

EE712: EMBEDDED SYSTEMS DESIGN

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TIVA-C INTRODUCTION

(COURTESY: TEXAS INSTRUMENTS)

INTRODUCTION

TI Embedded Processing Portfolio

Embedded Processing Portfolio

**Microcontroller (MCU)
Portfolio at a Glance**

**ARM®-Based Processor
Portfolio at a Glance**

**Digital Signal Processor (DSP)
Portfolio at a Glance**

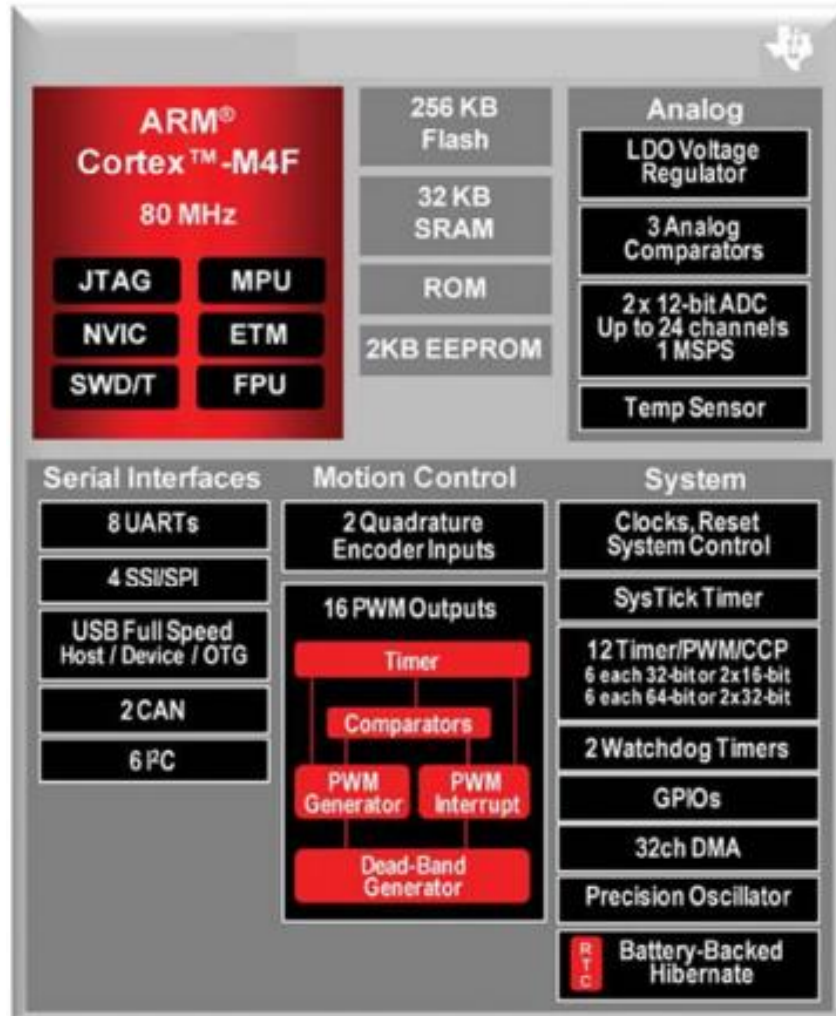
MCU	Software, Tools, Kits & Boards			DSP & ARM® MPU		
<div style="background-color: #eee; padding: 5px; margin-bottom: 5px;">16-bit ultra-low power MCUs</div> <div style="background-color: #f00; color: white; padding: 5px; margin-bottom: 5px;">MSP430™</div> <div style="background-color: #f00; color: white; padding: 2px; margin-bottom: 2px;">Overview</div> <div style="background-color: #f00; color: white; padding: 2px; margin-bottom: 2px;">Device Table</div> <div style="background-color: #f00; color: white; padding: 2px; margin-bottom: 2px;">SW & Kits</div> <div style="font-size: 0.8em;">Up to 25 MHz</div> <div style="font-size: 0.8em;">Flash 1 KB to 256 KB</div> <div style="font-size: 0.8em;">Analog I/O, ADC, LCD, USB, FRAM</div> <div style="font-size: 0.8em;">Measurement, sensing, general purpose</div> <div style="font-size: 0.8em;">\$0.25 to \$9.00</div>	<div style="background-color: #eee; padding: 5px; margin-bottom: 5px;">32-bit real-time MCUs</div> <div style="background-color: #f00; color: white; padding: 5px; margin-bottom: 5px;">C2000™</div> <div style="background-color: #f00; color: white; padding: 2px; margin-bottom: 2px;">Overview</div> <div style="background-color: #f00; color: white; padding: 2px; margin-bottom: 2px;">Device Table</div> <div style="background-color: #f00; color: white; padding: 2px; margin-bottom: 2px;">SW & Kits</div> <div style="font-size: 0.8em;">40 MHz to 300 MHz</div> <div style="font-size: 0.8em;">Flash, RAM 16 KB to 512 KB</div> <div style="font-size: 0.8em;">PWM, ADC, CAN, SPI, I²C</div> <div style="font-size: 0.8em;">Motor control, digital power, lighting, ren. energy</div> <div style="font-size: 0.8em;">\$1.85 to \$20.00</div>	<div style="background-color: #eee; padding: 5px; margin-bottom: 5px;">32-bit ARM® MCUs</div> <div style="background-color: #f00; color: white; padding: 5px; margin-bottom: 5px;">Tiva™ C Series ARM Cortex™-M4F</div> <div style="background-color: #f00; color: white; padding: 2px; margin-bottom: 2px;">Overview</div> <div style="background-color: #f00; color: white; padding: 2px; margin-bottom: 2px;">Device Table</div> <div style="background-color: #f00; color: white; padding: 2px; margin-bottom: 2px;">SW & Kits</div> <div style="font-size: 0.8em;">Up to 80 MHz</div> <div style="font-size: 0.8em;">Flash 32 KB to 256 KB</div> <div style="font-size: 0.8em;">USB, CAN, ADC, PWM, SPI</div> <div style="font-size: 0.8em;">Home, building, and industrial</div> <div style="font-size: 0.8em;">\$2.15 to \$5.25</div>	<div style="background-color: #eee; padding: 5px; margin-bottom: 5px;">32-bit ARM® safety MCUs</div> <div style="background-color: #f00; color: white; padding: 5px; margin-bottom: 5px;">Hercules™ ARM Cortex-R4F</div> <div style="background-color: #f00; color: white; padding: 2px; margin-bottom: 2px;">Overview</div> <div style="background-color: #f00; color: white; padding: 2px; margin-bottom: 2px;">Device Table</div> <div style="background-color: #f00; color: white; padding: 2px; margin-bottom: 2px;">SW & Kits</div> <div style="font-size: 0.8em;">Fixed/floating up to 220 MHz</div> <div style="font-size: 0.8em;">Flash 256 KB to 3 MB</div> <div style="font-size: 0.8em;">USB, ENET, FlexRay™, Timer/PWM, ADC, CAN, LIN, SPI, I²C, EMIF</div> <div style="font-size: 0.8em;">Safety, transportation, industrial & medical</div> <div style="font-size: 0.8em;">\$5.00 to \$30.00</div>	<div style="background-color: #eee; padding: 5px; margin-bottom: 5px;">32-bit ARM® processors</div> <div style="background-color: #f00; color: white; padding: 5px; margin-bottom: 5px;">Sitara™ ARM Cortex-A8 ARM9™</div> <div style="background-color: #f00; color: white; padding: 2px; margin-bottom: 2px;">Overview</div> <div style="background-color: #f00; color: white; padding: 2px; margin-bottom: 2px;">Device Table</div> <div style="background-color: #f00; color: white; padding: 2px; margin-bottom: 2px;">SW & Kits</div> <div style="font-size: 0.8em;">Up to 1.35 GHz</div> <div style="font-size: 0.8em;">Up to 32 KB I/D cache 256 KB L2, LPDDR, DDR2/3 support</div> <div style="font-size: 0.8em;">GEMAC, PCIe+PHY, SATA+PHY, CAN, USB+PHY, PR-ICSS</div> <div style="font-size: 0.8em;">Consumer, industrial, connected home, POS smart grid, medical</div> <div style="font-size: 0.8em;">\$5.00 - \$25.00</div>	<div style="background-color: #eee; padding: 5px; margin-bottom: 5px;">Singlecore DSPs</div> <div style="background-color: #f00; color: white; padding: 5px; margin-bottom: 5px;">C5000™ C6000™</div> <div style="background-color: #f00; color: white; padding: 2px; margin-bottom: 2px;">Overview</div> <div style="background-color: #f00; color: white; padding: 2px; margin-bottom: 2px;">Device Table</div> <div style="background-color: #f00; color: white; padding: 2px; margin-bottom: 2px;">SW & Kits</div> <div style="font-size: 0.8em;">Up to 800 MHz DSPs</div> <div style="font-size: 0.8em;">SDRAM, DDR2</div> <div style="font-size: 0.8em;">uPP, I²C, I²S, UHP, McASP/McBSP, LCD, C, integrated connectivity options: USB 2.0, EMAC</div> <div style="font-size: 0.8em;">Patent monitoring, biometric security, smart e-meter, industrial drives</div> <div style="font-size: 0.8em;">\$2.00 to \$25.00</div>	<div style="background-color: #eee; padding: 5px; margin-bottom: 5px;">Multicore processors</div> <div style="background-color: #f00; color: white; padding: 5px; margin-bottom: 5px;">C6000™ DSP and ARM Cortex-A15</div> <div style="background-color: #f00; color: white; padding: 2px; margin-bottom: 2px;">Overview</div> <div style="background-color: #f00; color: white; padding: 2px; margin-bottom: 2px;">Device Table</div> <div style="background-color: #f00; color: white; padding: 2px; margin-bottom: 2px;">SW & Kits</div> <div style="font-size: 0.8em;">Up to 10 GHz multicore, fixed/ floating + accelerators</div> <div style="font-size: 0.8em;">Up to 4 MB SL2, 32 KB L1, 1 MB L2</div> <div style="font-size: 0.8em;">RapidIO®, PCIe, McBSP, 10/100 MAC, uPP, UART, Hyperlink, DDR2/3</div> <div style="font-size: 0.8em;">Telecom, medical, mission critical, base stations</div> <div style="font-size: 0.8em;">\$30 to \$225.00</div>

MPUs – Microprocessors

If you're looking for DaVinci products, please click [here](#).



TIVA TM4C MICROCONTROLLER



- ❑ 32-bit ARM Cortex M4 Core
- ❑ System clock frequency: 80 MHz
- ❑ Unaligned data access
- ❑ Atomic bit manipulation
- ❑ Single precision floating point unit
- ❑ 8 – UART, 6 – I²C, 4 – SPI, 2 – CAN, USB 2.0
- ❑ Two SAR ADCs: 12-bit, 1 Msps (12 shared inputs)
- ❑ 3 – analog and 16 – digital comparators
- ❑ 32-channel uDMA
- ❑ 2 watchdog timers (separate clock)
- ❑ Nested-vectored interrupt controller

TIVA TM4C MEMORY

256KB Flash memory

- ◆ Single-cycle to 40MHz
- ◆ Pre-fetch buffer and speculative branch improves performance above 40 MHz

32KB single-cycle SRAM with bit-banding

Internal ROM loaded with TivaWare software

- ◆ Peripheral Driver Library
- ◆ Boot Loader
- ◆ Advanced Encryption Standard (AES) cryptography tables
- ◆ Cyclic Redundancy Check (CRC) error detection functionality

2KB EEPROM (fast, saves board space)

- ◆ Wear-leveled 500K program/erase cycles
- ◆ Thirty-two 16-word blocks
- ◆ Can be bulk or block erased
- ◆ 10 year data retention
- ◆ 4 clock cycle read time

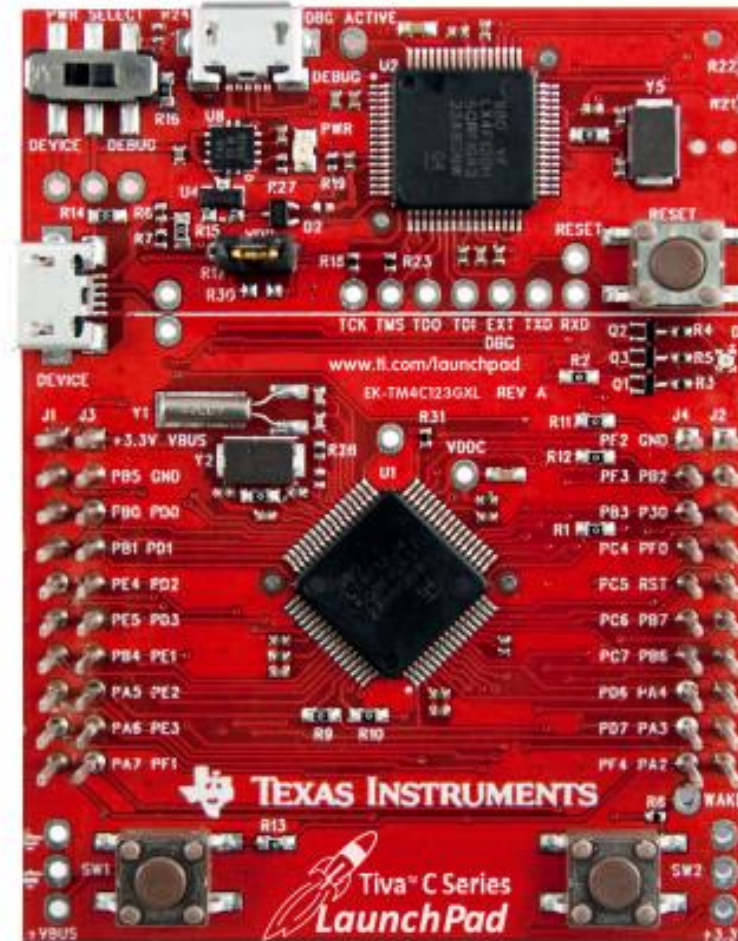


0x00000000 Flash
0x01000000 ROM
0x20000000 SRAM
0x22000000 Bit-banded SRAM
0x40000000 Peripherals & EEPROM
0x42000000 Bit-banded Peripherals
0xE0000000 Instrumentation, ETM, etc.



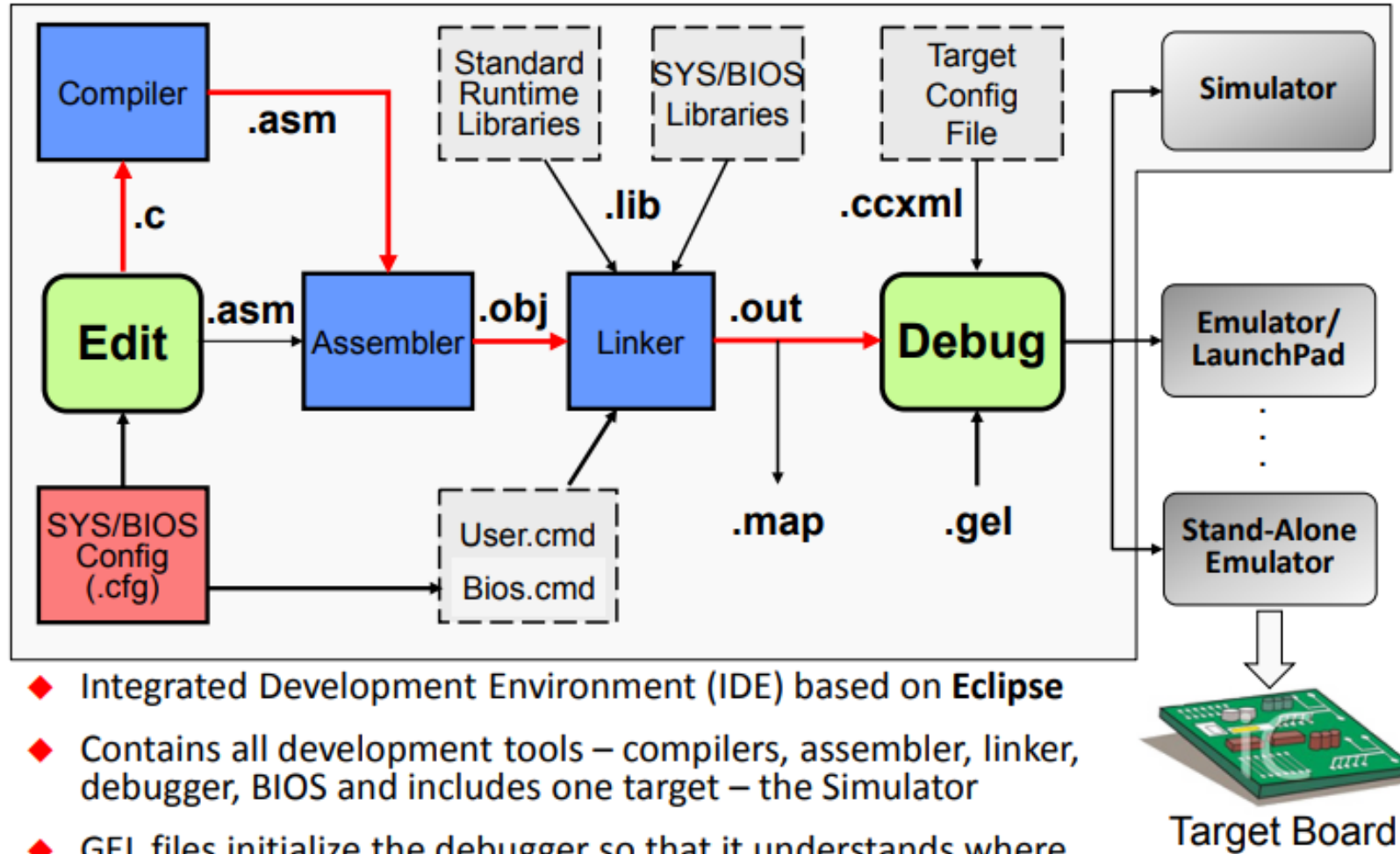
TIVA-C LAUNCHPAD

- ◆ **ARM® Cortex™-M4F**
64-pin 80MHz TM4C123GH6PM
- ◆ **On-board USB ICDI**
(In-Circuit Debug Interface)
- ◆ **Micro AB USB port**
- ◆ **Device/ICDI power switch**
- ◆ **BoosterPack XL pinout also supports legacy BoosterPack pinout**
- ◆ **2 user pushbuttons**
(SW2 is connected to the WAKE pin)
- ◆ **Reset button**
- ◆ **3 user LEDs (1 tri-color device)**
- ◆ **Current measurement test points**
- ◆ **16MHz Main Oscillator crystal**
- ◆ **32kHz Real Time Clock crystal**
- ◆ **3.3V regulator**
- ◆ **Support for multiple IDEs:**

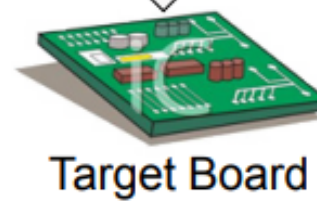


CCS OVERVIEW

Code Composer Studio Functional Overview

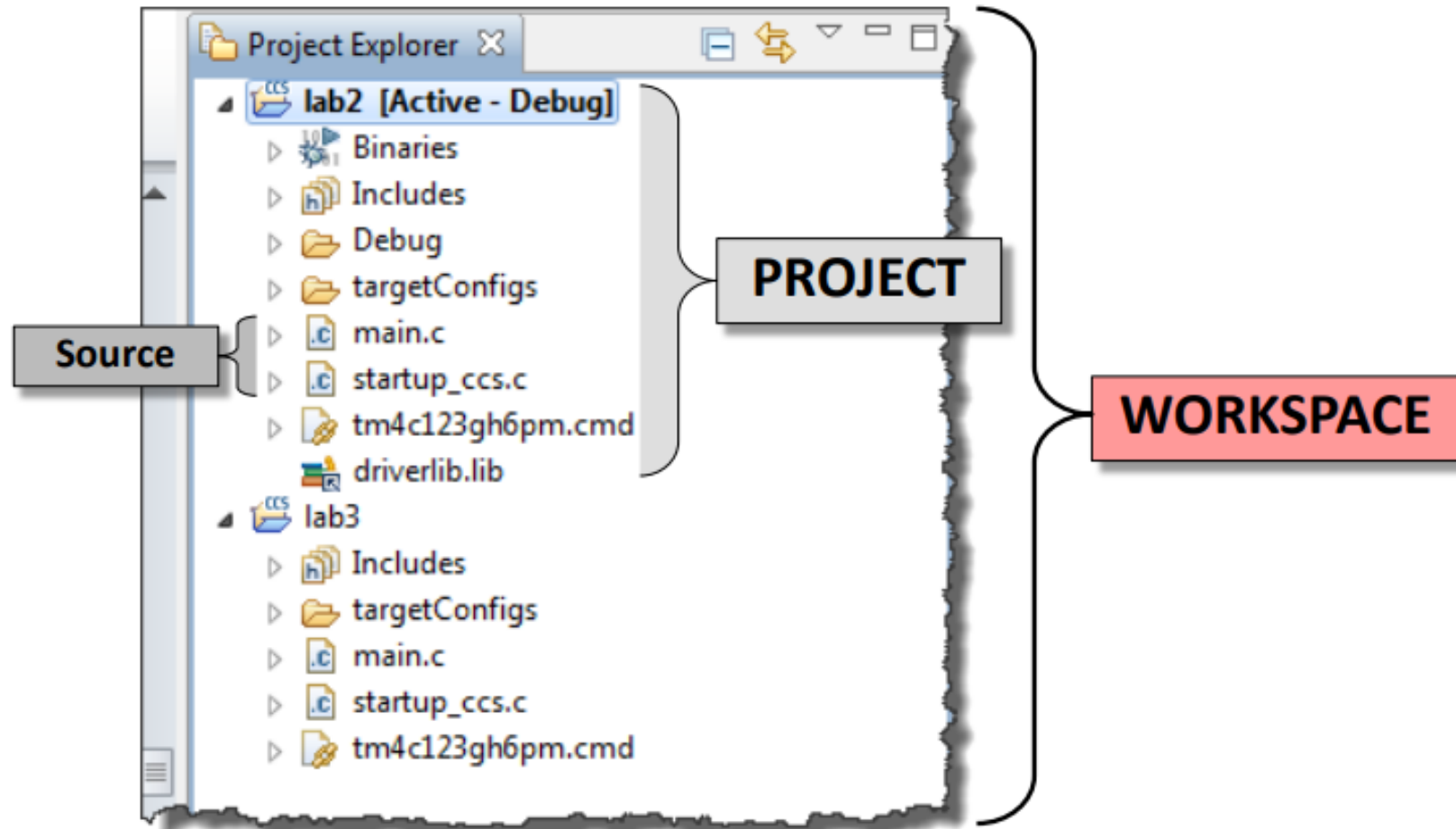


- ◆ Integrated Development Environment (IDE) based on **Eclipse**
- ◆ Contains all development tools – compilers, assembler, linker, debugger, BIOS and includes one target – the Simulator
- ◆ GEL files initialize the debugger so that it understands where memory, peripherals, etc. are



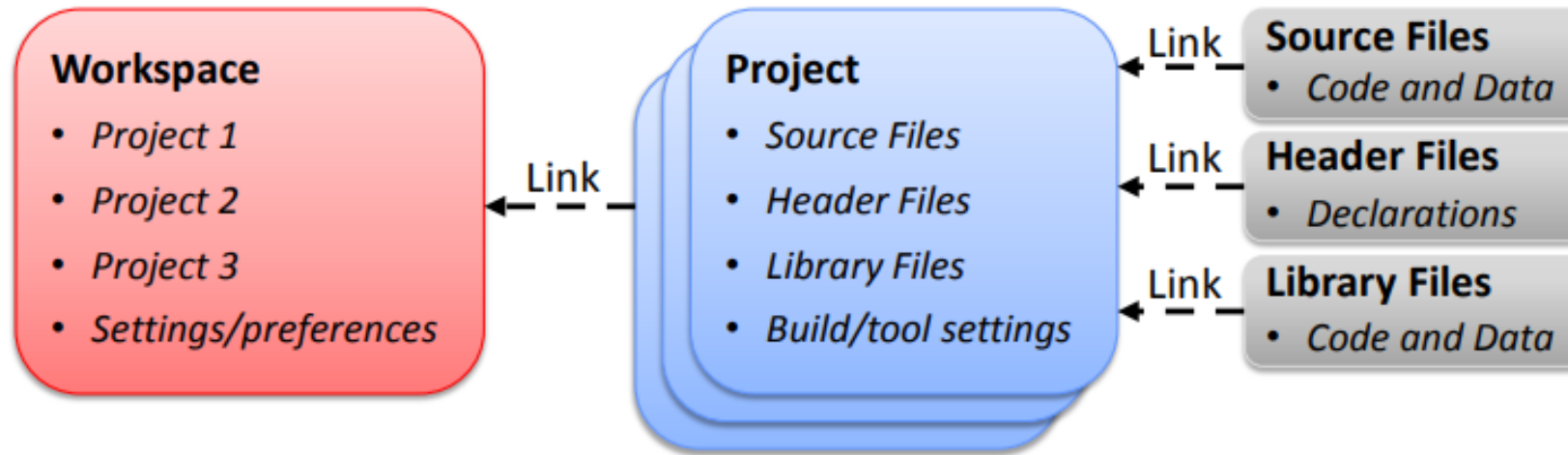
CCS OVERVIEW

Projects and Workspaces (viewed in CCS)



CCS OVERVIEW

Projects and Workspaces



◆ WORKSPACE folder contains:

- IDE settings and preferences
- Projects can **reside in** the workspace folder or be **linked** from elsewhere
- When importing projects into the workspace, linking is recommended
- Deleting a project within the Project Explorer only deletes the link

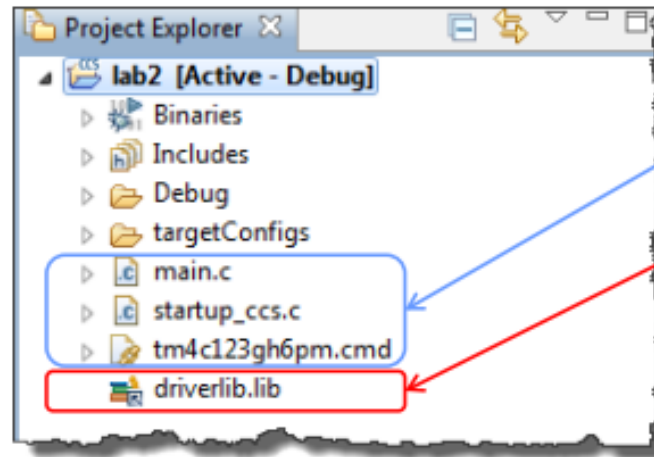
◆ PROJECT folder contains:

- Build and tool settings (for use in managed MAKE projects)
- Files can be **linked to** or **reside in** the project folder
- Deleting a linked file within the Project Explorer only deletes the link

CCS OVERVIEW

Portable Projects

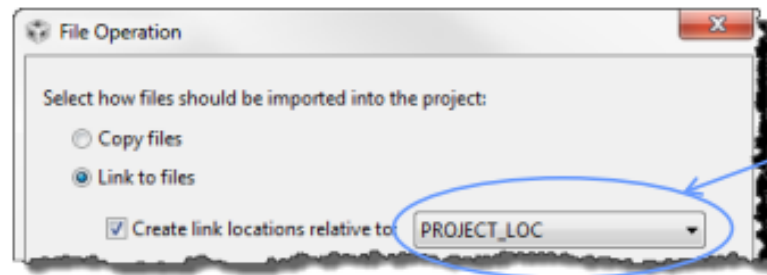
- ◆ Why make your projects “portable”?
 - Simplifies project sharing
 - You can easily re-locate your projects
 - Allow simple changes to link to new releases of software libraries



Copied files are not a problem (they move with the project folder)

Linked files may be an issue. They are located outside the project folder via a:

- absolute path, or
- relative path



This is the Path Variable for a relative path. This can be specified for every linked file.

CCS OVERVIEW

Path Variables and Build Variables

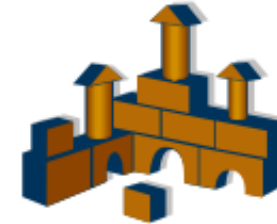
◆ Path Variables

- Used by CCS (Eclipse) to store the base path for relative linked files
- Example: **PROJECT_LOC** is set to the path of your project, say
`c:/Tiva_LaunchPad_Workshop/lab2/project`
- Used as a reference point for relative paths, e.g.
`${PROJECT_LOC}/../files/main.c`



◆ Build Variables

- Used by CCS (Eclipse) to store base path for build libraries or files
- Example: **CG_TOOL_ROOT** is set to the path for the code generation tools (compiler/linker)
- Used to find `#include .h` files, or object libraries, e.g.
`${CG_TOOL_ROOT}/include` or `${CG_TOOL_ROOT}/lib`



◆ How are these variables defined?

- The variables in these examples are automatically defined when you create a new project (**PROJECT_LOC**) and when you install CCS with the build tools (**CG_TOOL_ROOT**)
- What about TivaWare or additional software libraries? You can define some new variables yourself



CCS OVERVIEW

Build Configurations

- ◆ Code Composer has two pre-defined BUILD CONFIGURATIONS:
 - *Debug* (symbols, no optimization) – great for LOGICAL debug
 - *Release* (no symbols, optimization) – great for PERFORMANCE
- ◆ Users can create their own custom build configurations
 - Right-click on the project and select *Properties*
 - Then click “*Processor Options*” or any other category:

