

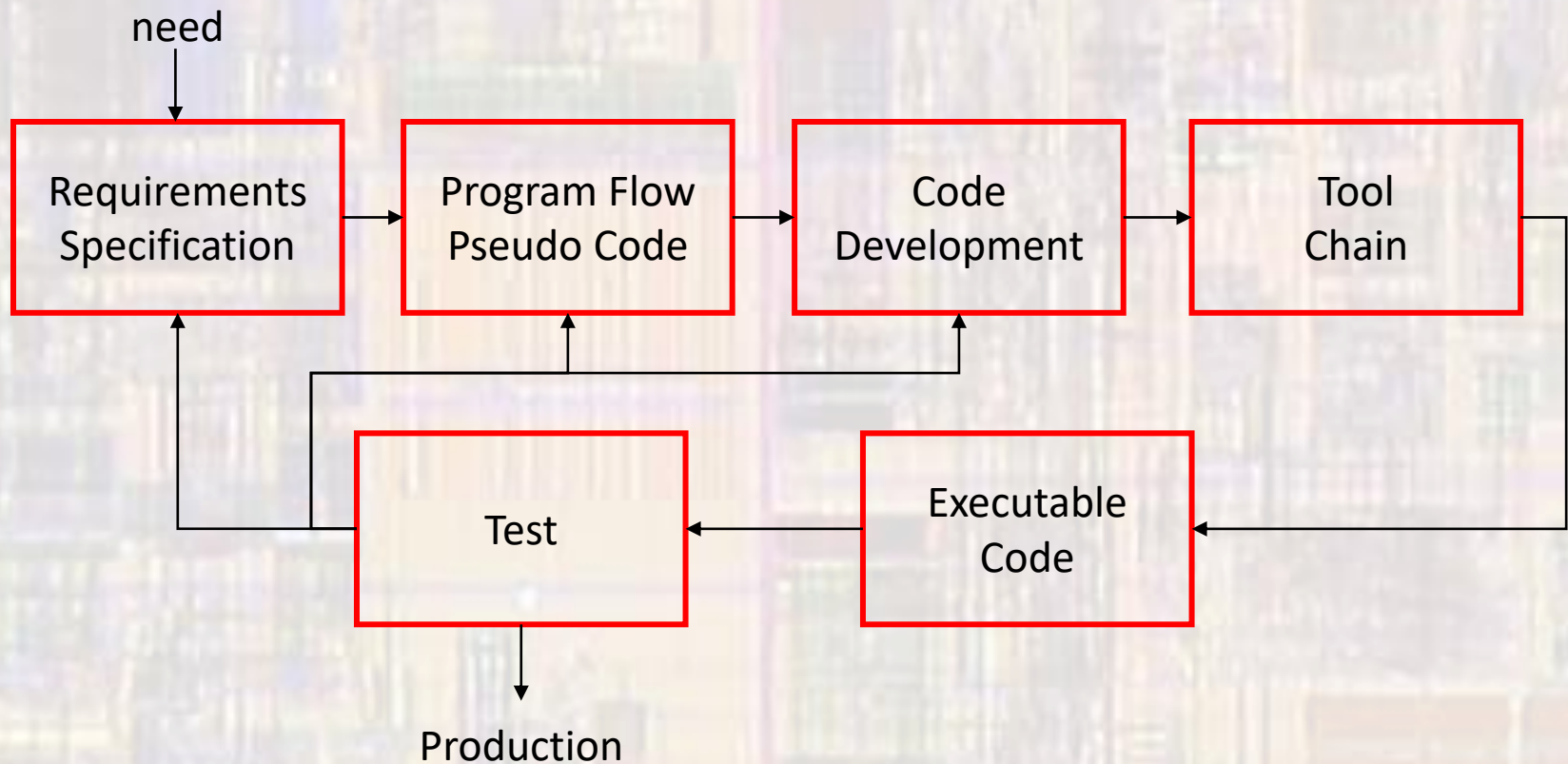
# Tool Chain

Last updated 6/14/23

These slides introduce the software development tool chain

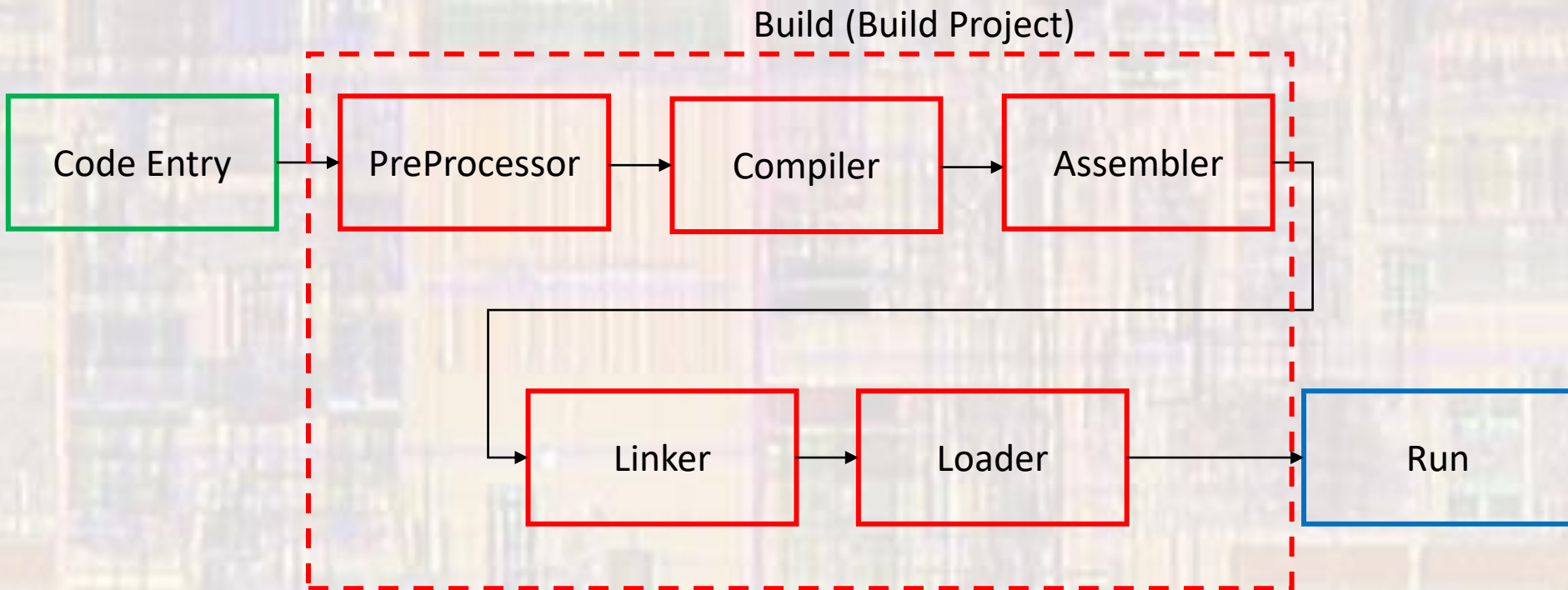
# Tool Chain

- Development process



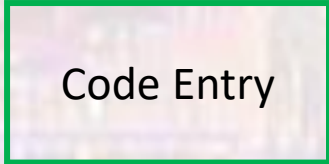
# Tool Chain

- Tool Chain



# Tool Chain

- Code Entry



Code Entry

- In C, the code goes into a file with a `.c` extension
  - filename.c
- Any text editor can be used to create the code file
- An Integrated Development Environment (IDE) provides additional features
  - Code checking and hints
  - Color coding
  - Debugging tools
- We will use Eclipse
  - Basis for TI (code composer) and STM (STM Cube) IDEs
- We may also use Visual Studio
  - Integrated IDE for Windows

# Tool Chain

- Preprocessor

PreProcessor

- Deals with any commands starting with #
- Tells the tool chain to include additional libraries
- Replaces any “defines” throughout the code
- Expands macros throughout the code
- Manages any conditional defines

# Tool Chain

- Compiler

Compiler

- Converts c-code to assembly language

- Assembly language

- Architecture specific programming language
  - ARM7, ARM9, RISCv, Intel ix, ...
- Direct access to specific registers, commands, memory

```
ldi R2, 5;           // load register R2 with the value 5
sts R2, 0x0200;      // copy the value in R2 to mem location 0x0200
add R2, R1;          // add the values of R2 and R1 and store in R2
```

# Tool Chain

- Assembler

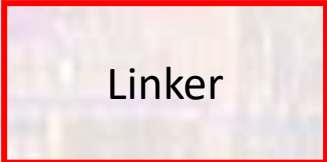
Assembler

- Converts assembly language to machine language
- Result is an object file (file.o)
- Machine language
  - Part specific programming language
    - Arm M3, M4, A7, A15, ...
  - Binary representation that the processor understands

```
1001 1000 1010 1101    // load register R2 with the value 5
1100 1011 1001 1100    // copy R2 to mem location 0x200
1100 1010 1100 0011    // add R2, R1 and store in R2
```

# Tool Chain

- Linker



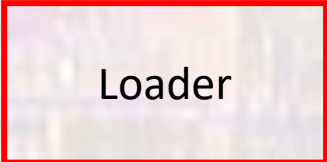
Linker

- Combines the machine language code from your program with all included libraries
- Configures all the code in memory
  - Aligns code segments
  - Makes connections where necessary (function calls)
  - Assigns variables to locations in memory
- Creates an executable file
  - file.exe for Windows systems
  - file.out (or no extension) for Linux systems



# Tool Chain

- Loader (programmer)



Loader

- Creates whatever environment is necessary on the executing machine
- Loads the executable program
- Starts the program

# Tool Chain

- Putting it all together

```
**** Build of configuration Debug for project Lab_MSP ****
```

```
"C:\\ti\\ccsv6\\utils\\bin\\gmake" -k all
'Building file: ../circle_msp.c'
'Invoking: MSP432 Compiler'
"C:/ti/ccsv6/tools/compiler/arm_15.12.3.LTS/bin/armcl" -mv7M4 --code_state=16 --float_support=FPv4SPD16 -me --
include_path="C:/ti/ccsv6/ccs_base/arm/include" --include_path="C:/ti/ccsv6/ccs_base/arm/include/CMSIS" --
include_path="C:/ti/ccsv6/tools/compiler/arm_15.12.3.LTS/include" --advice:power=all -g --gcc --define=__MSP432P401R__ --
define=TARGET_IS_MSP432P4XX --define=ccs --diag_warning=225 --diag_wrap=off --display_error_number --abi=eabi --preproc_with_compile --
preproc_dependency="circle_msp.d" "../circle_msp.c"
'Finished building: ../circle_msp.c'
''
'Building target: Lab_MSP.out'
'Invoking: MSP432 Linker'
"C:/ti/ccsv6/tools/compiler/arm_15.12.3.LTS/bin/armcl" -mv7M4 --code_state=16 --float_support=FPv4SPD16 -me --advice:power=all -g --gcc --
define=__MSP432P401R__ --define=TARGET_IS_MSP432P4XX --define=ccs --diag_warning=225 --diag_wrap=off --display_error_number --abi=eabi -
z -m"Lab_MSP.map" --stack_size=512 --heap_size=1024 -i"C:/ti/ccsv6/ccs_base/arm/include" -i"C:/ti/ccsv6/tools/compiler/arm_15.12.3.LTS/lib" -
i"C:/ti/ccsv6/tools/compiler/arm_15.12.3.LTS/include" --reread_libs --warn_sections --diag_wrap=off --display_error_number --
xml_link_info="Lab_MSP_linkInfo.xml" --rom_model -o "Lab_MSP.out" "../circle_msp.obj" "../startup_msp432p401r_ccs.obj"
"/system_msp432p401r.obj" "../msp432p401r.cmd" -llibc.a
<Linking>
remark #10371-D: (ULP 1.1) Detected no uses of low power mode state changing instructions
remark #10372-D: (ULP 4.1) Detected uninitialized Port 1 in this project. Recommend initializing all unused ports to eliminate wasted current
consumption on unused pins.
...
'Finished building target: Lab_MSP.out'
''

**** Build Finished ****
```