Building a cross compiler.

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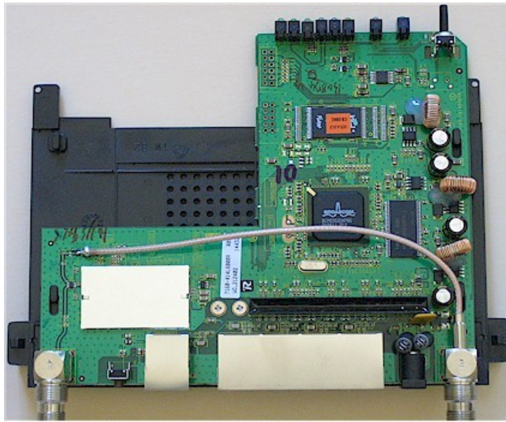
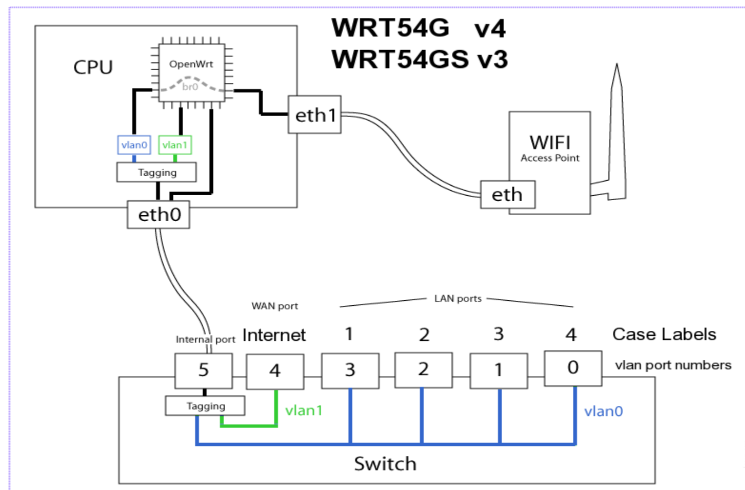
Source: Your PC

Target: Linksys WRT54G



Courtesy www.tomsguide.com



- 216 MHz MIPS-32 processor
- 16 MB RAM
- 4 MB Flash Memory
- 1 802.11B/G wireless interface
- 5 100Mbs ethernet ports

The processors

	X86	MIPS
Designer	Intel / AMD	MIPS Computer Systems
Design	CISC	RISC
Bits	16,32,64	32,64
Endian	Little	Bi *
Type	Register-Memory	Register-Register

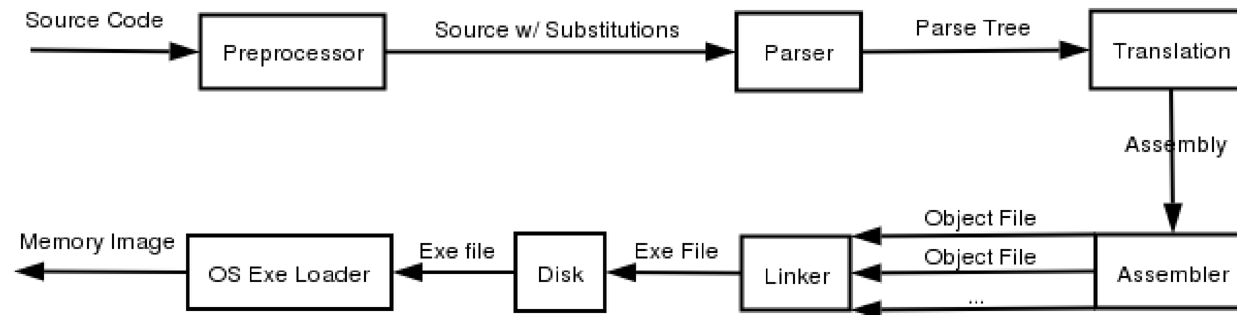
The operating systems

- Fedora Core 9 Linux
- Kernel 2.6.27.25-78.2.56.fc9.x86_64 #1 SMP

- OpenWrt Linux
- Kernel 2.6.25.20 #4

The compiler

- The Gnu Compiler Collection
- Includes front ends for C, C++, Objective-C, Fortran, Java, Ada, and associated libraries
- A 5-stage compiler (preprocessing, parsing, translation, assembly, linkage)



Courtesy http://www.acm.uiuc.edu/sigmil/RevEng/ch02.html

What do we need?

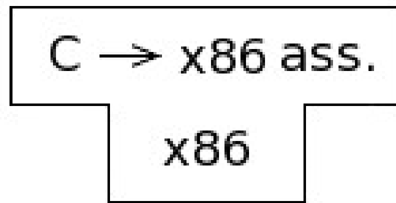
- The obvious answer is that we need a version of the GCC C compiler that can run on x86 hardware and can output machine code for the MIPS hardware.
- The not-so-obvious addendum to that is that, since we are writing software for an embedded device, we need to keep the machine code as small as possible.
- Having said that, we decide to use Newlib (http://sourceware.org/newlib/). It is a drop-in replacement for libc (the C standard library) that is specifically designed to provide a functional subset of capability on platforms with extremely limited resources. This includes many different embedded devices as well as software environments such as Cygwin.

The conundrum

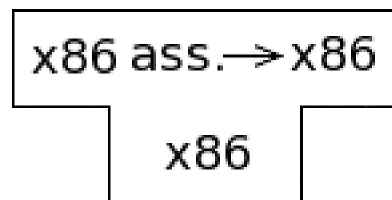
- In order to build our required version of GCC, we need to have an already-built version of Newlib to link against.
- However, in order to build Newlib, we need a working version of our compiler that can output code for our target platform.

What ever shall we do?

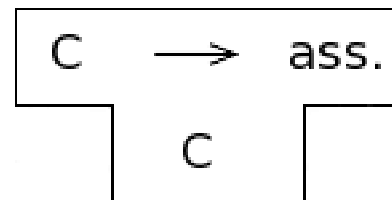
The givens



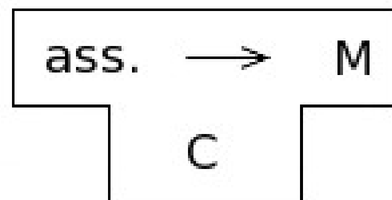
A natively-built **x86 C compiler** (provided by the GCC package as part of the Fedora linux distribution)



A natively-built **x86 assembler** (provided by the GCC package as part of the Fedora linux distribution)

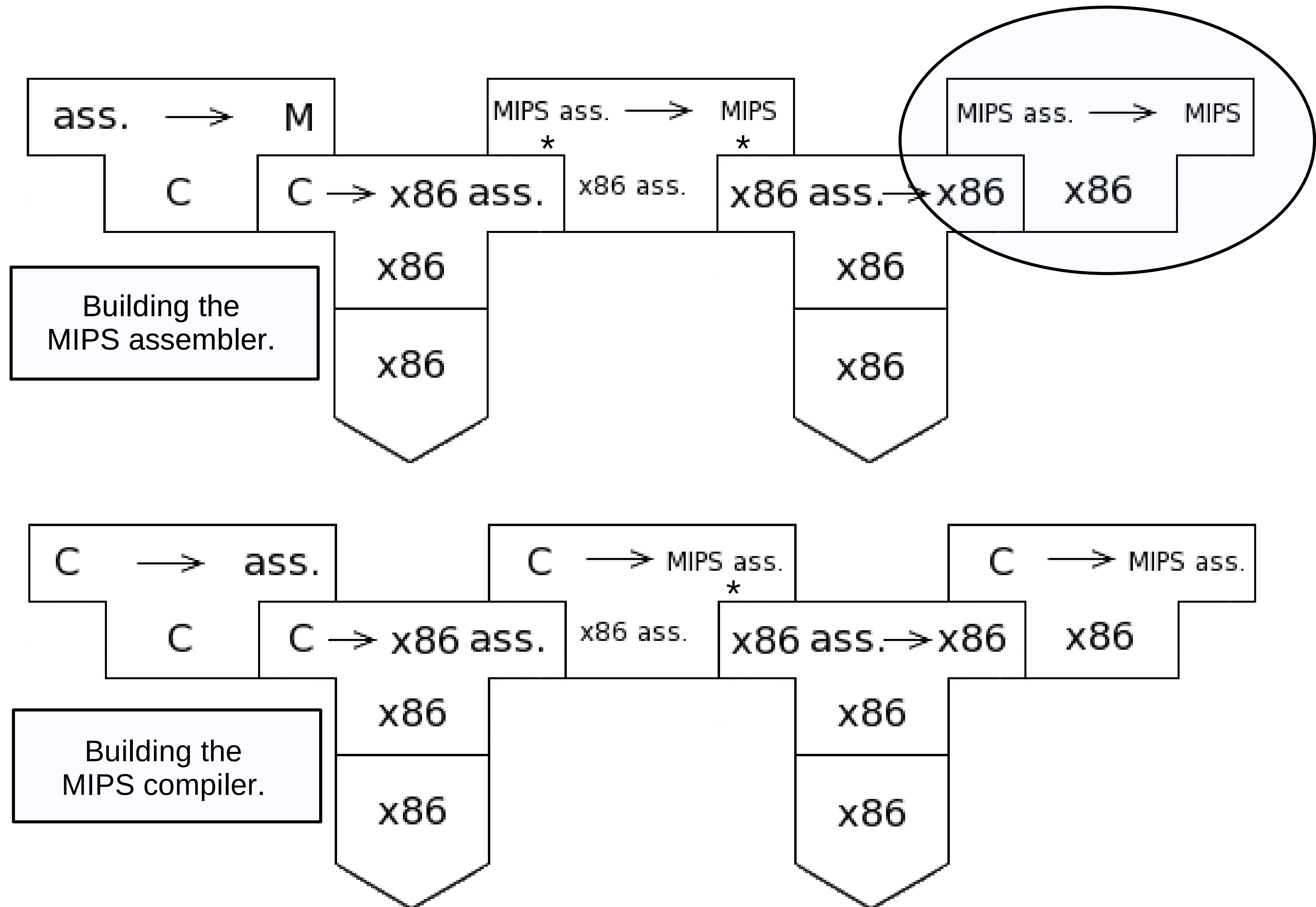


The source code for the GCC **C compiler** (from http://gcc.gnu.org)



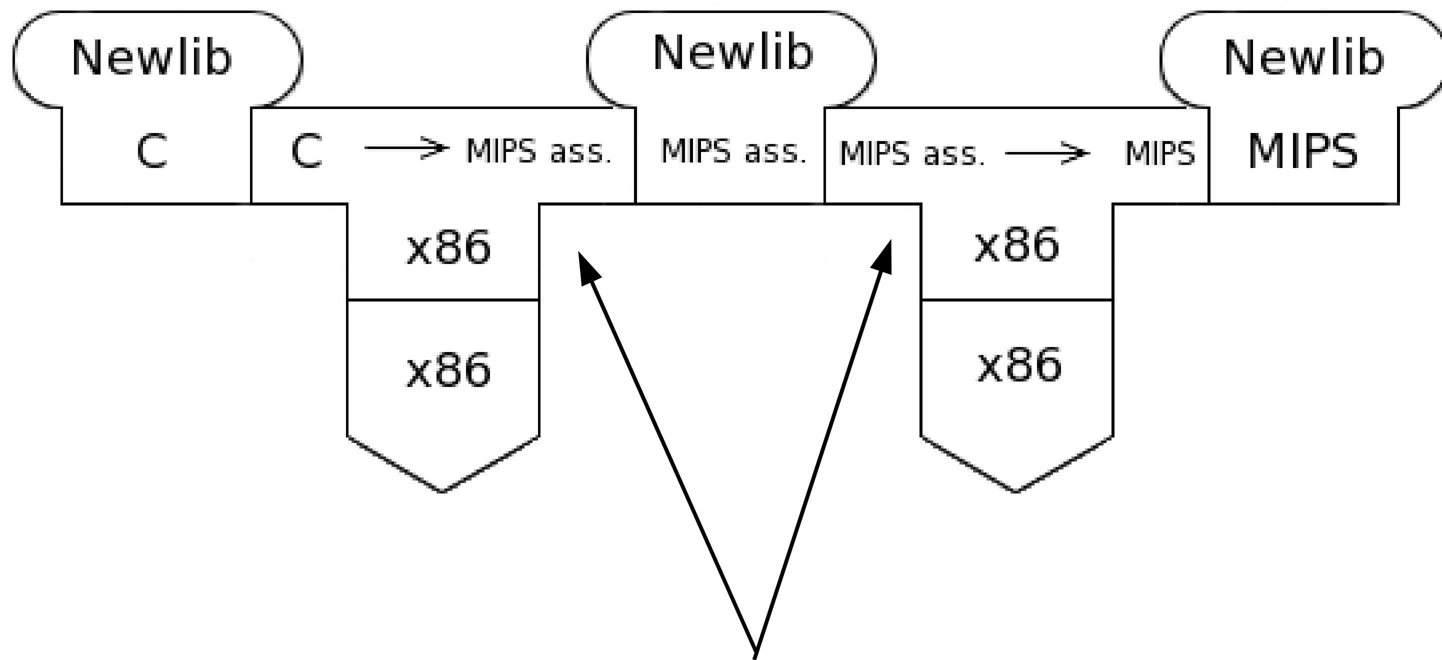
The source code for the **binutils assembler** (from http://www.gnu.org/software/binutils/)

The bootstrap



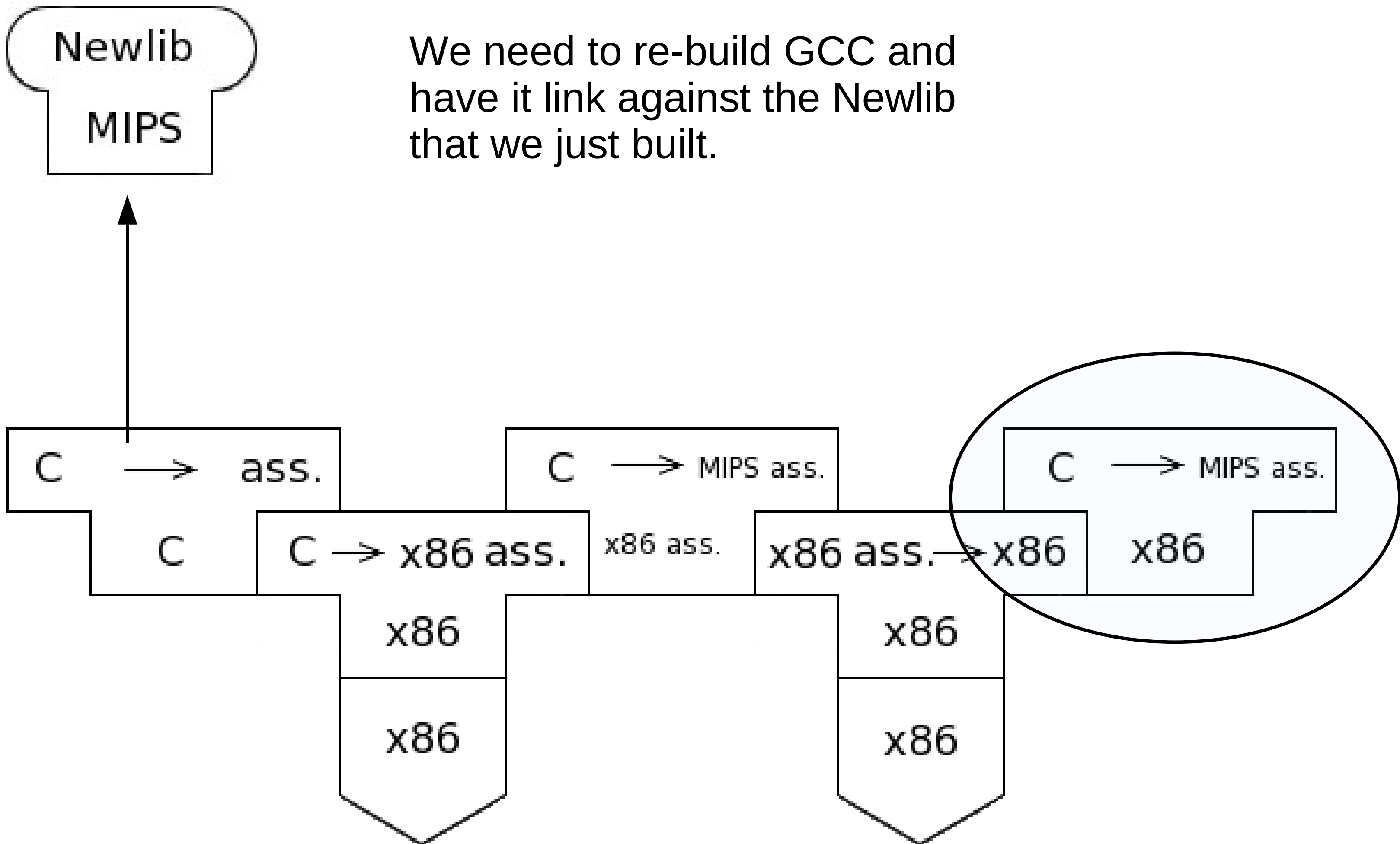
* Configured before compilation

Newlib



Re-build GCC

We need to re-build GCC and have it link against the Newlib that we just built.



The code

main.c

```
* #include <stdio.h>

void foo();
void bar();

int main(int argc, char **argv)
  {                                        *
    printf("Built %s - %s\n", __TIME__, __DATE__);
    foo();
    bar();
    return(0);
  } /* end main() */
```

foo.c

```
*int printf (__const char *__restrict __format, ...);

void foo()
  {
    printf("foo() called\n");
  } /* end foo() */
```

bar.c

```
int printf (__const char *__restrict __format, ...);

void bar()
  {
    printf("bar() called\n");
  } /* end bar() */
```

The Makefile

```
* SDK_DIR=/home/mips-sdk/staging_dir/toolchain-mipsel_gcc4.1.2
  MIPS_CC=${SDK_DIR}/bin/mipsel-linux-gcc
  X86_64_CC=/usr/bin/gcc

  all: main-mips main-x86_64

  deploy: main-mips
    scp main-mips root@10.0.0.23:/tmp

  clean:
    rm -rf *.o *.s *.pp *.tu main-mips main-x86_64

  # Let's build a mips binary
  main-mips: main.c foo-mips.o bar-mips.o
    ${MIPS_CC} -Wall -S $? -o $@.s 2>/dev/null
    ${MIPS_CC} -Wall $? -o $@
  foo-mips.o: foo.c
    ${MIPS_CC} -Wall -S $? -o $@.s
    ${MIPS_CC} -Wall -c $? -o $@
  bar-mips.o: bar.c
    ${MIPS_CC} -Wall -S $? -o $@.s
    ${MIPS_CC} -Wall -c $? -o $@

  # Let's build an x86_64 binary
  main-x86_64: main.c foo-x86_64.o bar-x86_64.o
    ${X86_64_CC} -Wall -E main.c -o $@.pp
    ${X86_64_CC} -Wall -S $? -o $@.s 2>/dev/null
    ${X86_64_CC} -Wall -fdump-translation-unit $? -o $@
  foo-x86_64.o: foo.c
    ${X86_64_CC} -Wall -S $? -o $@.s
    ${X86_64_CC} -Wall -c $? -o $@
  bar-x86_64.o: bar.c
    ${X86_64_CC} -Wall -S $? -o $@.s
    ${X86_64_CC} -Wall -c $? -o $@
```

Demo time

Things to do:

- Build the test program
- What can 'file' tell us about the programs?
- Run them both on x86. What happens?
- Deploy to and run on the WRT
- Look at the intermediate output files