

Embedded Software Essentials

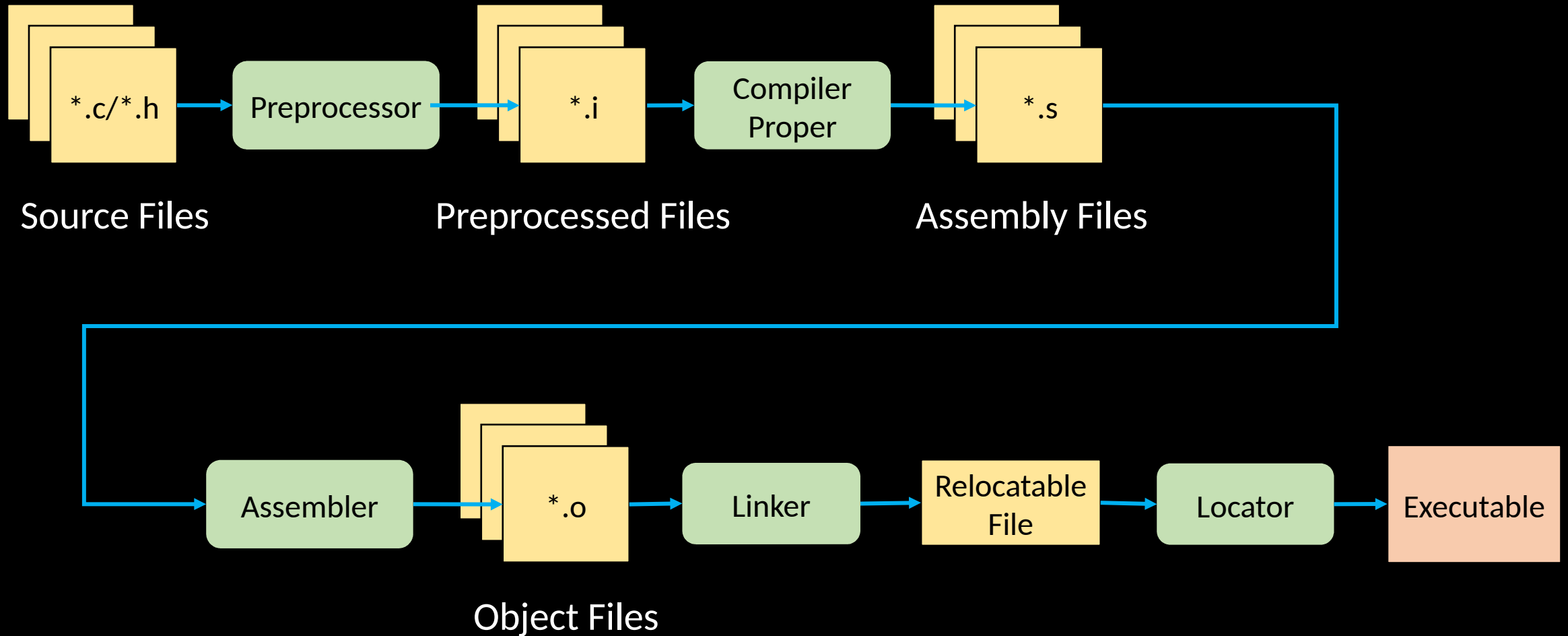
Compiling and Invoking GCC

C1 M2 V2

Copyright

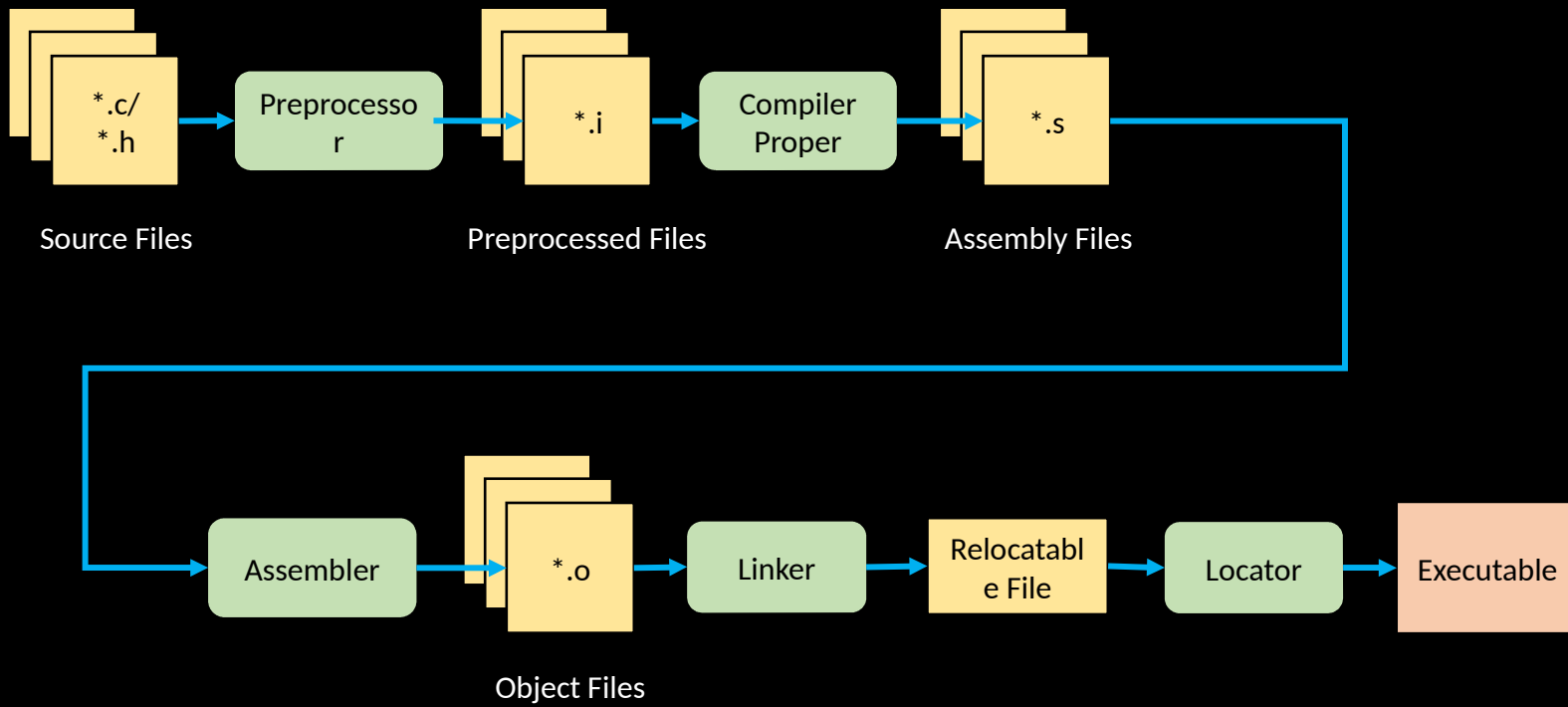
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Build Process (linear)

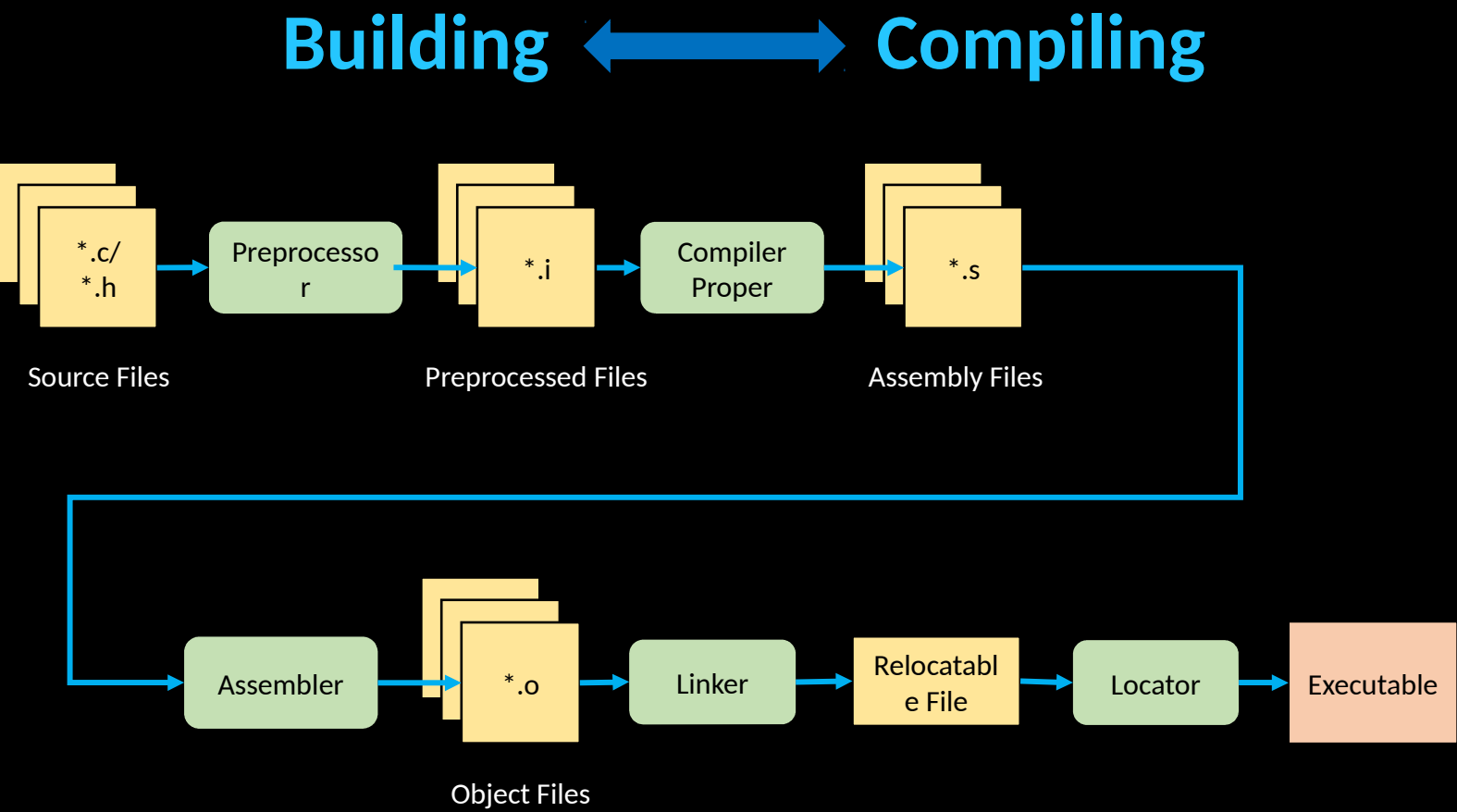


Build Process (linear)

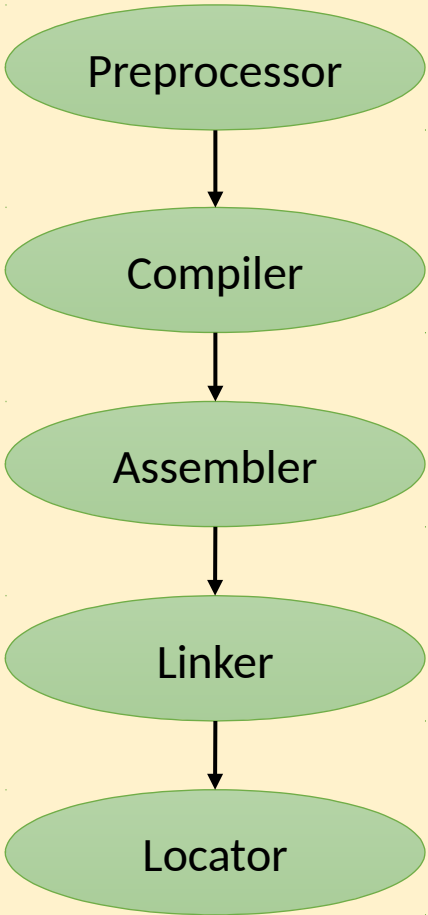
Building ↔ **Compiling**



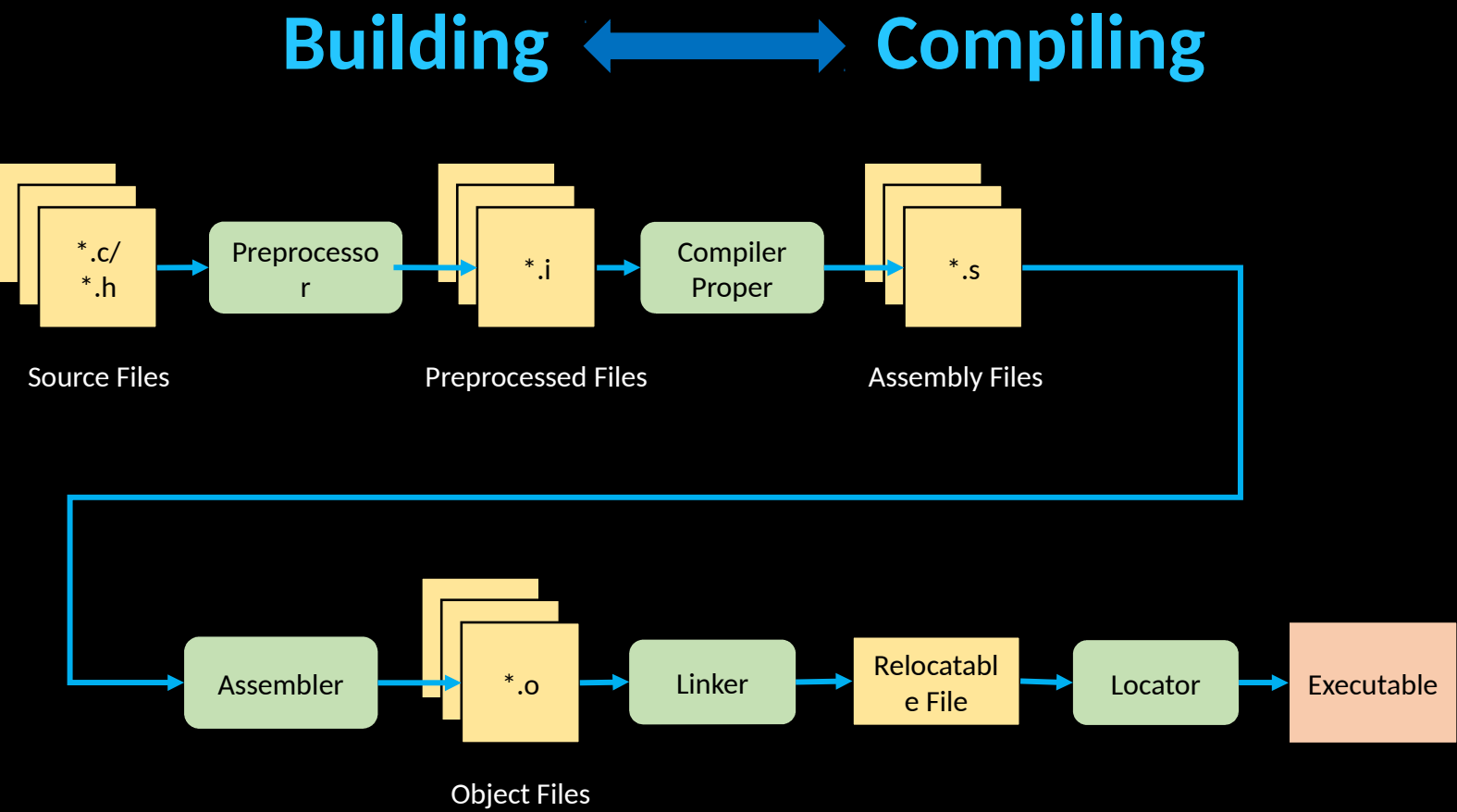
Build Process (linear)



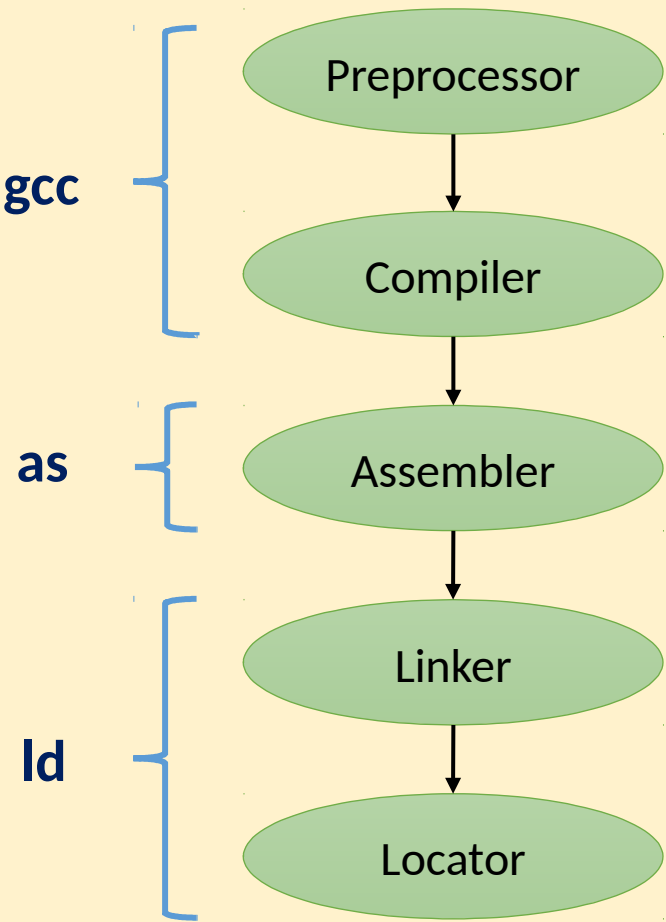
GNU's Compiler Collection (GCC) Toolchain



Build Process (linear)



GNU's Compiler Collection (GCC) Toolchain



GCC Tool Check

Many compilers toolchains can be installed

```
$ ls -la /usr/bin/*gcc
```

```
alex@ubuntu14: ~  
alex@ubuntu14:~$ ls -la /usr/bin/*gcc  
lrwxrwxrwx 1 root root 25 Oct 6 2012 /usr/bin/arm-linux-gnueabi-gcc -> arm-linux-gnueabi-gcc-4.7  
-rwxr-xr-x 1 root root 777744 Jun 28 08:48 /usr/bin/arm-none-eabi-gcc  
-rwxr-xr-x 1 root root 428 May 7 2006 /usr/bin/c89-gcc  
-rwxr-xr-x 1 root root 454 Apr 11 2011 /usr/bin/c99-gcc  
lrwxrwxrwx 1 root root 7 May 30 12:27 /usr/bin/gcc -> gcc-4.8  
lrwxrwxrwx 1 root root 7 May 30 12:27 /usr/bin/i686-linux-gnu-gcc -> gcc-4.8  
alex@ubuntu14:~$
```

<ARCH> - <VENDOR> - <OS> - <ABI>

arm-none-eabi-gcc

-Arch = ARM

-Vendor = N/A

-OS = None (Bare-Metal)

-ABI = EABI

arm-linux-gnueabi-gcc

-Arch = ARM

-Vendor = N/A

-OS = Linux OS

-ABI = GNUEABI

Compilers

```
alex@ubuntu14: ~  
alex@ubuntu14:~$ ls -la /usr/bin/*gcc  
lrwxrwxrwx 1 root root 25 Oct 6 2012 /usr/bin/arm-linux-gnueabi-gcc -> arm-linux-gnueabi-gcc-4.7  
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lrwxrwxrwx 1 root root 7 May 30 12:27 /usr/bin/i686-linux-gnu-gcc -> gcc-4.8  
alex@ubuntu14:~$
```

Native Compiler:

- gcc -> gcc-4.8

For code run on the
host machine

Cross Compiler:

- arm-none-eabi-gcc

For code run on the target
processor

Compilers

```
alex@ubuntu14: ~  
alex@ubuntu14:~$ ls -la /usr/bin/*gcc  
lrwxrwxrwx 1 root root 25 Oct 6 2012 /usr/bin/arm-linux-gnueabi-gcc -> arm-linux-gnueabi-gcc-4.7  
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lrwxrwxrwx 1 root root 7 May 30 12:27 /usr/bin/i686-linux-gnu-gcc -> gcc-4.8  
alex@ubuntu14:~$
```

Cross Compiler:

- **arm-none-eabi-gcc**

For code run on the target processor

Showd all tools in the Cross-Compiler Toolchain

```
$ ls -la /usr/bin/arm-none-eabi*
```

GCC Tool Check

\$ gcc --version

```
alex@ubuntu14: ~  
alex@ubuntu14:~$ gcc --version  
gcc (Ubuntu 4.8.4-2ubuntu1~14.04.3) 4.8.4  
Copyright (C) 2013 Free Software Foundation, Inc.  
This is free software; see the source for copying conditions. There is NO  
warranty; not even for MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE.  
  
alex@ubuntu14:~$ which gcc  
/usr/bin/gcc  
alex@ubuntu14:~$
```

\$ which gcc

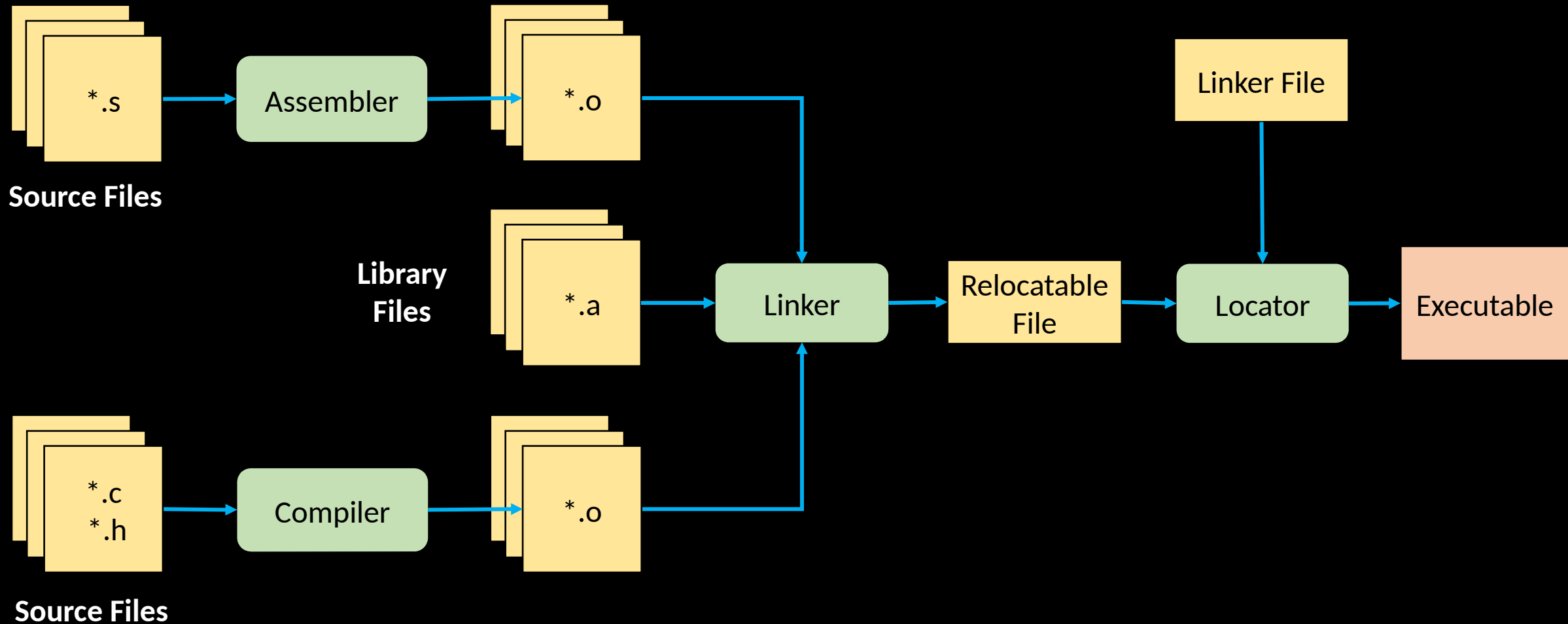
```
alex@ubuntu14: ~  
GCC(1)                                GNU                                GCC(1)  
  
NAME  
    gcc - GNU project C and C++ compiler  
  
SYNOPSIS  
    gcc [-c|-S|-E] [-std=standard]  
        [-g] [-pg] [-Olevel]  
        [-Wwarn...] [-Wpedantic]  
        [-Idir...] [-Ldir...]  
        [-Dmacro[=defn]...] [-Umacro]  
        [-foption...] [-mmachine-option...]  
        [-o outfile] [@file] infile...  
  
    Only the most useful options are listed here; see below for the  
    remainder.  g++ accepts mostly the same options as gcc.  
  
DESCRIPTION  
    When you invoke GCC, it normally does preprocessing, compilation,  
    assembly and linking.  The "overall options" allow you to stop this  
    process at an intermediate stage.  For example, the -c option says not  
    Manual page gcc(1) line 1 (press h for help or q to quit)
```

\$ man gcc



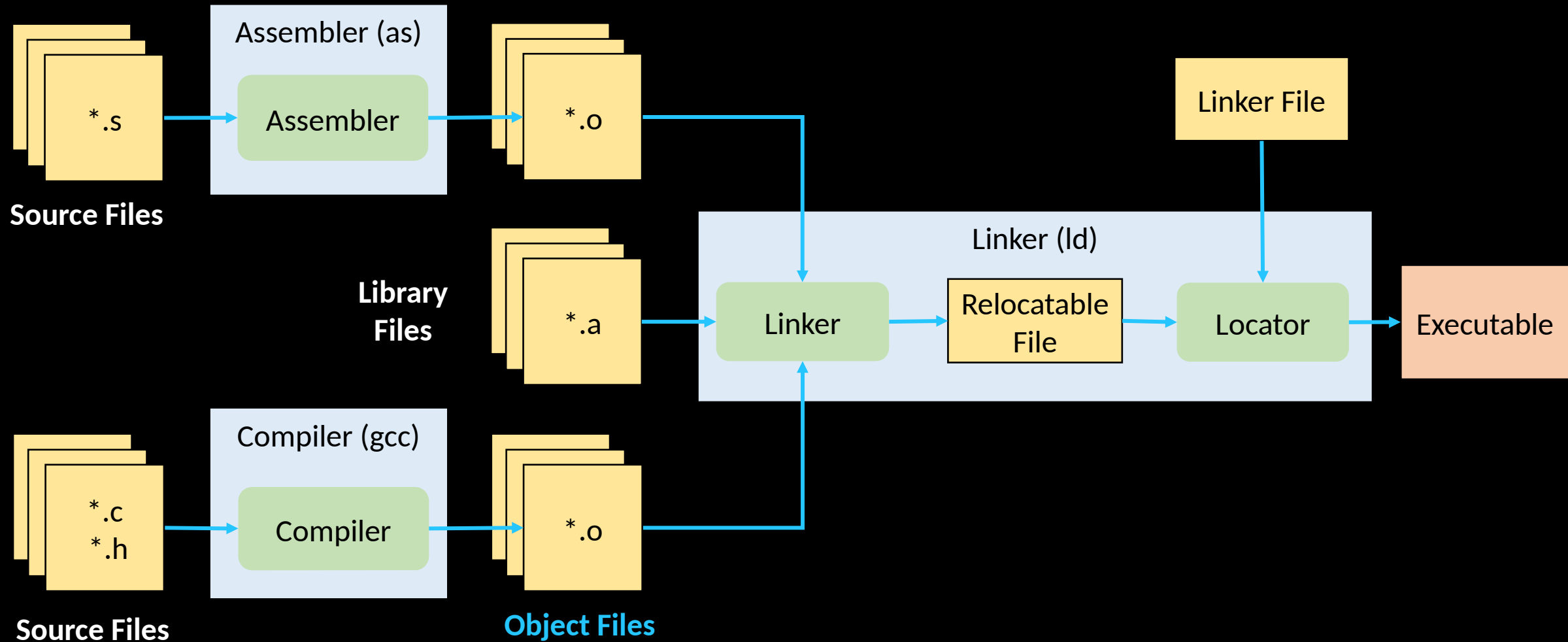
Typical Build Process

Assembly Files	≡	.s Extension
Object Files	≡	.o Extension
Library Files	≡	.a Extension (with .h)
Executable File	≡	Extension Varies

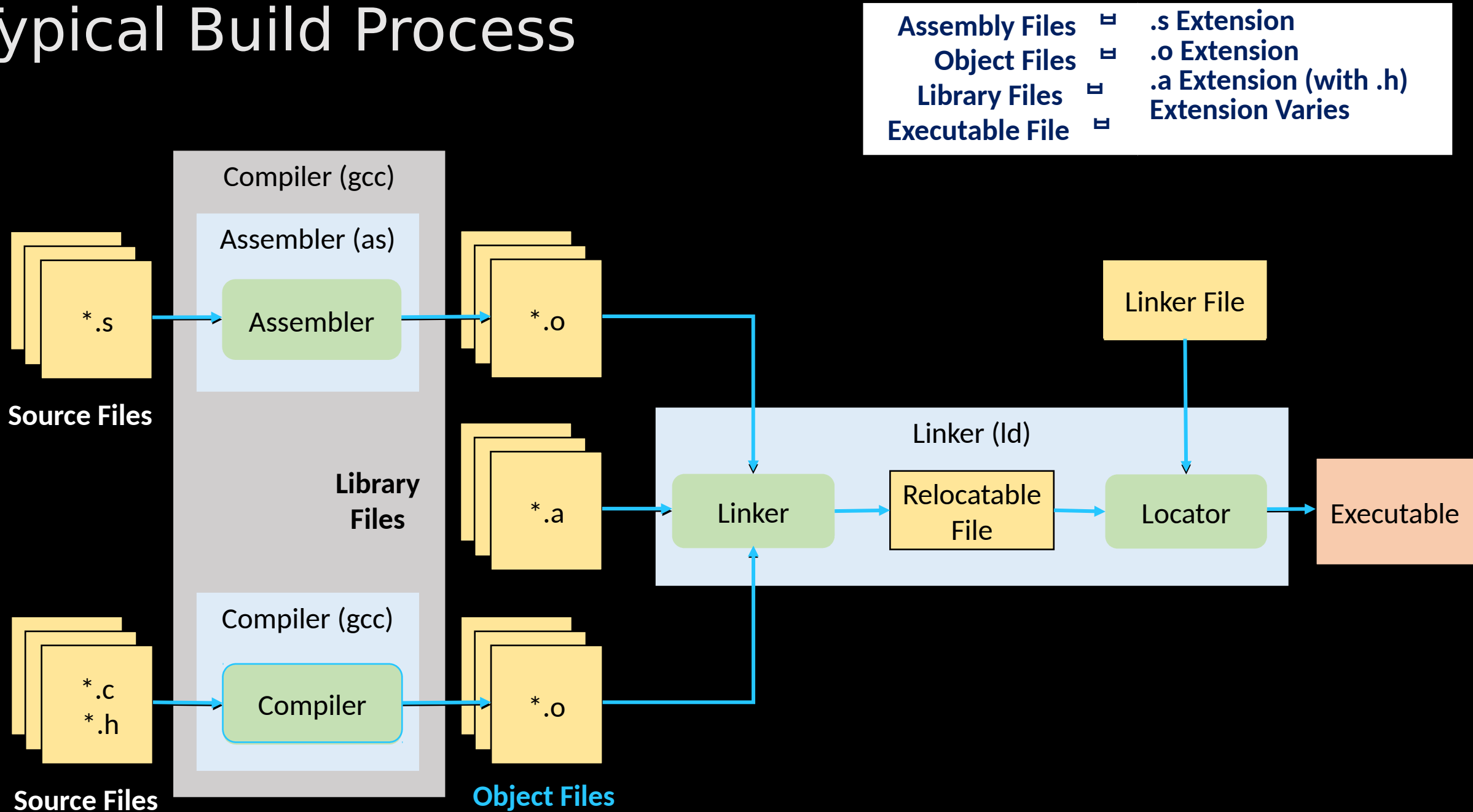


Typical Build Process

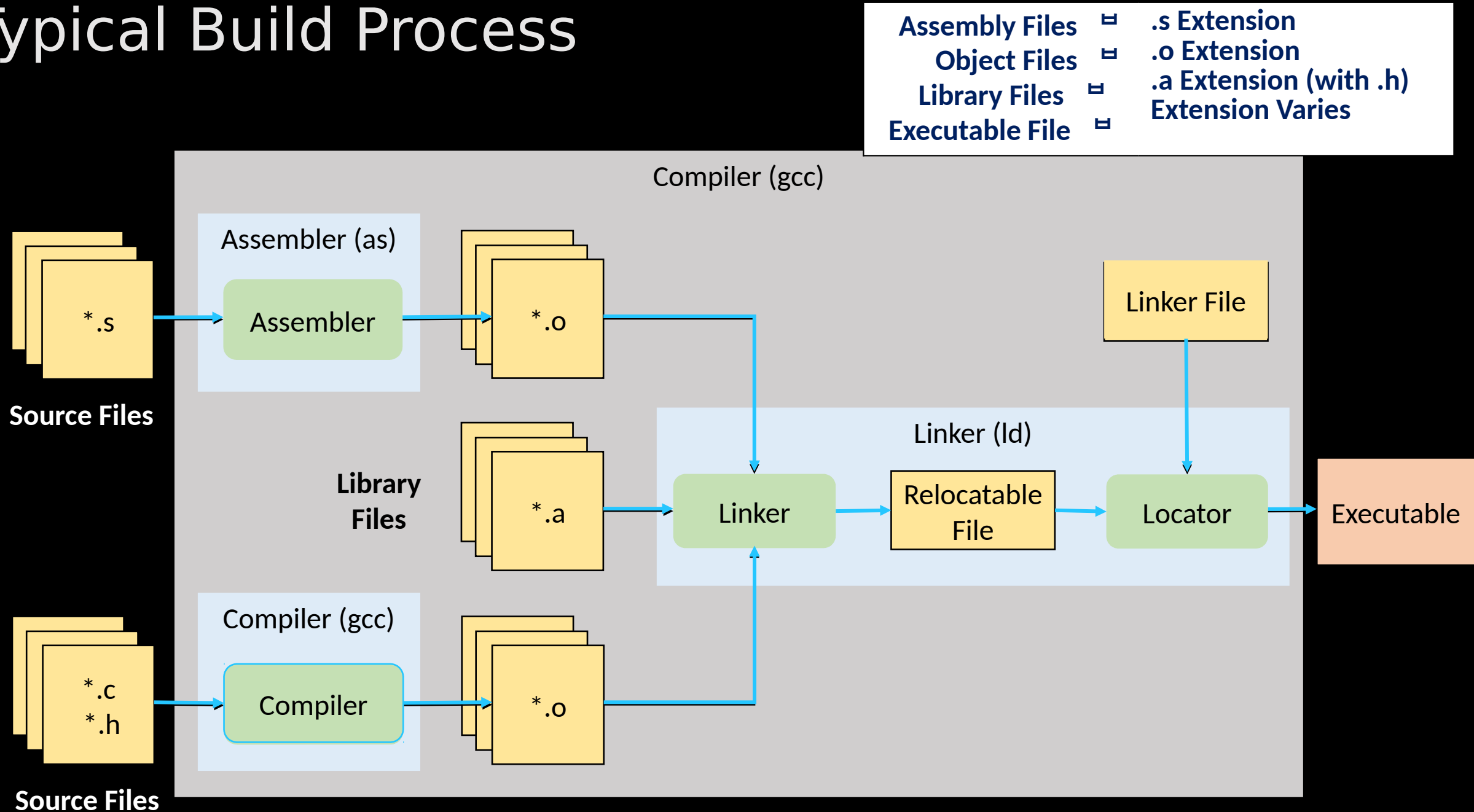
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Typical Build Process



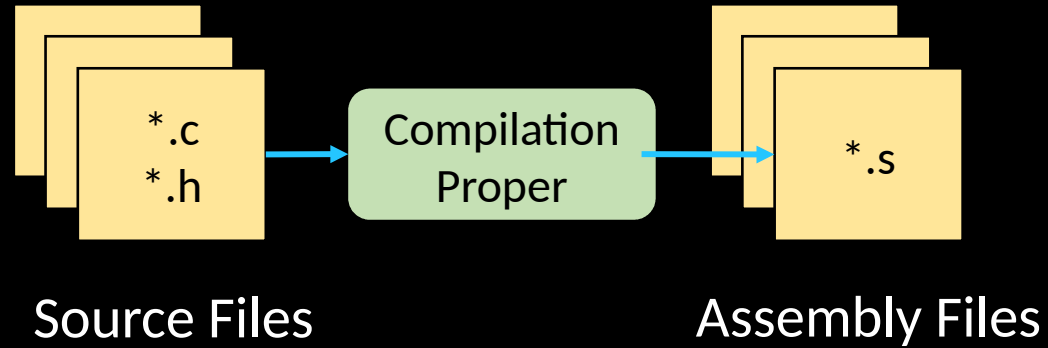
Typical Build Process



Compilation Proper

C-Programming (High Level Language)

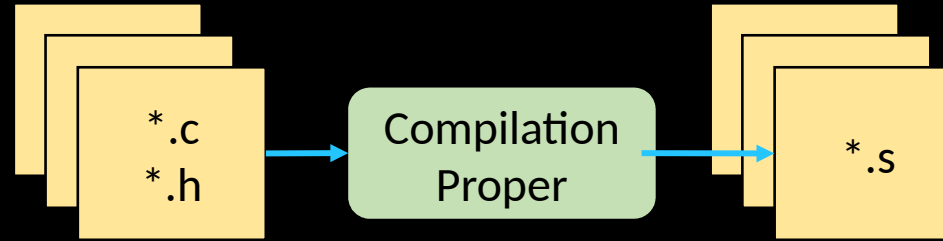
```
int x = 0;  
int y = 20;  
int z = 5;  
...  
while (y >= z) {  
    y = y - z;  
    x++;  
}
```



Compilation Proper

C-Programming (High Level Language)

```
int x = 0;
int y = 20;
int z = 5;
...
while (y >= z) {
    y = y - z;
    x++;
}
```



Source Files

Assembly Files

High level language
translated to low level
language via compiler

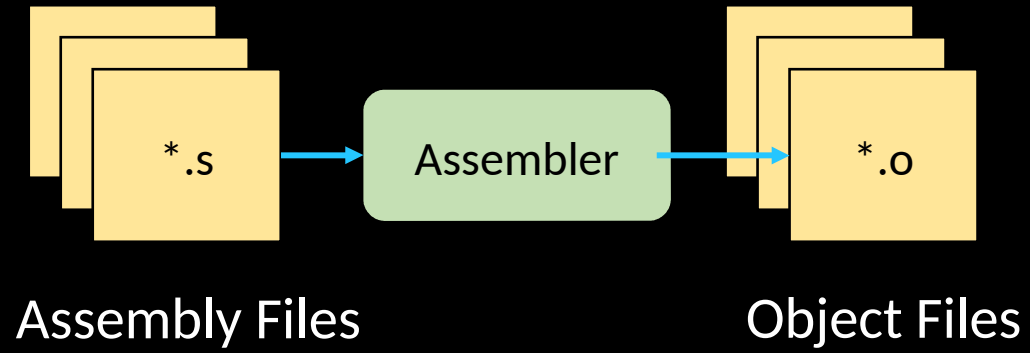
ARM Assembly Language

```
ldr    r2, y
ldr    r3, z
ldr    r4, x
```

LOOP:

```
sub    r2, r3
inc     r4
cmp     r2, r3
bgt     LOOP
str     r2, y
str     r4, x
```


Assembly to Machine Code



`movs` `r3, #0`

Operation **Operand**

General Compiler Flags

Option & Format	Purpose
-c	Compile and Assemble File, Do Not Link
-o <FILE>	Compile, Assemble, and Link to OUTPUT_FILE
-g	Generate Debugging Information in Executable
-Wall	Enable All Warning Messages
-Werror	Treat All Warnings as Errors
-I<DIR>	Include this <DIR> to Look for Header Files
-ansi -std=STANDARD	Specify Which Standard Version to Use (ex: c89,c99)
-v	Verbose Output from GCC

Architecture Specific Compiler Flags

Option & Format	Purpose
-mcpu=[NAME]	Specifies Target ARM Processor and Architecture (ex: cortex-m0plus)
-march=[NAME]	Target ARM Architecture (ex: armv7-m, thumb)
-mtune=[NAME]	Target ARM Processor (ex: cortex-m0plus)
-mthumb	Generate code in Thumb States (ISA)
-marm	Generate code in ARM State (ISA)
-mthumb-interwork	Generate code that supports calling between ARM and Thumb (ISA)
-mlittle-endian	Generate code for Little Endian Mode
-mbig-endian	Generate code for Big Endian Mode