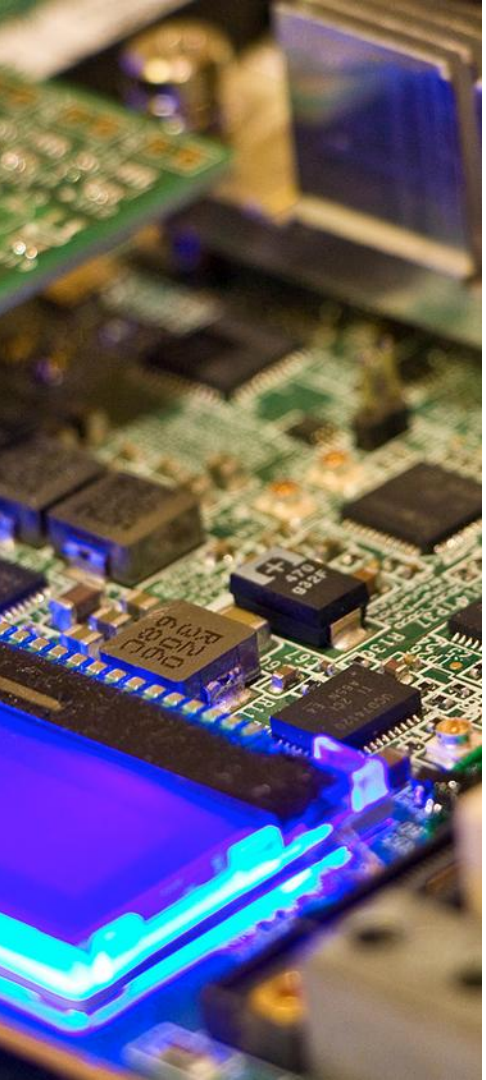

Binutils

gas is frequently needed because clang's integrated as doesn't support legacy constructs in common use (e. g. pre-unified syntax on ARM)

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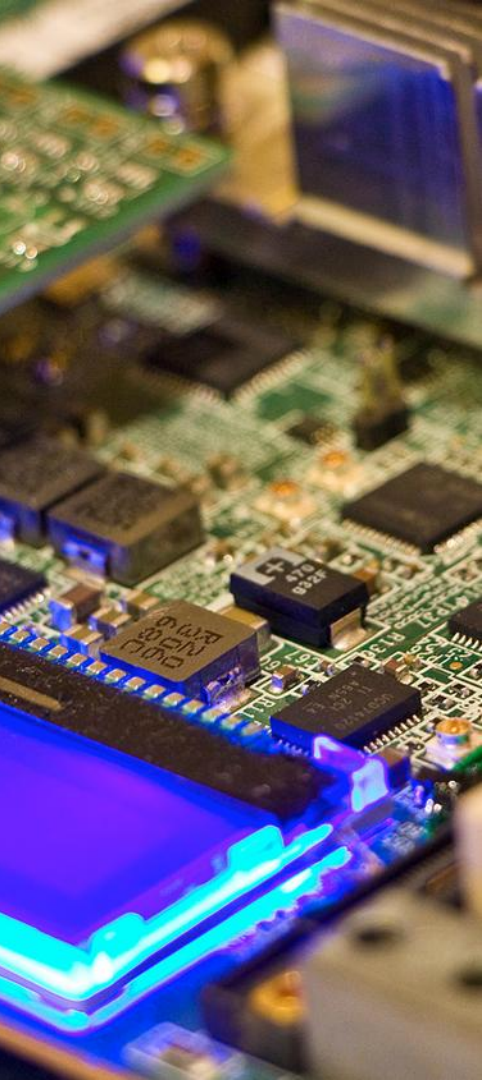

Binutils

Tools like nm need to get more complex: They should now deal with 3 types of input:

- regular object files
- LLVM bytecode (clang -flto)
- gcc interim code (gcc -flto)

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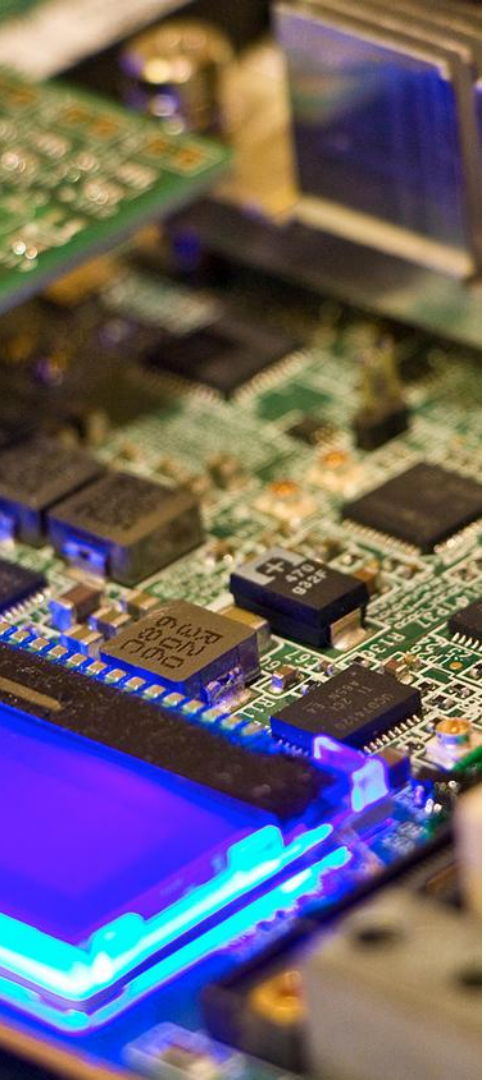

```
#!/bin/sh
REAL_NM=binutils-nm
PARENT="`readlink /proc/$PPID/exe`"
WRAPPED=false
# If /proc isn't mounted, let's do the least evil thing we can
if [ -z "$PARENT" ]; then
    WRAPPED=true
elif echo $PARENT |grep -qE -- '-nm$'; then
    # If we're being called by gcc-nm or llvm-nm, we're already
    # wrapped (and need to make sure we don't call ourselves recursively)
    WRAPPED=true
elif echo $PARENT |grep -qE -- 'qemu'; then
    # Fun... We're running inside qemu binfmt_misc emulation,
    # so we have to determine our parent the evil and less
    # reliable way...
    if grep -qP -- '-nm\x00' /proc/$PPID/cmdline; then
        WRAPPED=true
    fi
fi
```

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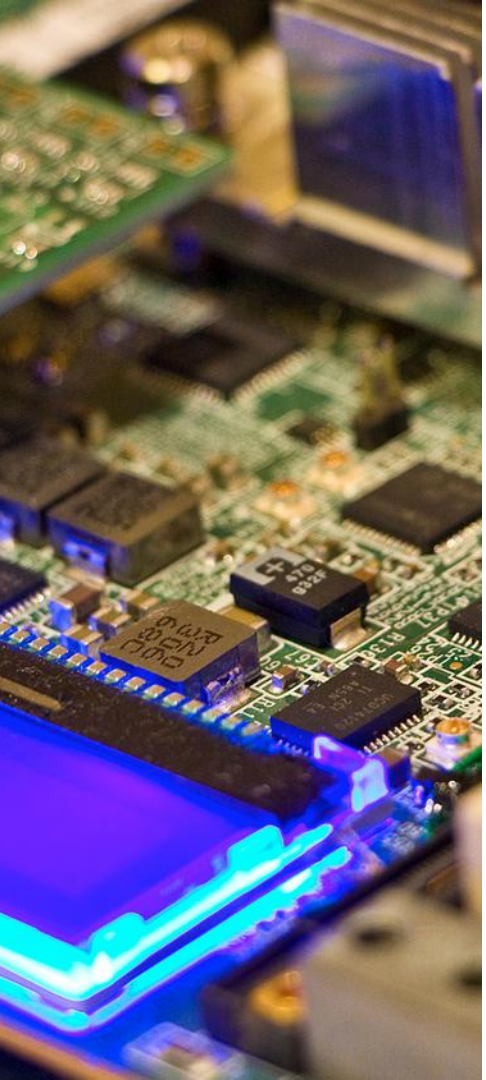

```
# If we're being called by gcc-nm or llvm-nm, we're
# already wrapped...
if ! $WRAPPED; then
    for i in "$@"; do
        [ "`echo $i |cut -b1`" = "-" ] && continue
        if echo $i |grep -qE '\.(o|a)$' && [ -e $i ]; then
            if LANG=C gcc-nm $i 2>&1 |grep -q "File format not recognized";
then
                which llvm-nm &>/dev/null && REAL_NM=llvm-nm
                break
            fi
        fi
    done
    if [ "$REAL_NM" = "binutils-nm" ] && which gcc-nm &>/dev/null; then
        REAL_NM=gcc-nm
    fi
fi
exec $REAL_NM "$@"
```

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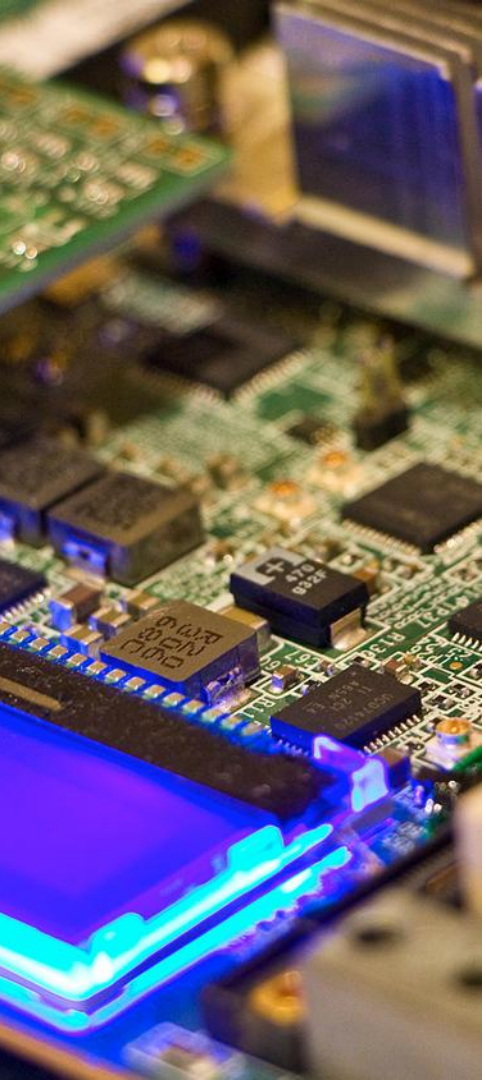

gcc

gcc can, for the most part, be replaced with clang these days.

OpenMandriva switched to clang as its primary compiler last year. OpenMandriva 3 (soon to be released) is almost fully built with clang 3.7.

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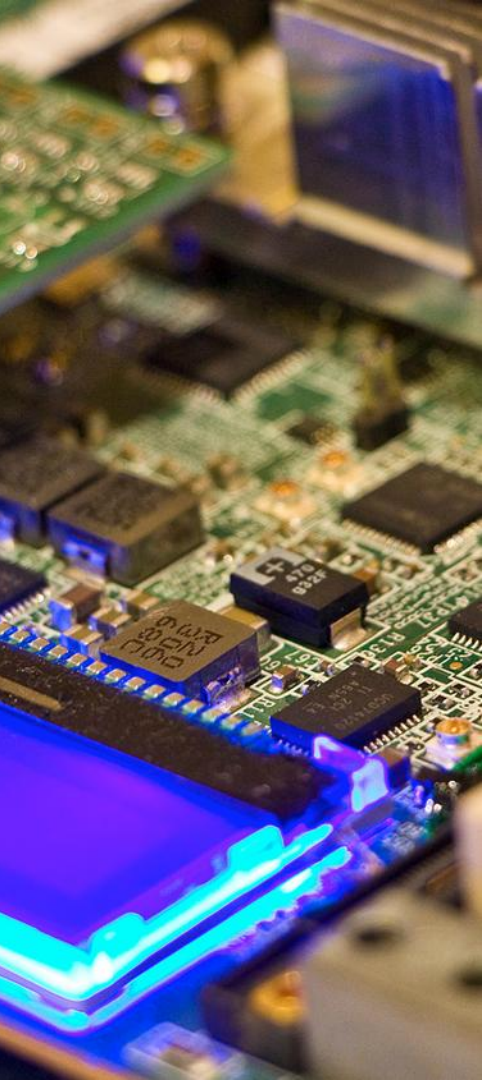

gcc

The transition was unproblematic, most packages that failed failed due to bad code or use of nonstandard gcc extensions.

We force some packages to build with CC=gcc CXX=g++.

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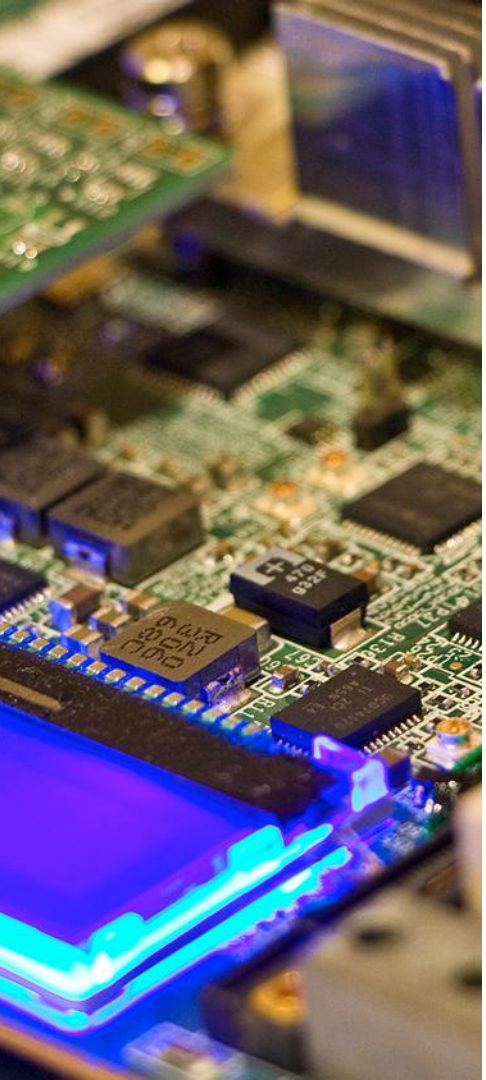

gcc

We still need to build gcc even if we don’t want to use it as a compiler though: We need libgcc, libgcc_s, libatomic and friends (and potentially libstdc++)

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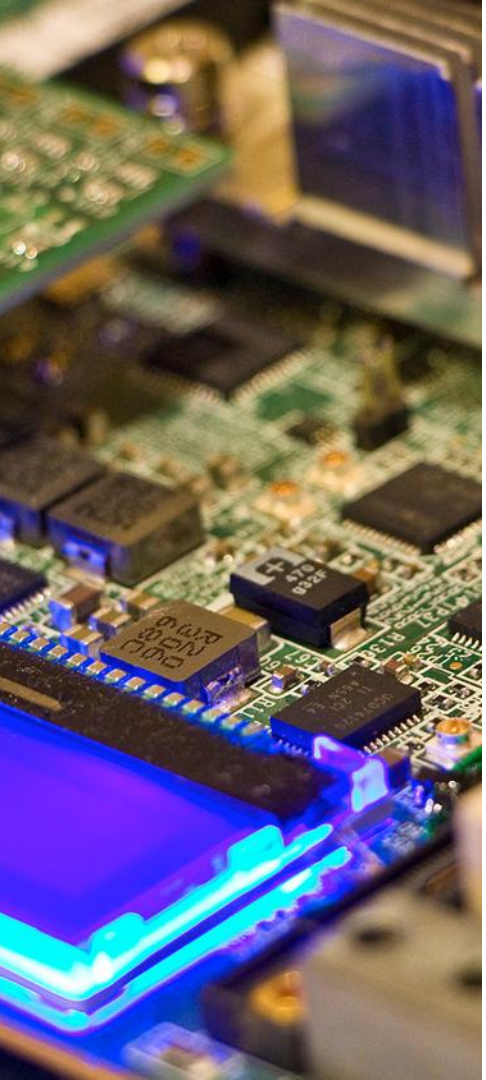

gcc

clang's __GNUC__ macro definitions are too conservative, claiming to be gcc 4.2.1, causing code that checks __GNUC__ to leave out optimizations.

Patching it to say 4.9 produces better code. (real fix is to check for features instead of compiler versions)

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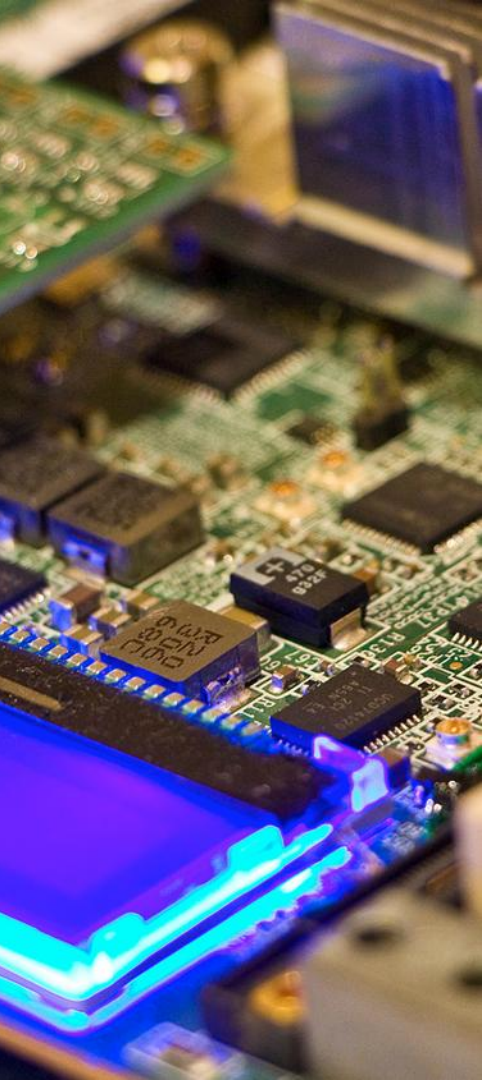

Things to avoid for compatibility

- Nested functions
- Variable length arrays in structs
- Variable length arrays of non-POD types
- Empty structs
- Array subscripts of type “char” (`value['0']=0;`)
- Reserved words (“_Nullable” defined by both clang and Qt)

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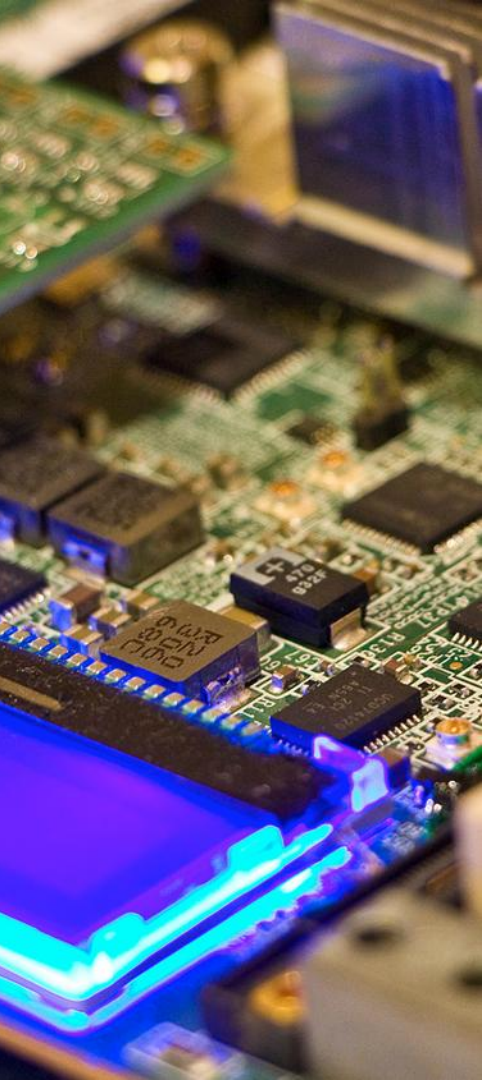

Things to avoid for compatibility

- Undefined internal functions and variables -- even if they aren't used:

```
static void a();
void b() {
    if (0)
        a();
}
```

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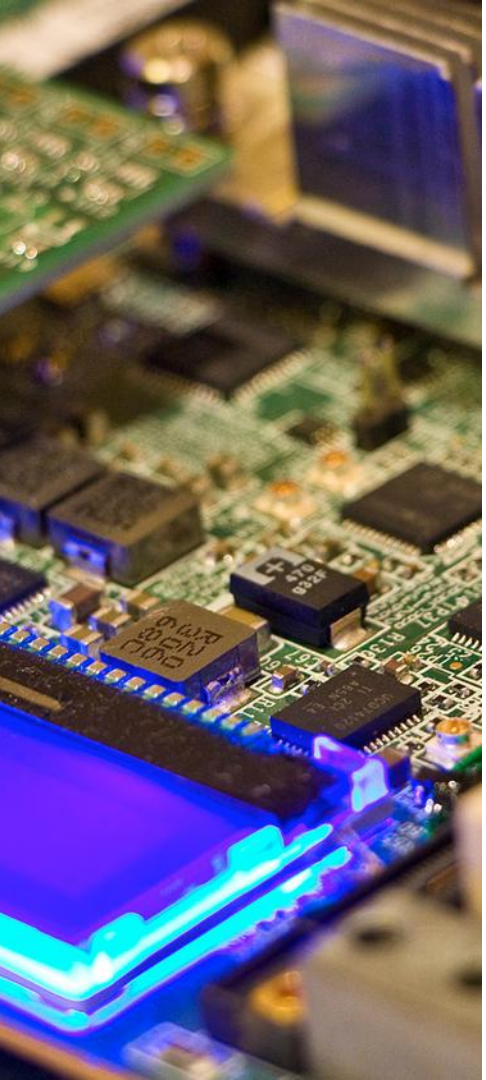

Things to avoid for compatibility

- gcc 5.x's changed libstdc++ ABI

  https://llvm.org/bugs/show_bug.cgi?id=23529

  - clang doesn't implement gcc's __attribute__((abi_tag)), needed by gcc 5.x's libstdc++ built in new ABI mode
  - build gcc with `--with-default-libstdcxx-abi=gcc4-compatible` for now

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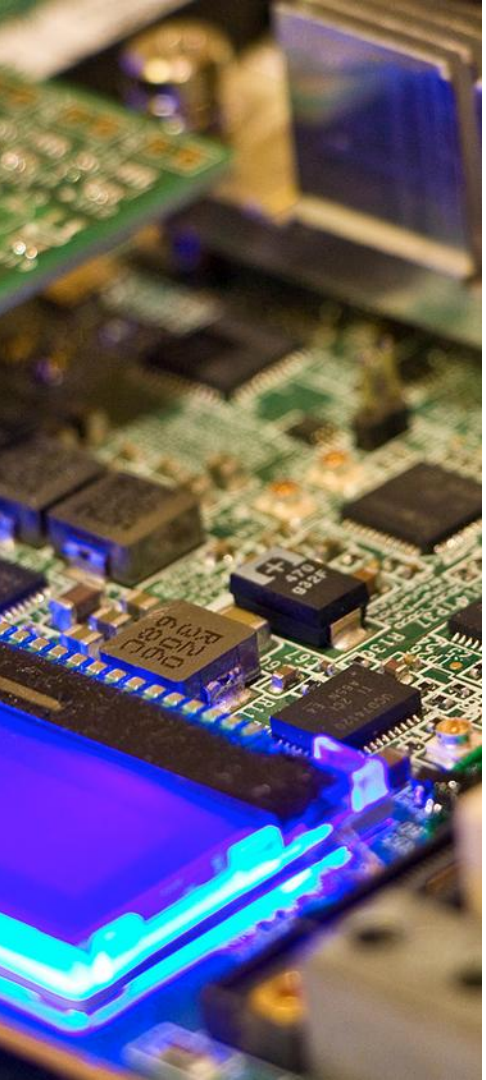

Things to avoid for compatibility

- C89-isms and C++98-isms, e.g. changed meaning of “`extern inline`”

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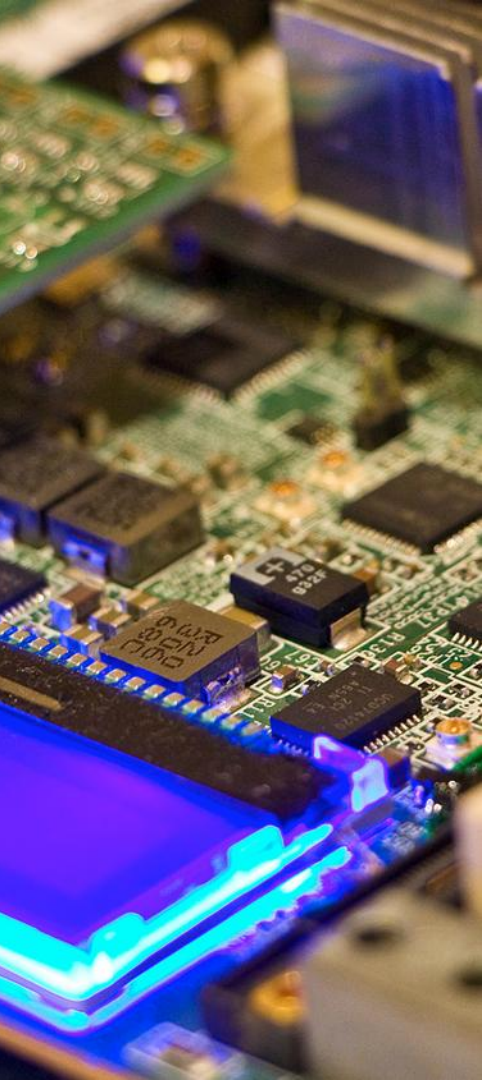

Interesting bugs found by clang

```
void something(char n[30]) {
   if(!memcmp(buffer, n, sizeof(n))) {
      …
   }
}
```

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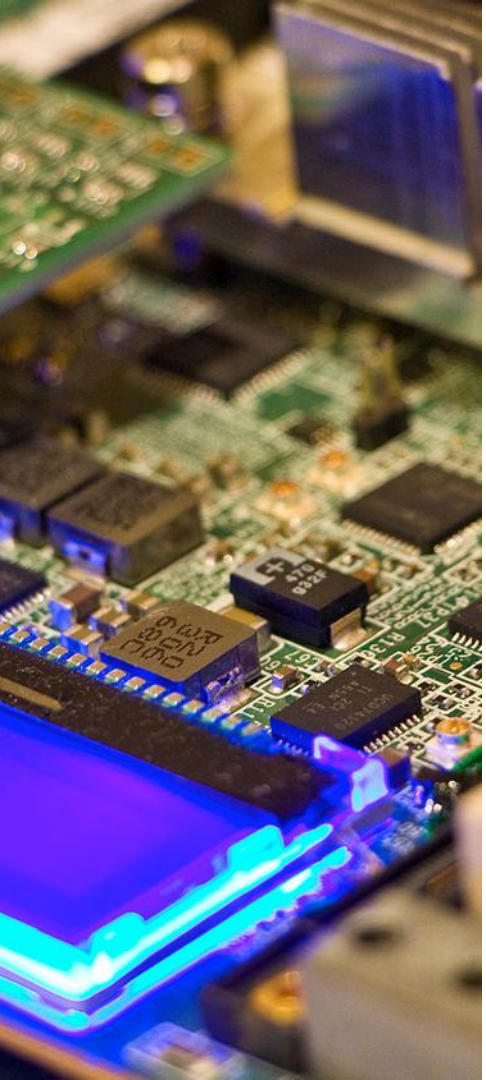

Interesting bugs found by clang

```
void something(char n[30]) {
   if(!memcmp(buffer, n, sizeof(n))) {
      …
   }
}
```

size of a pointer - not quite 30

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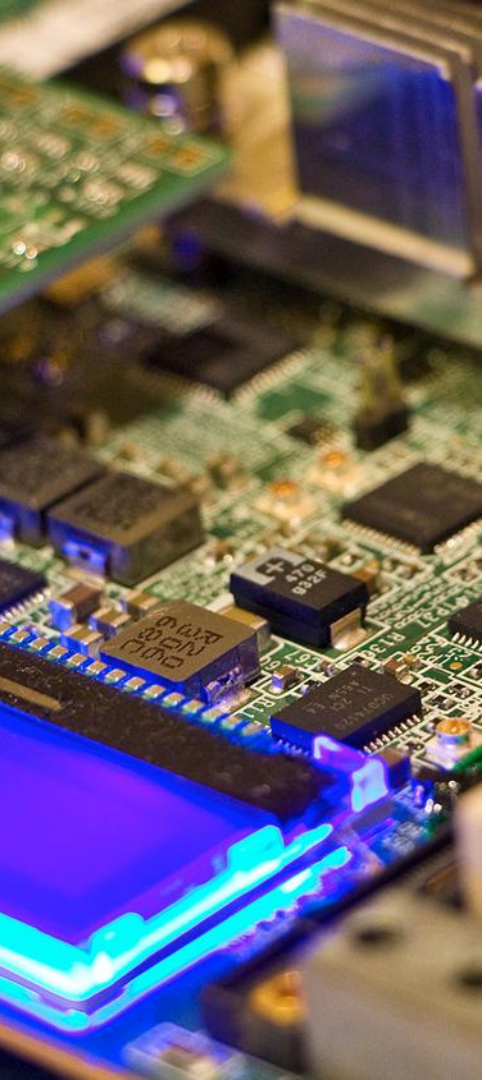

Interesting bugs found by clang

```
unsigned char a[X];
for(int i=0; i<X; i++)
   b = a ? tagCpe++ : tagSce++;
```

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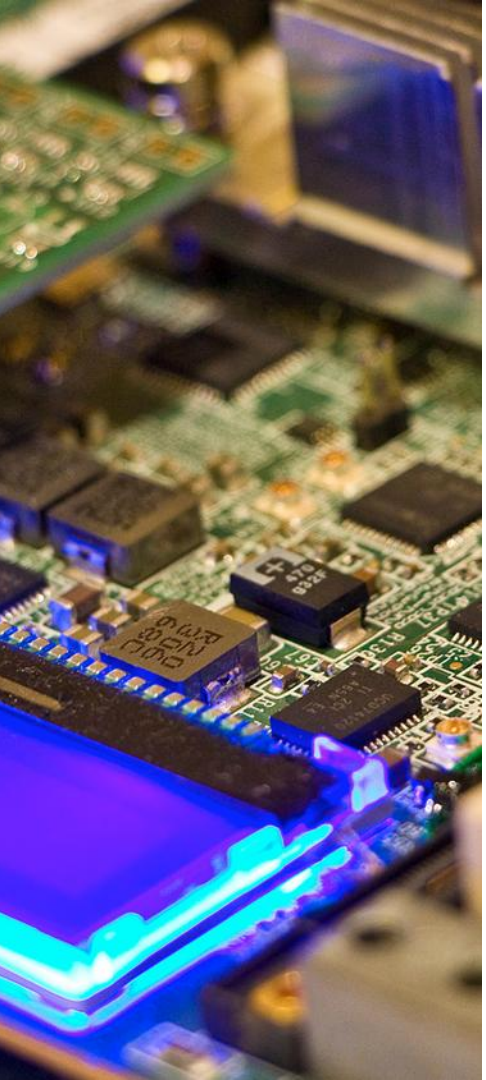

Interesting bugs found by clang

```
unsigned char a[X];
for(int i=0; i<X; i++)
   b = a ? tagCpe++ : tagSce++;
```

always true -- address of an array. This should have been a[i]

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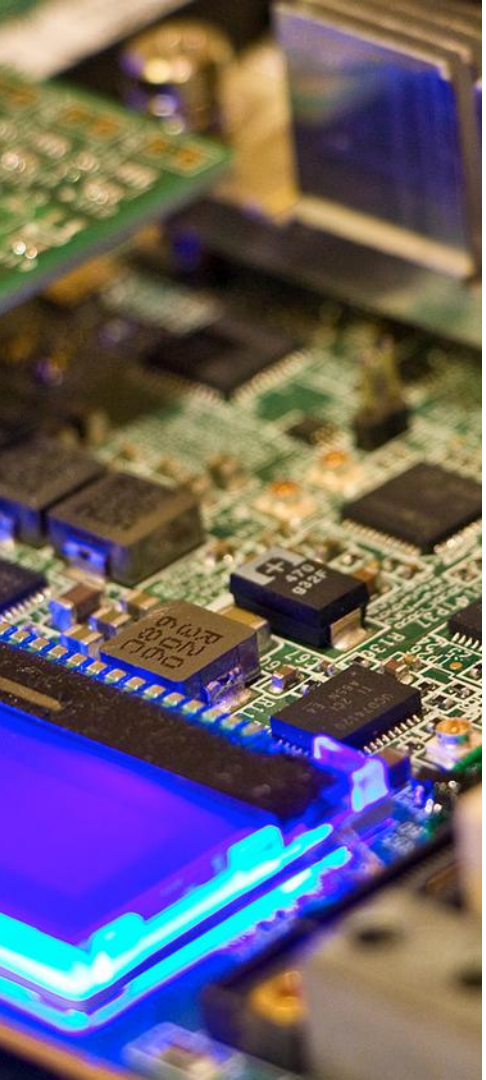

glibc

musl is at a point where using it as the sole system libc is viable (if you don’t care about binary compatibility with other distributions).

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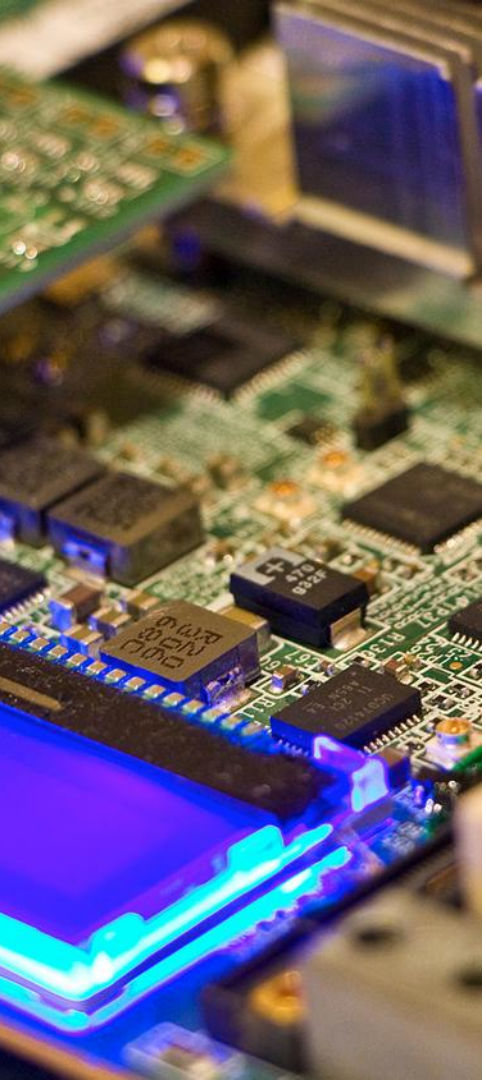

glibc

clang currently doesn’t support musl, but that’s fixable: https://abf.io/openmandriva/llvm

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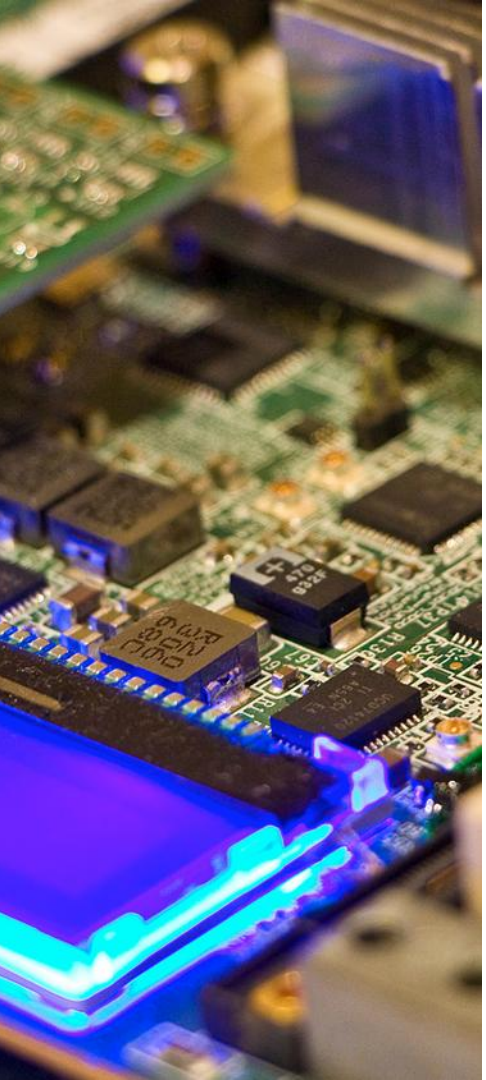

libstdc++

LLVM’s libc++ is ready to replace libstdc++ where binary compatibility is not a concern.

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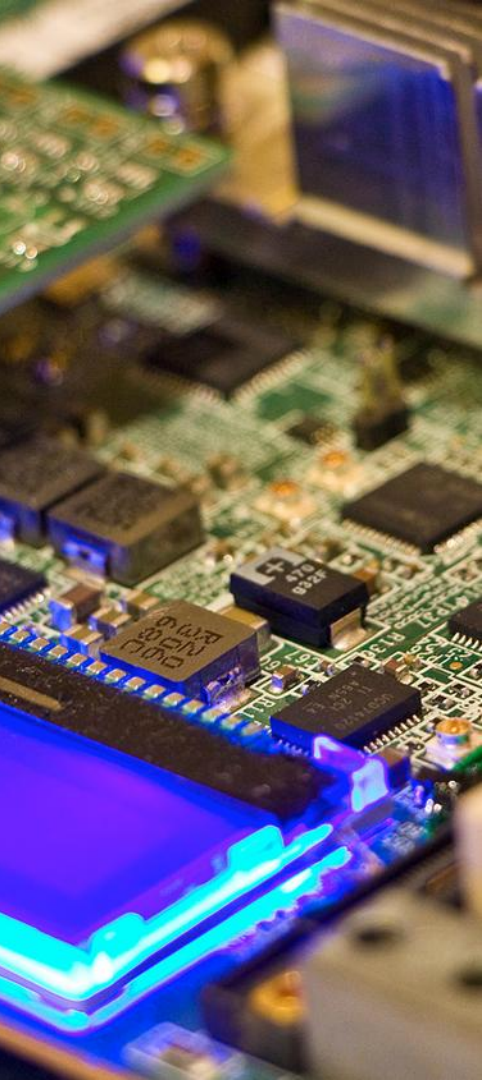

libstdc++

Unfortunately, binary compatibility is a concern for many uses -- and while libstdc++ and libc++ can coexist, problems start showing up with other libraries (Qt linked to libc++, binary-only application uses Qt and links to libstdc++ → crash)

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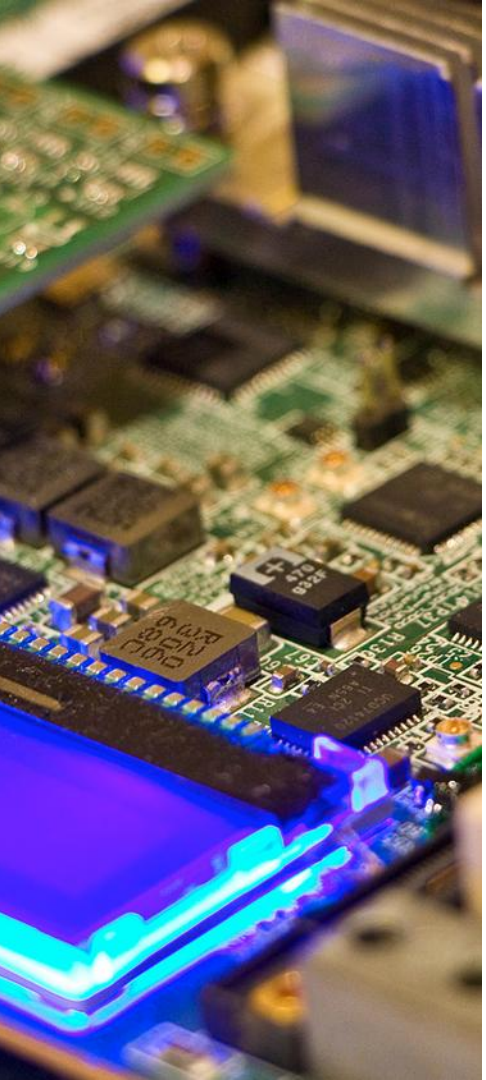

libstdc++

libc++ is the better choice if binary compatibility is not a concern -- roughly 50% space saved, full C++14 support.

Android is doing the right thing by switching to libc++ (from STLport)

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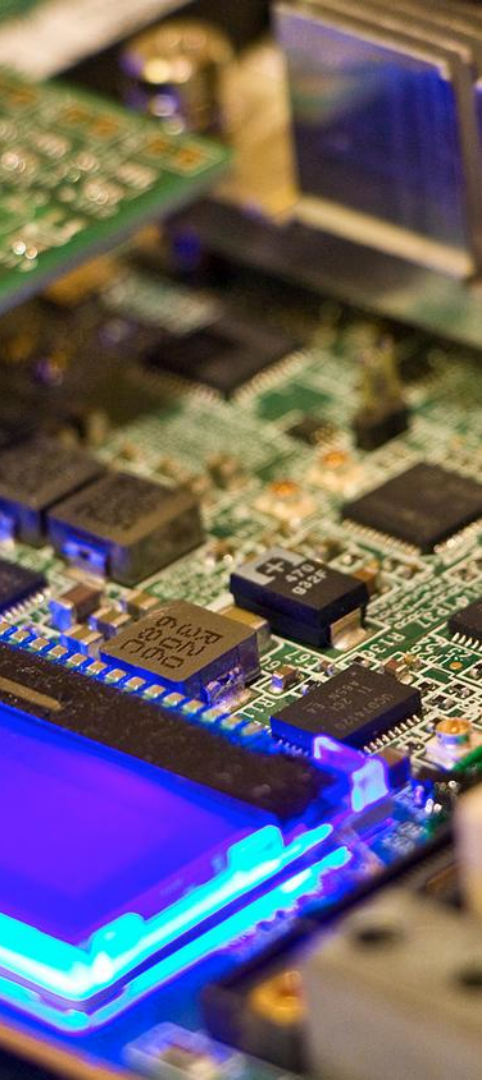

crosscompiling

Switching to an LLVM/clang based toolchain is interesting for crosscompiling - a regular clang already has crosscompiling support built in, no need to build a fresh compiler for every new target

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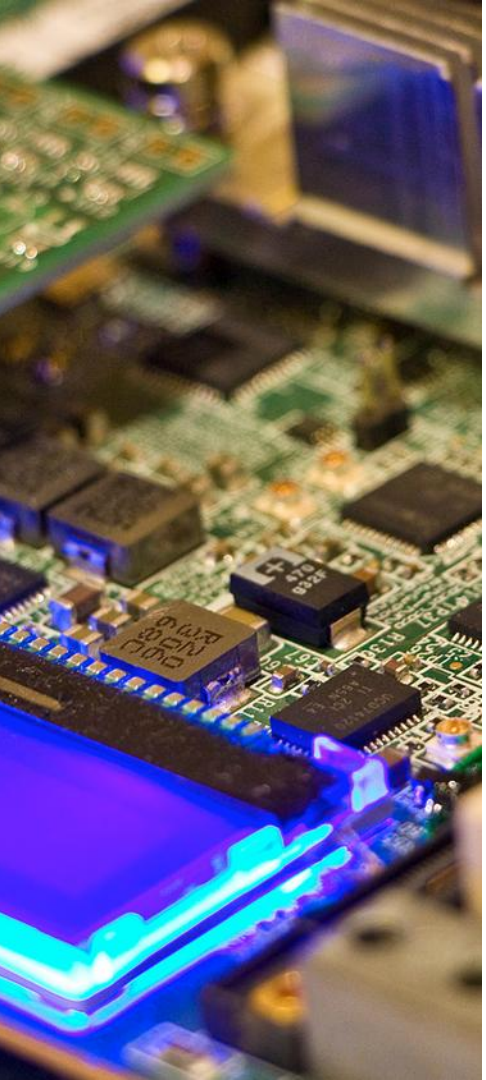

crosscompiling

--sysroot in clang needs work: Still sees host system headers.
Wrapper scripts can be used to work around this.

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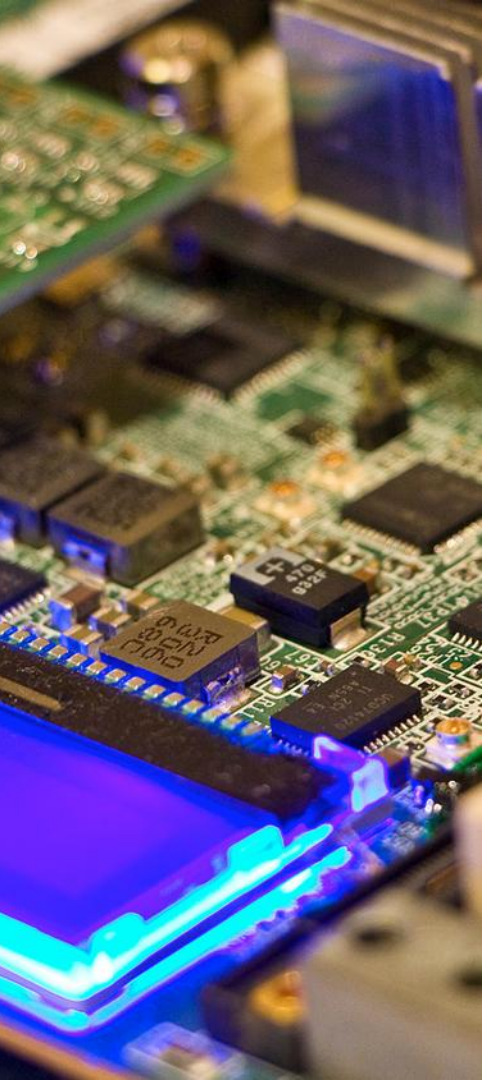

crosscompiling

```
Lopts="-L$SYSROOT/usr/lib -L$SYSROOT/lib"
# Warnings like "argument unused during compilation"
# can break configure scripts
for i in "$@"; do
    if [ "$i" = "-E" -o "$i" = "-c" ]; then
        Lopts=""
        break
    fi
done
exec clang -target $TARGET \
    --sysroot=$SYSROOT -nostdinc \
    -isysroot $SYSROOT \
    -isystem $SYSROOT/usr/include \
    $Lopts \
    -ccc-gcc-name $TARGET-gcc "$@"
```

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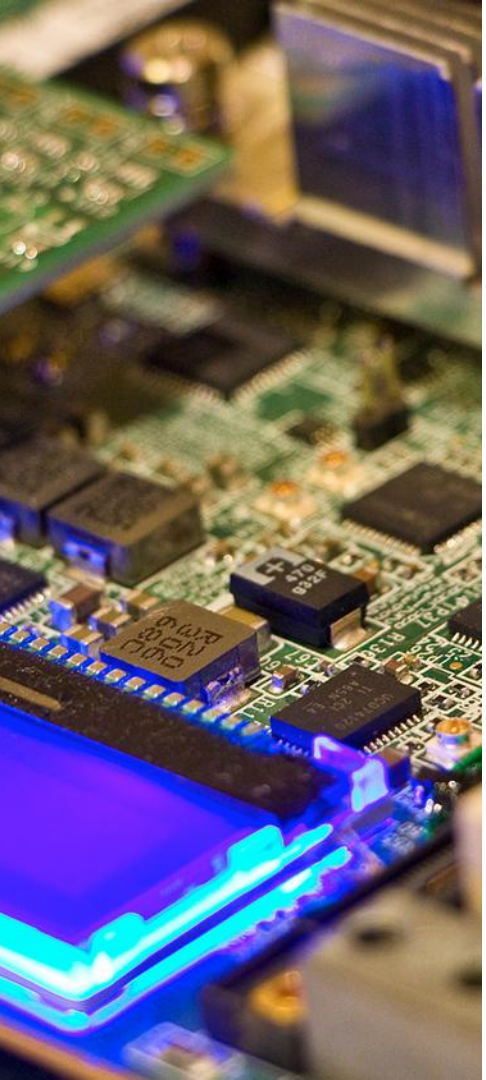

crosscompiling

Automated toolchain and core system bootstrapping being worked on:
https://abf.io/openmandriva/crossbuild/blob/master/build-clang-musl.sh

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Questions? Comments?

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