Embedded Software Essentials
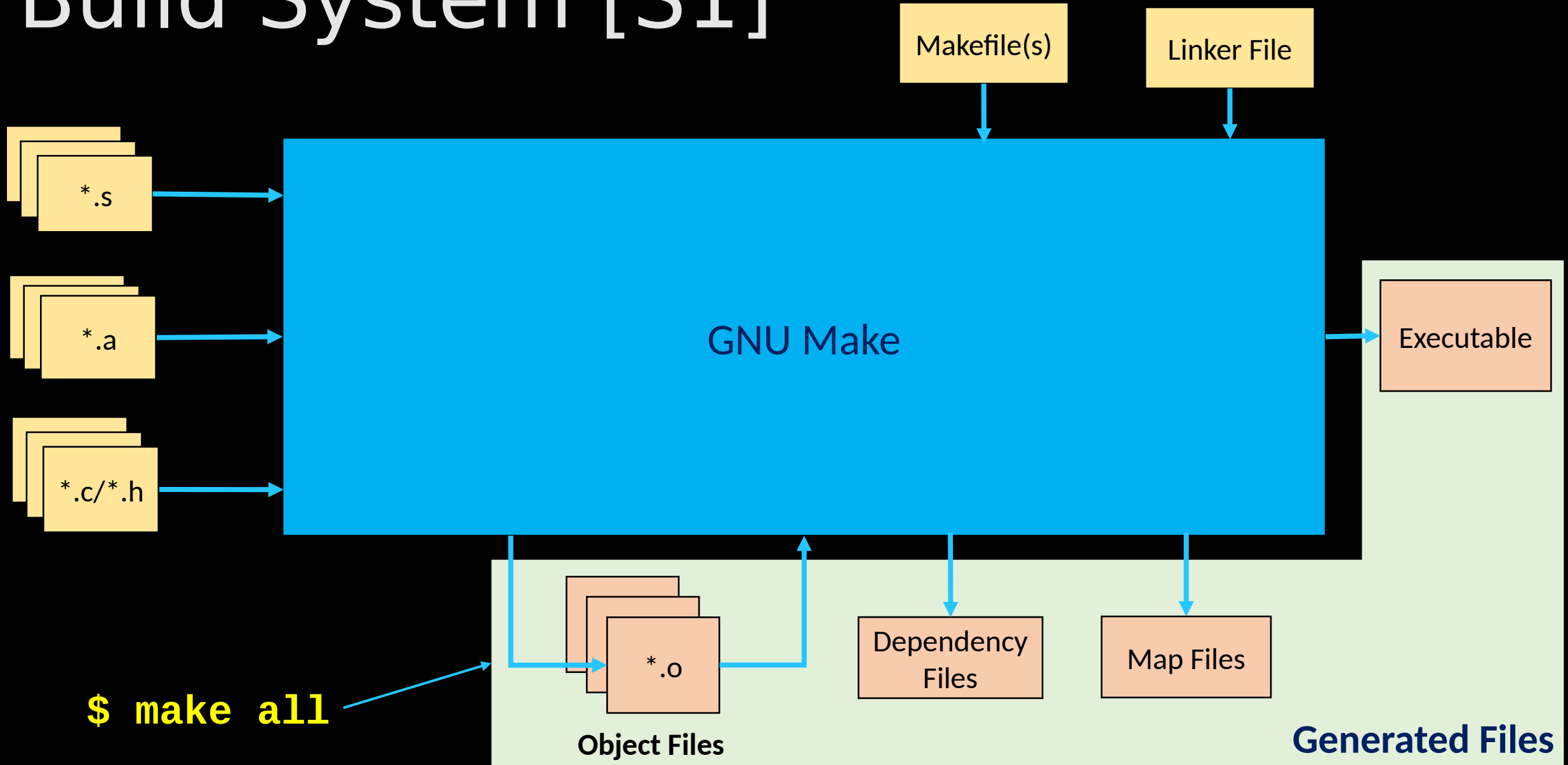
Makefiles Part 1

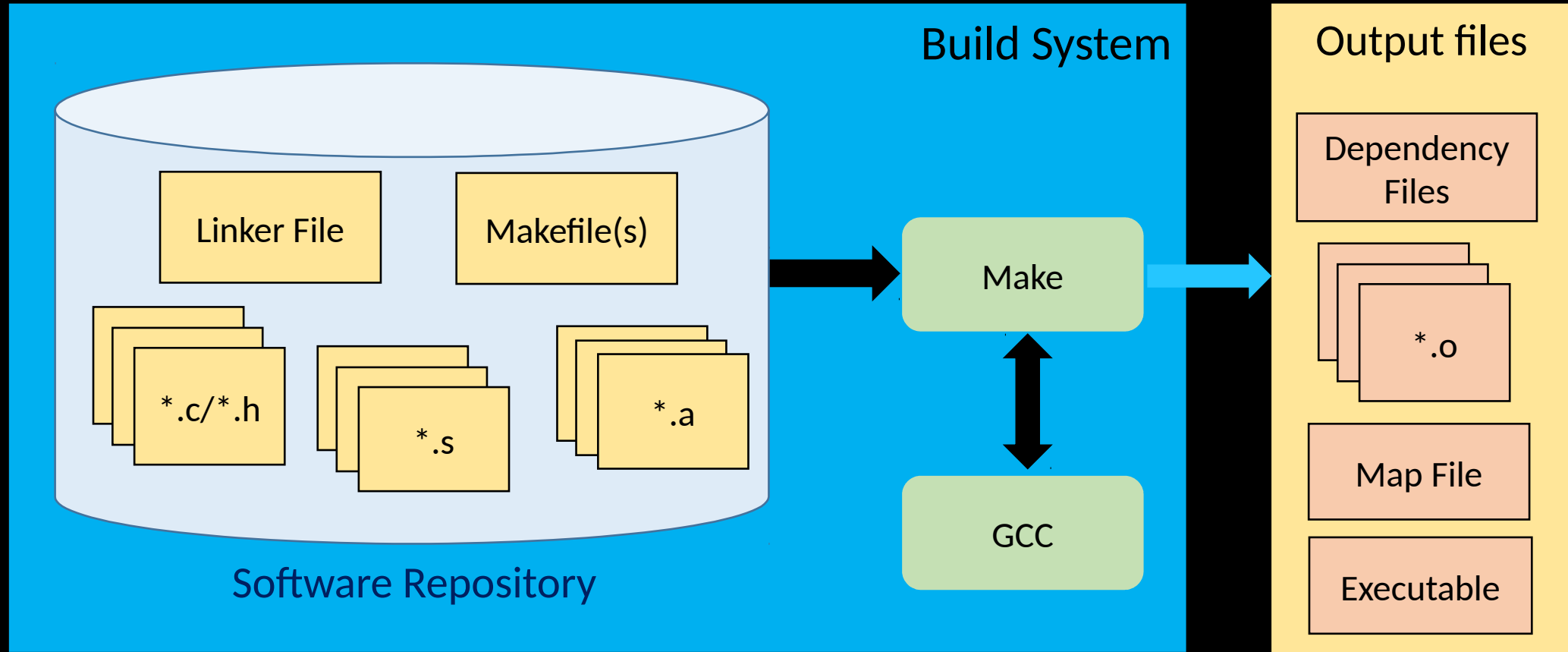**C1 M2 V7**

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Build System [S1]

Version Controlled Build System [S2]

Makefiles [S3]

- One or more files used to tell **make** how to build a particular project

  ```
  makefile, Makefile, sources.mk, includes.mk, …
  ```

- Makefiles have build **targets** or build **rules**

  ```
  $ make all      $ make clean      $ make main.out      $ make main.o
  ```

- Targets can have **dependencies** or **prerequisites**

  ```
  main.out: main.o my_file.o
      gcc –g –Wl,-Map=main.map –o main.out main.o my_file.o
  ```

Makefiles – Rules [S4]

- Build **rules** require a specific syntax of **target : prerequisite**s, and **commands**
- These are **recipes** for how to build a particular executable or non-source file
- A recipe can only be executed if the **dependencies** are met

Dependency List

```
target: prerequisite1 prerequisite2 prerequisite3
        command1
        command2
```

Recipes

Rule

- Simple my_file.o build rule: Depends on my_file.c and my_file.h

```
$ make my_file.o
```

Generates the **my_file.o** target by executing the following rule

```
my_file.o: my_file.c my_file.h
        gcc –c my_file.c –o my_file.o
```

Makefile Syntax [S5]

- Comments start with a #
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```
# This is a comment

# This includes another file
include sources.mk

# Variable & Line Continuance
FLAGS = -g          \
          -Werror \
          -std=c99

# my_file.o target binary
my_file.o: my_file.h my_file.c
     gcc $(FLAGS) –c –o my_file.o my_file.c

# main.o target binary
main.o: my_file.h
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# Main Target Executable
main.out: main.o my_file.o
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Makefile Variables [S6]

- Variables can be set to strings of text and can include other variables
  - Variable access is done with the **$(**_variable-name_**)** syntax

- Recursively Expanded Variables (**=**)
  - Expands **whenever** used
- Simply Expanded Variables (**:=**)
  - Expands **once** at the time of definition

- Use variables for things like
  - Compiler flags -> **CFLAGS**
  - Linker Flags -> **LDFLAGS**

Example Recursively Expanded Variables

```
CSTD=c89
CPU=cortex-m0plus
CC=arm-none-eabi-gcc
```

Example Simply Expanded Variables

```
ARCH:=$(shell arch)
CWD:=$(shell pwd)
OS:=$(shell uname)
```

Special examples that run Linux commands to set data

C-Flags Example Variables

```
CFLAGS = -g –std=$(CSTD) –mcpu=$(CPU) -mthumb
```

Include Paths and Sources [S7]

- Can control what **directories** and **source files** are used for building
  - Includes provide path to code (absolute or relative paths)
  - Sources determine what needs to be built

```
INCLUDES=   \          SRCS=          \
    -I./libs  \             ./main.c   \
    -I./modem \             ./memory.c \
    -I./uart  \             ./uart.c   \
    -I./arch                ./data.c
```

- Can reference a variable for include directories and sources files
  - Creates dynamic targets instead of statically defined targets

Building the Executable [S8]

- Use **variables** in your target rules

```
main.out: main.o my_file.o
    gcc –Wl,map=main.map –I./inc –o main.out main.o my_file.o


$(TARGET): $(OBJS)
    $(CC) $(CFLAGS) $(INCLUDES) $(LDFLAGS) –o $(TARGET) $(OBJS)
```

- **Automatic Variables** - variables in a recipe with a scope

```
$@ - Target              $(TARGET): $(OBJS)
$^ - All Prerequisites       $(CC) $(CFLAGS) $(LDFLAGS) $(INCLUDES) –o $@ $^
$< - First Prerequisite
```