Enhanced Project Management for Embedded C/C++ Programming using Software Components

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The Architecture for the Digital World®

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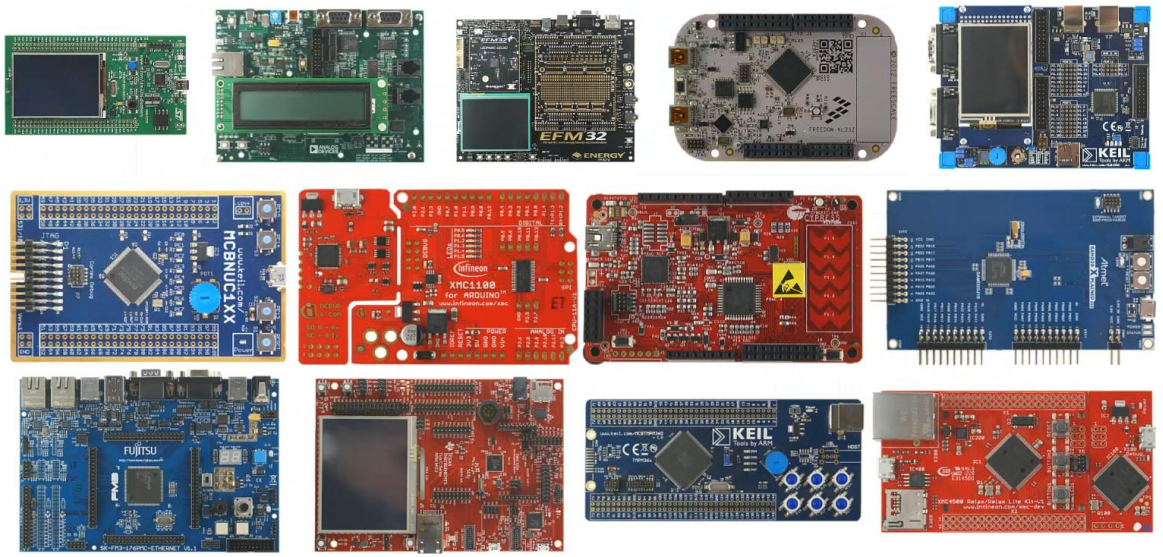
Outline

- Introduction
  - Challenges of embedded software development
  - What is CMISIS and CMSIS-Packs
- CMSIS-Pack Eclipse Plug-in
  - Demo
  - Architecture: plug-ins and their dependencies, major types, data flow
  - RTE (Run Time Environment) Model: component filtering and resolving dependencies
  - CDT integration: creating and updating project, managing toolchain settings
  - Accessing RTE configuration information: device properties, selected components, files
- Conclusions

Embedded software development challenges

- Growing complexity of embedded devices
  - availability of device and board information
  - startup code
  - device drivers
  - flash programming algorithms
  - debug awareness



- Software complexity and flexibility
  - possibility to reuse middleware and application software components

- Application portability across different devices from different vendors
  - unification in software interfaces to processors and peripherals

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What is CMSIS?

- The ARM Cortex Microcontroller Software Interface Standard,
  a vendor-independent standard for silicon partners, tool vendors and end users
- Establishes a software foundation with a set of specifications, libraries, and interfaces
- Enables consistent software layers and device support across a wide range of development tools and microcontrollers.

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CMSIS-Pack: delivery mechanism for SW components

- CMSIS-Pack specifies a way to deliver software components and device information in a structured manner
- Designed to be versatile and usable for a wide range of use cases

- The pack deliverables include:
  - Source code, header files, software libraries
  - Documentation, source code templates and examples
  - Device parameters along with startup code and flash programing algorithms

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CMISIS-Pack: description file content

Components	• Uniquely identified by its taxonomy: class, group, sub-group, and variant • List of files that make up a software component
Conditions	• Describes dependencies on device, processor, tools, or other components • Components are only available if their conditions resolve to fulfilled
Devices	• Hierarchical list of devices supported by the Pack (family/subFamily/device) • Properties: processor, memory, debug info, books, features
Boards	• Defines development boards • Information is used in tools but also on web pages
Examples	• Project examples acting as usage references of software components • References to boards identify the targeted hardware

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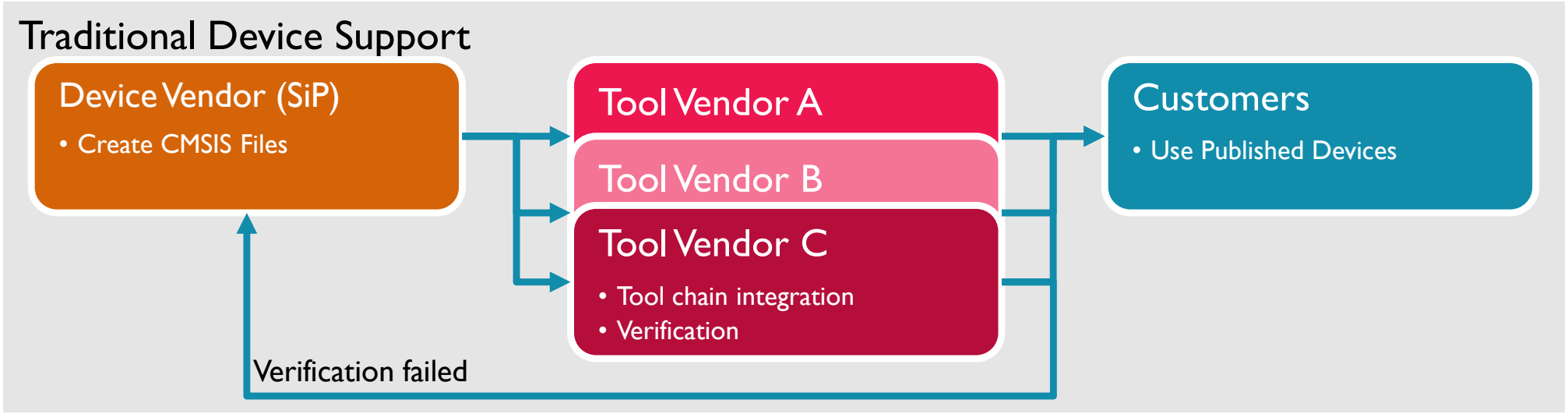
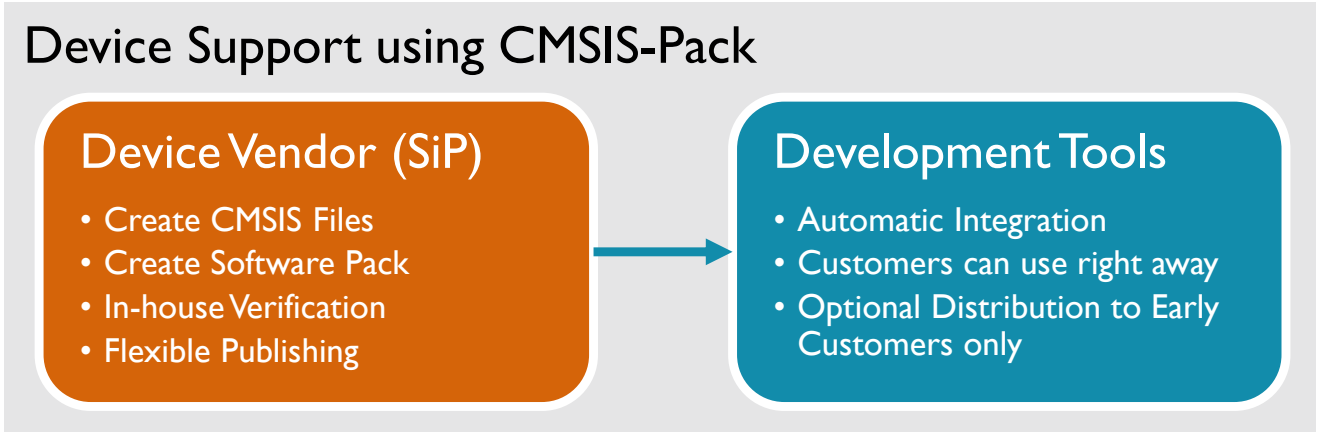
Faster device support with CMSIS-Pack





Early verification during chip design phase
→ better overall quality

One Pack for multiple tool chains
Flexible distribution to customers
→ faster development start

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CMSIS-Pack Eclipse Plug-in

- Reference implementation of CMSIS-Pack support in Eclipse environment.
  - open source under Eclipse Public License 1.0
  - https://github.com/ARM-software/cmsis-pack-eclipse
- Implements the fundamentals to access the Pack information and resources:
  - parses installed CMSIS-Packs
  - creates and manages Run-Time Environment configurations
- Provides CDT integration:
  - creates and dynamically manages C/C++ projects
  - updates toolchain settings
- Can be re-used by the ARM eco-system in tools such as:
  - development environments, configuration utilities

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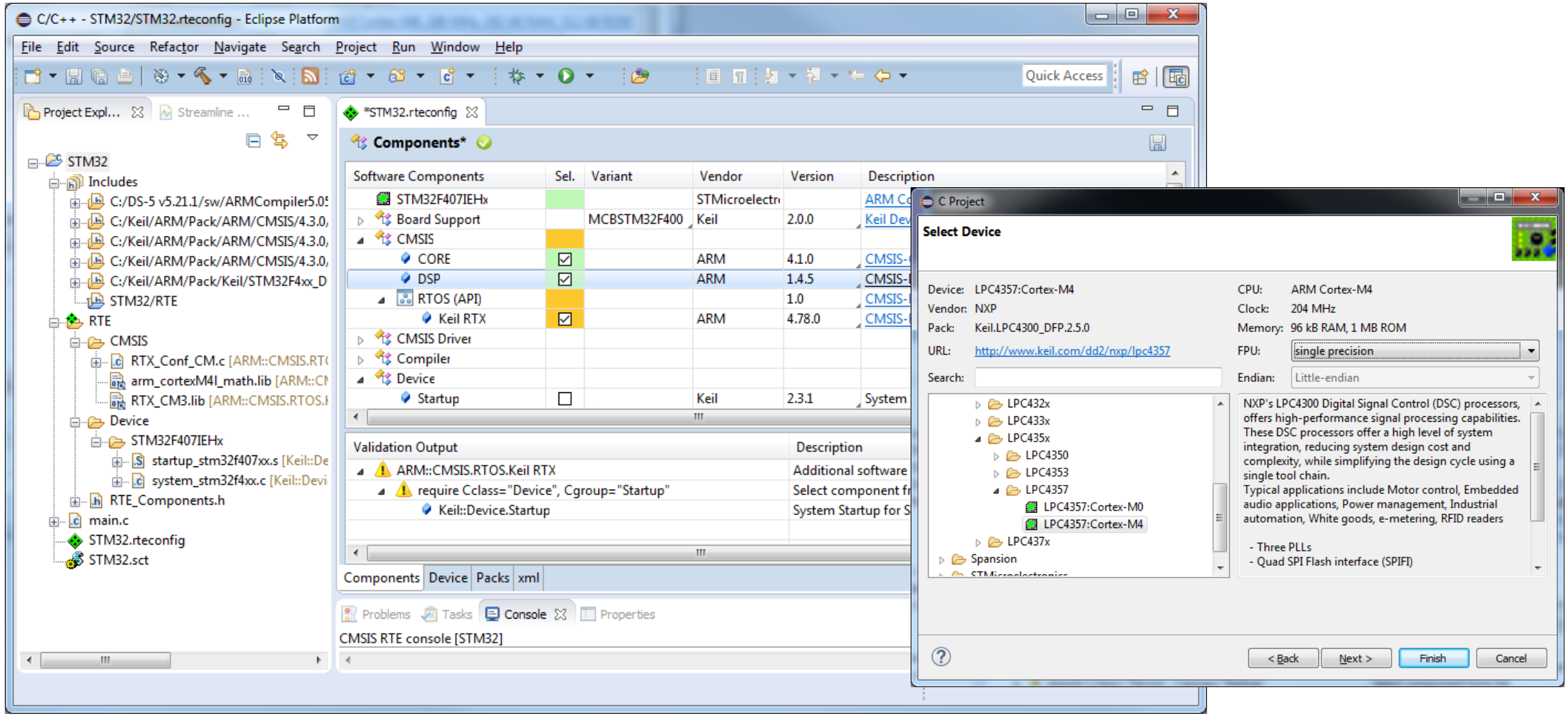
Demo


C/C++ - STM32/STM32.rteconfig - Eclipse Platform
File Edit Source Refactor Navigate Search Project Run Window Help
Quick Access
Project Expl...
Streamline ...
STM32
Includes
C:/DS-5 v5.21.1/sw/ARMCompiler5.0
C:/Keil/ARM/Pack/ARM/CMSIS/4.3.0/
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C:/Keil/ARM/Pack/Keil/STM32F4xx_D
STM32/RTE
RTE
CMSIS
RTX_Conf_CM.c [ARM::CMSIS.RT
arm_cortexM4l_math.lib [ARM::C
RTX_CM3.lib [ARM::CMSIS.RTOS.
Device
STM32F407IEHx
startup_stm32f407xx.s [Keil::De
system_stm32f4xx.c [Keil::Devi
RTE_Components.h
main.c
STM32.rteconfig
STM32.sct
*STM32.rteconfig
Components*
Software Components
Sel.
Variant
Vendor
Version
Description
STM32F407IEHx
STMicroelectr
Board Support
MCBSTM32F400
Keil
2.0.0
CMSIS
CORE
ARM
4.1.0
DSP
ARM
1.4.5
RTOS (API)
1.0
Keil RTX
ARM
4.78.0
CMSIS Driver
Compiler
Device
Startup
Keil
2.3.1
System
Validation Output
Description
ARM::CMSIS.RTOS.Keil RTX
Additional software
require Cclass="Device", Cgroup="Startup"
Select component fr
Keil::Device.Startup
System Startup for S
Components
Device
Packs
xml
Problems
Tasks
Console
Properties
CMSIS RTE console [STM32]
C Project
Select Device
Device: LPC4357:Cortex-M4
Vendor: NXP
Pack: Keil.LPC4300_DFP.2.5.0
URL: http://www.keil.com/dd2/nxp/lpc4357
CPU: ARM Cortex-M4
Clock: 204 MHz
Memory: 96 kB RAM, 1 MB ROM
FPU: single precision
Endian: Little-endian
Search:
LPC432x
LPC433x
LPC435x
LPC4350
LPC4353
LPC4357
LPC4357:Cortex-M0
LPC4357:Cortex-M4
LPC437x
Spansion
NXP's LPC4300 Digital Signal Control (DSC) processors, offers high-performance signal processing capabilities. These DSC processors offer a high level of system integration, reducing system design cost and complexity, while simplifying the design cycle using a single tool chain.
Typical applications include Motor control, Embedded audio applications, Power management, Industrial automation, White goods, e-metering, RFID readers
- Three PLLs
- Quad SPI Flash interface (SPIFI)
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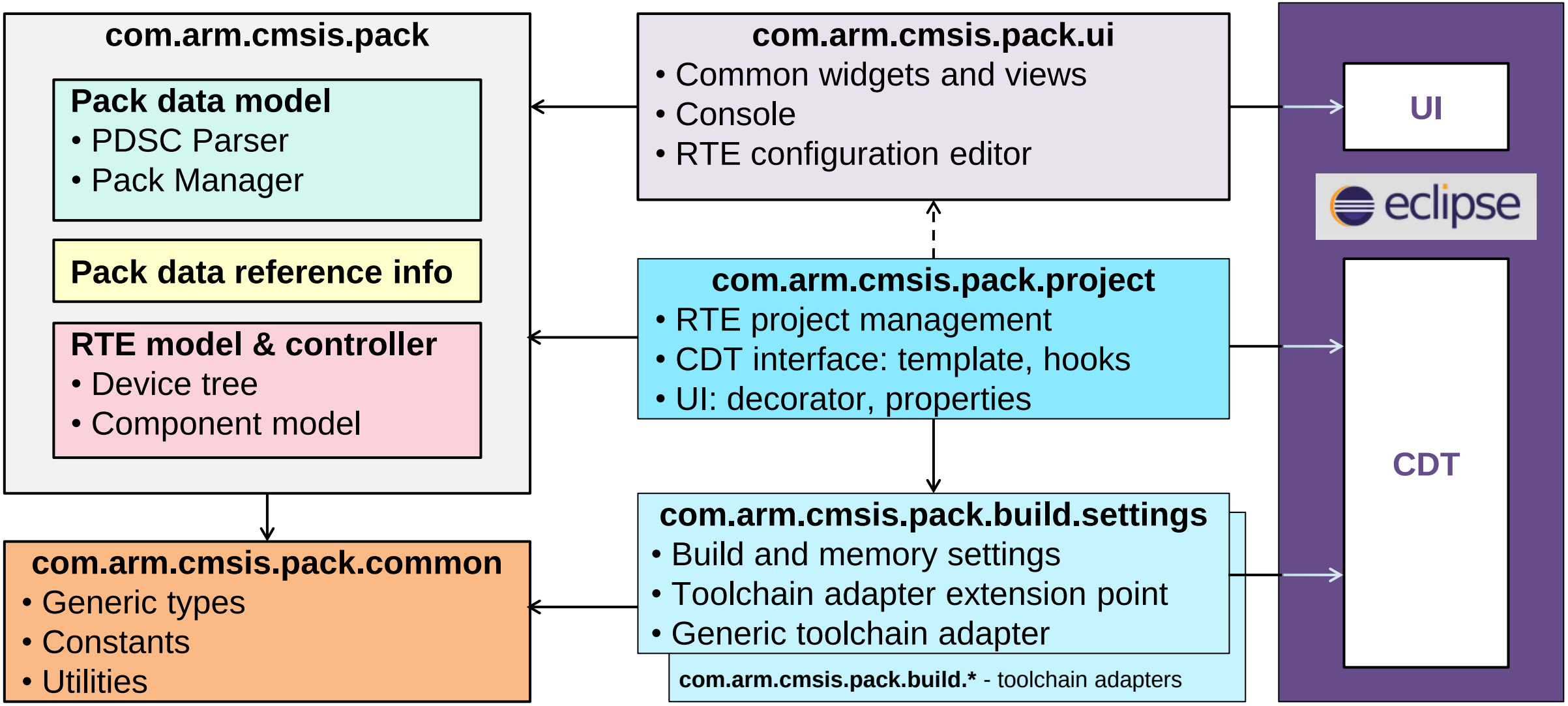
Architecture: modules



Major data types

- Pack data model read from PDSC (Pack Description) files:
  - **ICpItem** – base interface for CMSIS-Pack elements, implements most of functionality
  - basics functions: getTag(), getText(), getAttribute(), getParent(), getChildren()
  - advanced functions: getName(), getId(), getVendor(), getVersion(), getUrl(), getPack()
  - derived interfaces: *ICpPack, ICpComponent, ICpFile, ICpDeviceItem*
- Reference information stored in *rteconfig* file:
  - **ICpItemInfo** – CMSIS-Pack element references, extends **ICpItem**
  - derived interfaces: *ICpPackInfo, ICpComponentInfo, ICpFileInfo, ICpDeviceInfo*
- RTE Model constructed from Pack data and reference info:
  - **IRteComponentItem** – component tree
  - **IRteDeviceItem** – device tree
  - **IRtePackItem** – pack tree

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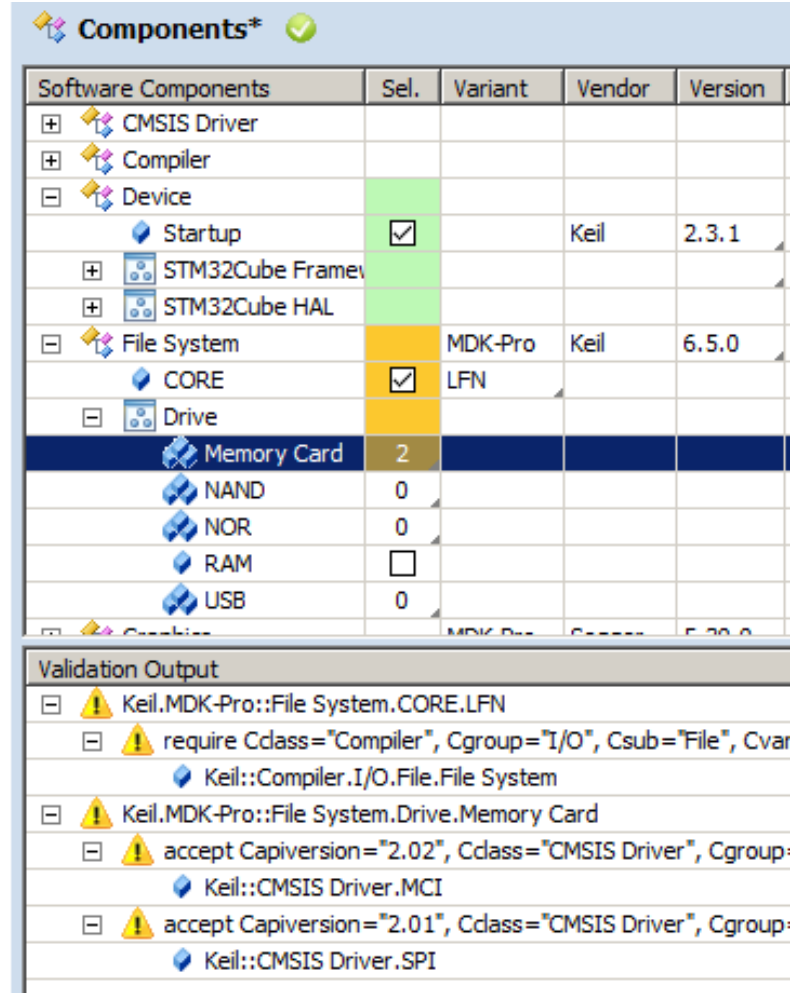
RTE (Run-Time-Environment) Model

- Filters components for selected device and toolchain
  - evaluates conditions using *ICpConditionContext* as strategy/visitor
- Aggregates components from different packs into single tree
  - according to taxonomy: class/group/sub-group
- Manages component selection via RTE controller
  - saves configuration as collection of *ICpComponentInfo* items
- Evaluates and resolves component dependencies
  - evaluates conditions using *IRteDependencySolver* as strategy/visitor
- Resolves previously saved component references



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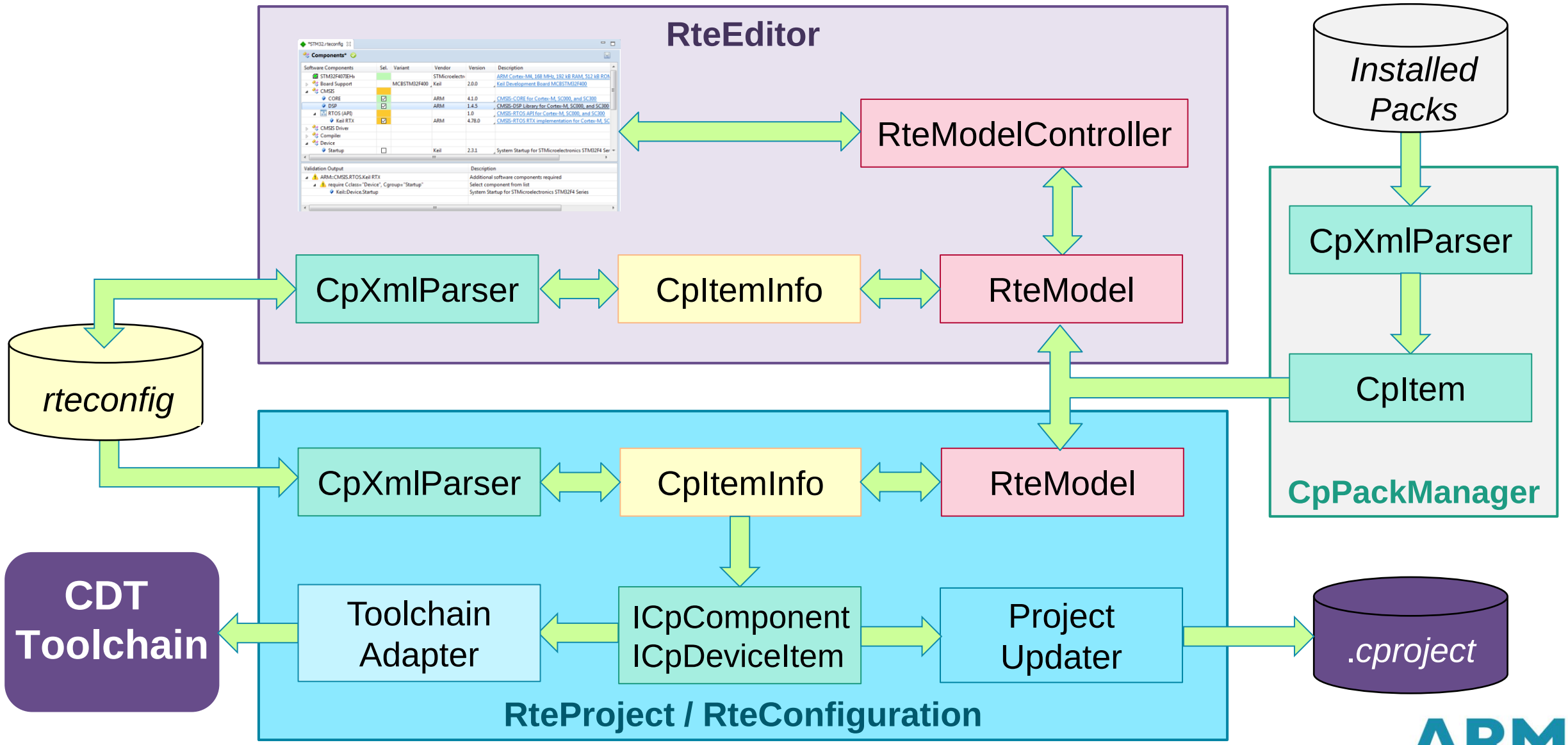
Architecture: data flow



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CDT integration: Toolchain adapter

- Responsible for setting toolchain options according to selected device and components:

include paths, libraries, preprocessor defines	• can be done generically, depending on *IOption.getValueType()*
CPU type, FPU type, endian	• requires option base ID, for instance "*com.arm.tool.c.compiler.option.targetcpu*" • might require consistent update of several options
linker script / scatter file	• requires option base ID • initial script could be generated from device information (optional)

- Any toolchain needs an adapter, even for the same compiler:
  - Use *com.arm.cmsis.pack.build.settings.ToolChainAdapter* extension point
  - Implement *IRteToolChainAdapter* or extend *RteToolChainAdapter*
- Toolchains supported by CMSIS-Pack Eclipse plug-in:
  - ARM Compiler 5 (ARM DS-5 built-in)
  - Cross ARM GCC (http://gnuarmeclipse.github.io/)

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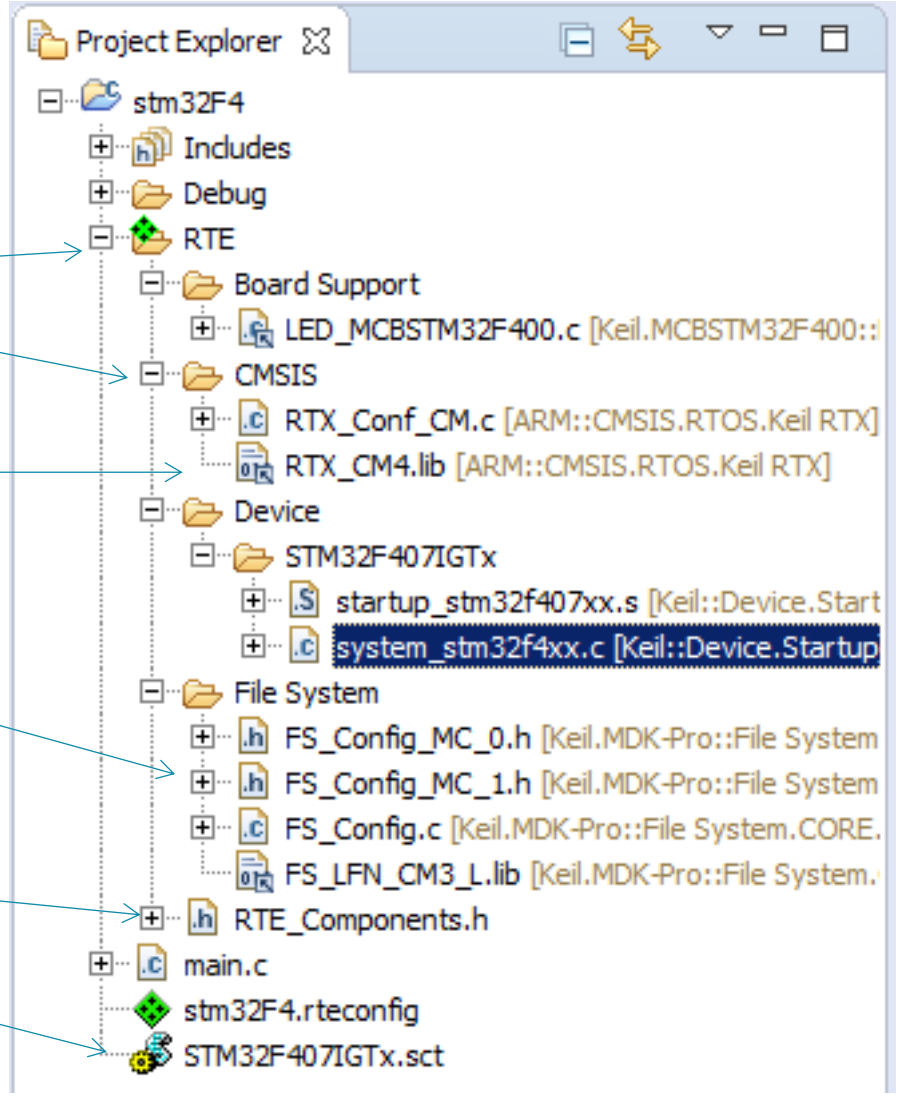
CDT integration: updating project

- Project update job is scheduled when:
  - project gets loaded or configuration file *${ProjName}.rteconfig* changes
- Component files are added to RTE/*Cclass* folders:
  - referenced as a link to pack location

    ${cmsis_pack_root}/ARM/CMSIS/4.3.0/CMSIS/RTOS/RTX/LIB/ARM/RTX_CM4.lib
  - copied to project, *_n* suffix is used for multiple component instances

    ${workspace_loc}/${ProjName}/RTE /File System/FS_Config_MC_1.h
  - unused files are removed
- RTE_components.h file is generated
- Linker script is generated on create and device change
- Toolchain adapter is called to update build settings



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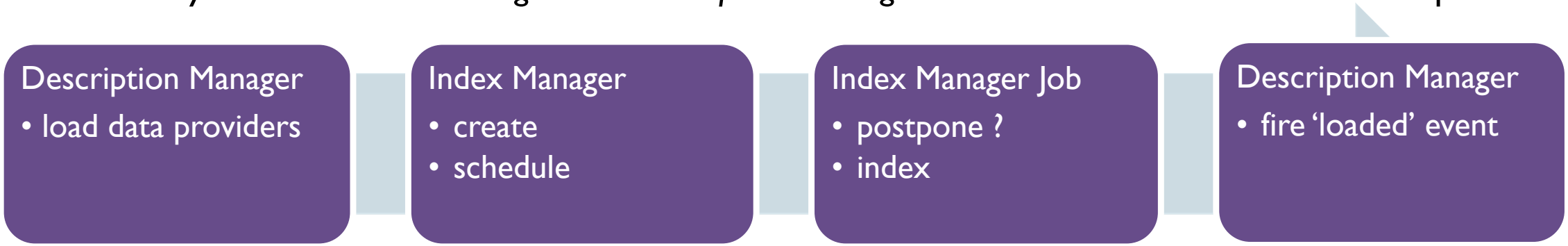
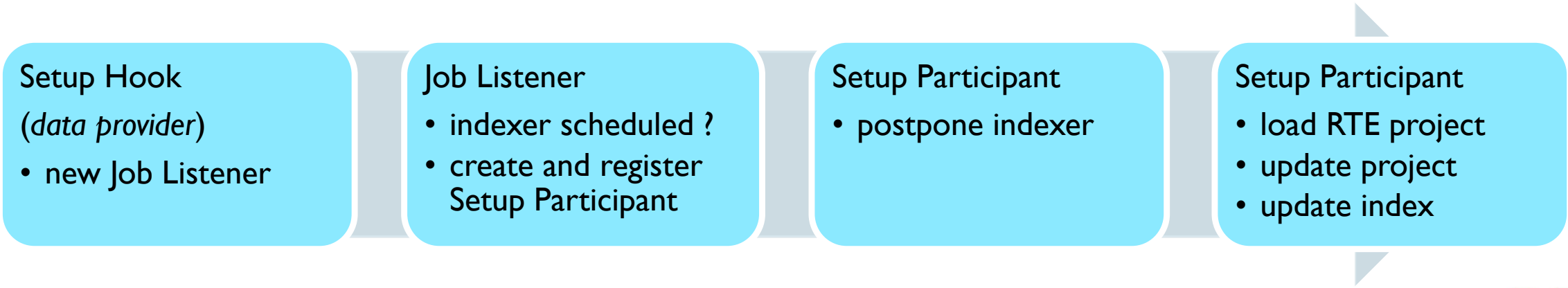
CDT integration: hooking into CDT startup

- Task: load C/C++ project, load RTE configuration, update project, update index
  - load *Data Provider*, then register *Project Description Listener* and *Indexer Setup Participant*
  - tricky: neither *Index Manager* nor *Description Manager* are available at *Data Provider* load point



- Solution: register listeners when indexer job gets scheduled



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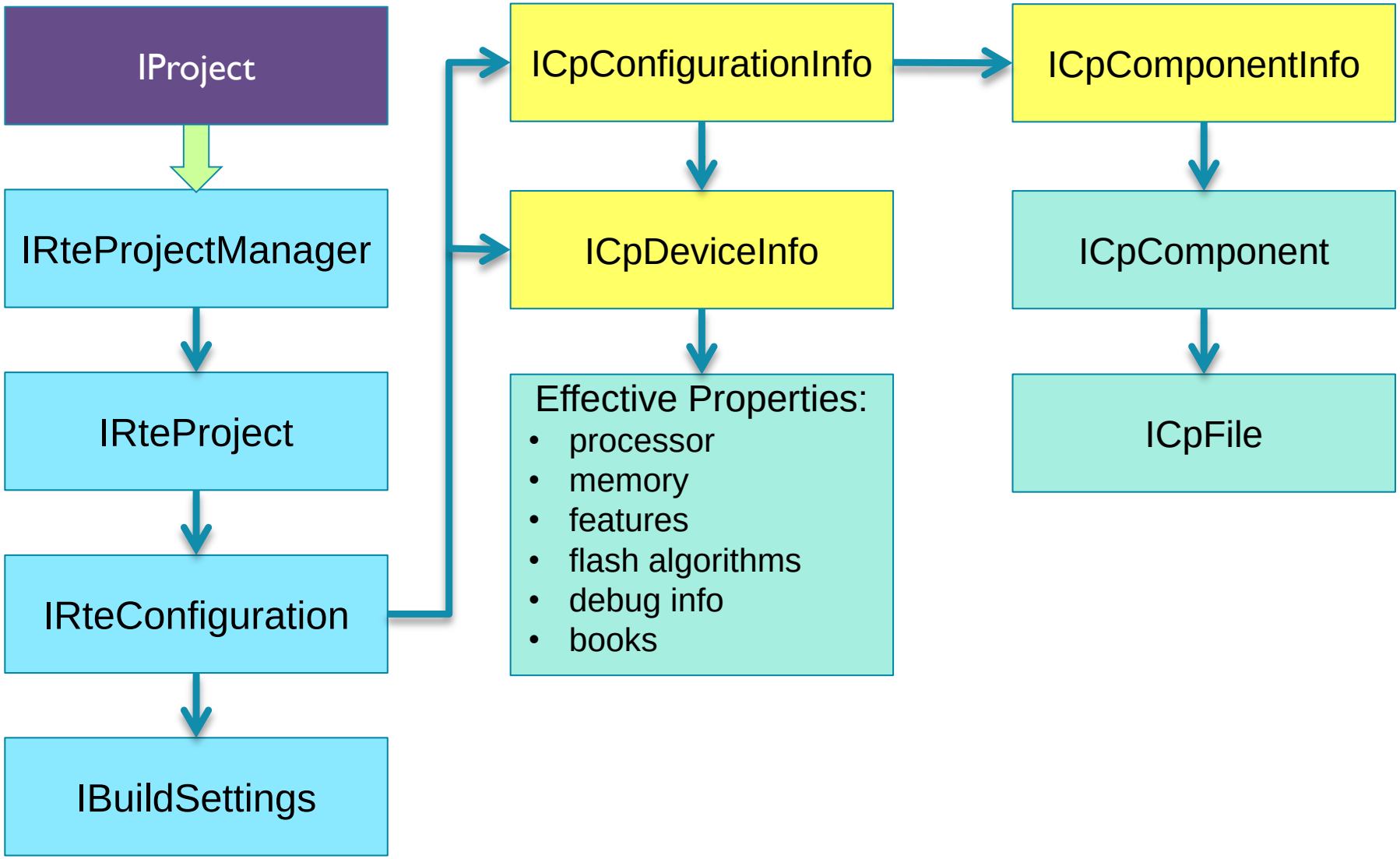
Accessing RTE configuration information



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Conclusions

- CMSIS establishes a software foundation that enables consistent device support and software components reuse across an wide range of development tools and microcontrollers.
- CMSIS-Pack is a delivery mechanism for software components and device specifications
- CMSIS-Pack plug-in is an open-source reference implementation of the CMSIS-Pack support for Eclipse environment
- The plug-in enhances project management with CMSIS software components to accelerate Embedded Software Development

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Thank You!

- CMSIS-Pack Eclipse Plug-in :
  - https://github.com/ARM-software/cmsis-pack-eclipse
  - https://github.com/ARM-software/cmsis-pack-eclipse-prebuilt
- Packs repository:
  - http://www.keil.com/dd2/pack/
- CMSIS online specification and tutorials
  - http://www.keil.com/cmsis
- GNU ARM Eclipse Toolchain and Pack Manager
  - http://gnuarmeclipse.github.io/
  - http://gnuarmeclipse.github.io/plugins/packs-manager/

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