

TriBITS Developers Guide and Reference

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Abstract

This document describes the usage of TriBITS to build, test, and deploy complex software. The primary audience are those individuals who develop on a software project which uses TriBITS. The overall structure of a TriBITS project is described including all of the various project- and package-specific files that TriBITS requires or can use and how and what order these files are processed. It also contains detailed reference information on all of the various TriBITS macros and functions directly used in TriBITS project CMake files. Many other topics of interest to a TriBITS project developer and architect are discussed as well.

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1 Introduction

This document describes the usage of the TriBITS (Tribal Build, Integration, Test System) to develop software projects. An initial overview of TriBITS is provided in the [TriBITS Overview](#) document which contains the big picture and provides a high-level road map to what TriBITS provides. This particular document, however, describes the details on how to use the TriBITS system to create a CMake build system for a set of compiled software packages.

TriBITS is a fairly extensive framework that is build on CMake/CTest/CPack/CDash which in of itself is a very extensive system of software and tools. The most important thing to remember is that software project that use TriBITS are really just CMake projects. TriBITS makes no attempt to hide that either from the TriBITS project developers or from the users that need to configure and build the software. Therefore, to make effective usage of TriBITS, one must learn the basics of CMake. In particular, CMake is a Turing complete programming language with local and global variables (with strange scoping rules), macros, functions, targets, commands, and other features. One needs to understand how to define and use variables, macros, functions in CMake. One needs to know how to debug CMakeLists.txt files and CMake code in general (i.e. using `MESSAGE()` print statements). One needs to understand how CMake defines and uses targets for various qualities like libraries, executables, etc. Without this basic understanding of CMake, one will have trouble resolving problems when they might occur.

The remainder of this document is structured as follows. First, there is some additional [Background](#) material provided. Then, a detailed specification of [TriBITS Project Structure](#) is given. This is followed up by short descriptions of *Example TriBITS Projects* that are provided with the TriBITS source tree that are used throughout this document. The topic of [Package Dependencies and Enable/Disable Logic](#) is then discussed. An overview of the foundations for [TriBITS Automated Testing](#) is then given. The topic of TriBITS [Multi-Repository Support](#) is examined next. [Development Workflows](#) using TriBITS is then explored. This is followed by a set of detailed [Howtos](#). Later some [Additional Topics](#) are presented that don't fit well into other sections. Then the main bulk of the detailed reference material for TriBITS is given in the section [TriBITS Detailed Reference Documentation](#). Finally, several bits of information is provided in the [Appendix](#).

2 Background

Before diving into the details about TriBITS in the following sections, first some background is in order. First, a discussion of [TriBITS Developer and User Roles](#) for TriBITS is provided to help the reader identify their own roles and to help guide the reader to the appropriate documentation. Then, section [CMake Language Overview and Gotchas](#) tries to orient readers with little to no CMake knowledge or experience on where to start and provide some warnings about non-obvious CMake behavior that often trip up new users of TriBITS.

2.1 TriBITS Developer and User Roles

There are approximately five different types roles with respect to TriBITS. These different roles require different levels of expertise and knowledge of CMake and knowledge of the TriBITS system. The primary roles are 1) *TriBITS Project User*, 2) *TriBITS Project Developer*, 3) *TriBITS Project Architect*, 4) *TriBITS System Developer*, and 5) *TriBITS System Architect*. Each of these roles builds on the necessary knowledge of the lower-level roles.

The first role is that of a **TriBITS Project User** who only needs to be able to configure, build, and test a project that uses TriBITS as its build system. A person acting in this role needs to know little about CMake other than basics about how to run the `cmake` and `ctest` executables, how to set CMake cache variables, and the basics of building software and running tests with `ctest`. The proper reference for a TriBITS Project User is the [Project-Specific Build Quick Reference](#). Also, the [TriBITS Overview](#) document may be of some help also. A TriBITS project user does not need to know anything about the CMake language itself or any of the TriBITS macros or functions described in [TriBITS Macros and Functions](#) or really anything else described in this current document.

A **TriBITS Project Developer** is someone who contributes to a software project that uses TriBITS. They will add source files, libraries and executables, test executables and define tests run with `ctest`. They have to configure and build the project code in order to be able to develop and run tests and therefore this role includes all of the necessary knowledge and functions of a TriBITS Project User. A casual TriBITS Project Developer typically does not need to know a lot about CMake and really only need to know a subset of the [TriBITS Macros](#)

and [Functions](#) defined in this document in addition to the generic [TriBITS Build Quick Reference](#) document. A slightly more sophisticated TriBITS Project Developer will also add new packages, add new package dependencies, and define new TPLs. This current TriBITS Developers Guide and Reference document should supply everything such a developer needs to know and more. Only a smaller part of this document needs to be understood and accessed by people assuming this role.

The next level of roles is a **TriBITS Project Architect**. This is someone (perhaps only one person on a project development team) that knows the usage and functioning of TriBITS in great detail. They understand how to set up a TriBITS project from scratch, how to set up automated testing using the TriBITS system, and know how to use TriBITS to implement the overall software development process. A person in this role is also likely to be the one who makes the initial technical decision for their project to adopt TriBITS as its native build and test system. This document (along with detailed CMake/CTest/CDash documentation provided by Kitware and the larger community) should provide most of what a person in this role needs to know. A person assuming this role is the primary audience for this document.

The last two roles **TriBITS System Developer** and **TriBITS System Architect** are for those individuals that actually extend and modify the TriBITS system itself. A TriBITS System Developer needs to know how to add new functionality while maintaining backward compatibility, how to add new unit tests to the TriBITS system, and perform other related tasks. Such a developer needs to be very knowledgeable of the basic functioning of CMake and know how TriBITS is implemented in the CMake language. A TriBITS System Architect is someone who must be consulted on almost all non-trivial changes or additions to the TriBITS system. A TriBITS System Architect in addition needs to know the entire TriBITS system, the design philosophy that provides the foundation for TriBITS and be an expert in CMake, CTest, and CDash. Everything that needs to be known by a TriBITS System Developer and a TriBITS System Architect is not contained in this document. Instead, the primary documentation will be in the TriBITS CMake source code and various unit tests itself. At the time of this writing, there is currently only one TriBITS System Architect (who also happens to be the primary author of this document).

An explicit goal of this document is to make new TriBITS Project System Architects (i.e. those who would make the decision to adopt TriBITS), and new TriBITS System Developers to help extend and maintain the system. As TriBITS matures and its development stabilizes, the need for a TriBITS System Architect will be diminished.

So depending on the particular role that a reader falls into, this document may or may not be necessary but instead the TriBITS Overview or the <Project>BuildQuickRef documents may be more appropriate.

2.2 CMake Language Overview and Gotchas

TriBITS removes a lot of the boiler plate code needed to write a CMake project. As a result, many people can come into a project that uses TriBITS and quickly start to contribute by adding new source files, adding new libraries, adding new tests, and even adding new TriBITS packages and TPLs; all without really having learned anything about CMake. One just needs to copy-and-paste existing example CMake code and files as basically “monkey see, monkey do”. As long as nothing out of the ordinary happens, many people can get along just fine in this mode for a time.

However, we have observed that most mistakes that people make when using TriBITS, and most of the problems they have when using the system, are due to a basic lack of knowledge of the CMake language. One can find basic tutorials and references on the CMake language in various locations online for free. One can also purchase the [official CMake reference book](#). Also, documentation for any built-in CMake command is available locally by running:

```
$ cmake --help-command <CMAKE_COMMAND>
```

Because tutorials and detailed documentation for the CMake language already exists, this document will not even attempt to provide a first reference to CMake (which is a large topic in itself). However, what we try to provide below is a short overview of the more quirky or surprising aspects of the CMake language that a programmer experienced in another language might get tripped up by or surprised by. Some of the more unique features of the language are described in order to help avoid some of these common mistakes and provide greater understanding of how TriBITS works.

The CMake language that is used to write CMake projects with TriBITS (and that core TriBITS itself is implemented in) is a fairly simply programming language with fairly simple rules (for the most part). However,

compared to other programming languages, there are a few peculiar aspects to the CMake language like strange variable scoping rules, arguments to macros and function, that can make working with it difficult if you don't understand these. Also, CMake has some interesting gotchas. In order to effectively use TriBITS (or just raw CMake) to construct and maintain a project's CMake files, one must know the basic rules of CMake.

The first thing to understand about the CMake language is that everything line of CMake code is just a command taking a string (or an array of strings) and functions that operate on strings. An array argument is just a single with elements separated by semi-colons "`<str0>;<str1>;...`". CMake is a bit odd in how it deals with these arrays (which just represented as a string with elements separated with semi-colons '`'`;`'`'). For example, all of the following are equivalent and pass in a CMake array with 3 elements `[A]`, `[B]`, and `[C]`:

```
SOME_FUNC (A B C)
SOME_FUNC ("A" "B" "C")
SOME_FUNC ("A;B;C")
```

However, the above is *not* the same as:

```
SOME_FUNC ("A B C")
```

which just passes in a single element with value `[A B C]`. Raw quotes in CMake basically escapes the interpretation of space characters as array element boundaries. Quotes around arguments with no spaces does nothing (as seen above). In order to get a quote char `["]` into string, you must escape it as:

```
SOME_FUNC (\ "A\ " )
```

which passes an array with the single argument `[\ "A\ "]`.

Variables are set using a built-in CMake function that just takes string arguments like:

```
SET (SOME_VARIABLE "some_value")
```

In CMake, the above is identical, in every way, to:

```
SET (SOME_VARIABLE some_value)
SET ("SOME_VARIABLE;"some_value")
SET ("SOME_VARIABLE;some_value")
```

The function `SET()` simply interprets the first argument to as the name of a variable to set in the local scope. Many other built-in and user-defined CMake functions work the same way. That is some of the string arguments are interpreted as the names of variables.

However, CMake appears to parse arguments differently for built-in CMake control structure functions like `FOREACH()` and `IF()` and does not just interpret them as a string array. For example:

```
FOREACH (SOME_VAR "a;b;c")
  MESSAGE ("SOME_VAR=' ${SOME_VAR}' ")
ENDFOREACH ()
```

prints `'SOME_VAR=' a;b;c'` instead of printing `SOME_VAR=' a'` followed by `SOME_VAR=' b'`, etc., as you would otherwise expect. Therefore, this simple rule for the handling of function arguments as string arrays does not hold for CMake logic control commands. Just follow the CMake documentation for these control structures..

CMake offers a rich assortment of built-in functions for doing all sorts of things. As part of these functions are the built-in `MACRO()` and the `FUNCTION()` functions which allow you to create user-defined macros and functions (which is what TriBITS is built on). All of these built-in and user-defined macros and functions work exactly the same way; they take in an array of string arguments. Some functions take in positional arguments but most actually take a combination of positional and keyword arguments (see [PARSE_ARGUMENTS\(\)](#)).

Variable names are translated into their stored values using `${SOME_VARIABLE}`. The value that is extracted depends on if the variable is set in the local or global (cache) scope. The local scopes for CMake start in the base

project directory in its base `CMakeLists.txt` file. Any variables that are created by macros in that base local scope are seen across an entire project but are *not* persistent across `cmake` configure invocations.

The handling of variables is one area where CMake is radically different from most other languages. First, a variable that is not defined simply returns nothing. What is surprising to most people about this is that it does not even return an empty string! For example, the following set statement:

```
SET (SOME_VAR a ${SOME_UNDEFINED_VAR} c)
```

produces `SOME_VAR='a;c'` and *not* `'a;;c'`! The same thing occurs when an empty variable is dereferenced such as with:

```
SET (EMPTY_VAR "")
SET (SOME_VAR a ${EMPTY_VAR} c)
```

which produces `SOME_VAR='a;c'` and *not* `'a;;c'`. In order to always produce an element in the array even if the variable is empty, one must quote the argument as with:

```
SET (EMPTY_VAR "")
SET (SOME_VAR a "${EMPTY_VAR}" c)
```

which produces `SOME_VAR='a;;c'`, or three elements as one might assume.

This is a common error that people make when they call CMake functions (built-in or TriBITS-defined) involving variables that might be undefined or empty. For example, for the macro:

```
MACRO (SOME_MACRO A_ARG B_ARG C_ARG)
    ...
ENDMACRO ()
```

if someone tries to call it with:

```
SOME_MACRO(a ${SOME_OTHER_VAR} c)
```

and if `SOME_OTHER_VAR=""` or if it is undefined, then CMake will error out with the error message saying that the macro `SOME_MACRO()` takes 3 arguments but only 2 were provided. If a variable might be empty but that is still a valid argument to the command, then it must be quoted as:

```
SOME_MACRO(a "${SOME_OTHER_VAR}" c)
```

Related to this problem is that if you misspell the name of a variable in a CMake `IF()` statement like:

```
IF (SOME_VARBLE)
    ...
ENDIF ()
```

then it will always be false and the code inside the if statement will never be executed! To avoid this problem, use the utility function [ASSERT_DEFINED\(\)](#) as:

```
ASSERT_DEFINED (SOME_VARBLE)
IF (SOME_VARBLE)
    ...
ENDIF ()
```

In this case, the misspelled variable would be caught.

While on the subject of `IF()` statements, CMake has a strange convention. When you say:

```
IF (SOME_VAR)
    DO_SOMETHING ()
ENDIF ()
```


then `SOME_VAR` is interpreted as a variable and will be considered true and `DO_SOMETHING()` will be called if `${SOME_VAR}` does *not* evaluate to 0, OFF, NO, FALSE, N, IGNORE, "", or ends in the suffix `-NOTFOUND`. How about that for a true/false rule! To be safe, use ON/OFF and TRUE/FALSE pairs for setting variables. Look up native CMake documentation on `IF()`.

CMake language behavior with respect to case sensitivity is also strange:

- Calls of built-in and user-defined macros and functions is *case insensitive*! That is `set(...)`, `SET(...)`, `Set()`, and all other combinations of upper and lower case characters for 'S', 'E', 'T' all call the built-in `SET()` function. The convention in TriBITS is to use all caps for functions and macros (was adopted by following the conventions used in the early versions of TriBITS, see [History of TriBITS](#)). The convention in CMake literature from Kitware seems to use lower-case letters for functions and macros.
- The names of CMake variables (local or cache/global) are *case sensitive*! That is, `SOME_VAR` and `some_var` are *different* variables. Built-in CMake variables tend to use all caps with underscores (e.g. `CMAKE_CURRENT_SOURCE_DIR`) but other built-in CMake variables tend to use mixed case with underscores (e.g. `CMAKE_Fortran_FLAGS`). TriBITS tends to use a similar naming convention where most variables have mostly upper-case letters except for proper nouns like the project, package or TPL name (e.g. `TribitsProjTRIBITS_DIR`, `TRIBITS_SOURCE_DIR`, `Boost_INCLUDE_DIRS`).

I don't know of any other programming language that uses different case sensitivity rules for variables versus functions. However, because we must parse macro and function arguments when writing user-defined macros and functions, it is a good thing that CMake variables are case sensitive. Case insensitivity would make it much harder and more expensive to parse argument lists that take keyword-based arguments (see [PARSE_ARGUMENTS\(\)](#)).

Other mistakes that people make result from not understanding how CMake scopes variables and other entities. CMake defaults a global scope (i.e. "cache" variables) and several nested local scopes that are created by `ADD_SUBDIRECTORY()` and entering `FUNCTIONS`. See [DUAL_SCOPE_SET\(\)](#) for a short discussion of these scoping rules. It is not just variables that can have local and global scoping rules. Other entities, like defines set with the built-in command `ADD_DEFINITIONS()` only apply to the local scope and child scopes. That means that if you call `ADD_DEFINITIONS()` to set a define that affects the meaning of a header-file in C or C++, for example, that definition will *not* carry over to a peer subdirectory and those definitions will not be set (see warning in [TRIBITS_ADD_LIBRARY\(\)](#)).

Now that some CMake basics and common gotchas have been reviewed, we now get into the meat of TriBITS starting with the overall structure of a TriBITS project.

3 TriBITS Project Structure

TriBITS is a framework, implemented in CMake to create CMake projects. As a framework, it defines the overall structure of a CMake build system for a project and processes project, repository, and package specific files in a specified order. All of this processing takes place in the [TRIBITS_PROJECT\(\)](#) macro.

3.1 TriBITS Structural Units

A CMake project that uses TriBITS as its build and test system is composed of a single *TriBITS Project*, one or more *TriBITS Repositories* and one or more *TriBITS Packages*. In addition, a TriBITS Package can be broken up into *TriBITS Subpackages*. Together, the collection of TriBITS Packages and TriBITS Subpackages are called *TriBITS Software Engineering Packages*, or *TriBITS SE Packages* for short.

First, to establish the basic nomenclature, the key structural TriBITS units are:

- **TriBITS Package:** A collection of related software that typically includes one or more source files built into one or more libraries and has associated tests to help define and protect the functionality provided by the software. A package also typically defines a unit of documentation and testing (see [TriBITS Automated Testing](#)). A TriBITS package may or may not be broken down into multiple subpackages. Examples of TriBITS packages in `TribitsExampleProject` include `SimpleCXX`, `MixedLanguage` and `PackageWithSubpackages`. (Don't confuse a TriBITS "Package" with a raw CMake "Package" (see [History of TriBITS](#)). A raw CMake "Package" actually maps to a [TriBITS TPL](#).)

- **TriBITS Subpackage:** A part of a parent package that also typically has source files built into libraries and tests but is documented and tested along with the other subpackages the parent package. The primary purpose for supporting subpackages is to provide finer-grained control of software dependencies. In `TribitsExampleProject`, `PackageWithSubpackages` is an example of a package with subpackages `SubpackageA`, `SubpackageB`, and `SubpackageC`. The full subpackage name has the parent package name prefixed to the subpackage name (e.g. `PackageWithSubpackagesSubpackageA`). The parent package is always implicitly dependent on its subpackages.
- **TriBITS SE Package:** The combined set of TriBITS packages and subpackages. SE packages are the basis for setting dependencies in the TriBITS system. For example, the SE Packages provided by the example `PackageWithSubpackages` is (in order of increasing dependencies) `PackageWithSubpackagesSubpackageA`, `PackageWithSubpackagesSubpackageB`, `PackageWithSubpackagesSubpackageC`, and `PackageWithSubpackages`.
- **TriBITS TPL:** The specification for a particular external dependency that is required or can be used in one or more TriBITS SE Packages. A TPL (a Third Party Library) typically provides a list of libraries or a list include directories for header files but can also be manifested in other ways as well. Examples of basic TPLs include BLAS, LAPACK, and Boost.
- **TriBITS Repository:** A collection of one or more TriBITS packages specified in a `PackagesList.cmake` file.
- **TriBITS Project:** A collection of TriBITS Repositories and Packages that defines a CMake `PROJECT` and can be configured, built, and tested.

The following subsections define the major structural units of a TriBITS project in more detail. Each structural unit is described along with the files and directories associated with each. In addition, a key set of TriBITS CMake variables for each are defined as well.

In the next major section following this one, some [Example TriBITS Projects](#) are described. For those who just want to jump in and learn best by example, these example projects are a good way to start. These example projects will be referenced in the more detailed descriptions given in this document.

The CMake variables defined by TriBITS described in the structural units below fall into one of two types:

- *Local Fixed-Name Variables* are used temporarily in the processing of a TriBITS unit. These include variables such as `PROJECT_NAME`, `REPOSITORY_NAME`, `PACKAGE_NAME`, and `PARENT_PACKAGE_NAME`. These are distinguished by having a fixed/constant name. They are typically part of TriBITS reflection system, allowing subordinate units to determine the encapsulating unit in which they are participating. For example, a TriBITS subpackage can determine its name, its parent package's name and directories, its parent repository name and directories, and the enclosing project's name and directories.
- *Namespaced Variables* are used to refer to properties of a named TriBITS unit. These include variables such as `${REPOSITORY_NAME}_SOURCE_DIR` (e.g. `TribitsExProj_SOURCE_DIR`) and `${PACKAGE_NAME}_BINARY_DIR` (e.g. `SimpleCXX_BINARY_DIR`). They are available after processing the unit, for use by downstream or subordinate units. They are part of the TriBITS dependency system, allowing downstream units to access properties of their known upstream dependencies.

More information about these various files is described in section [Processing of TriBITS Files: Ordering and Details](#).

TriBITS Project

A TriBITS Project:

- Defines a complete CMake project and calls `PROJECT (${PROJECT_NAME} ...)`.
- Consists of one or more TriBITS Repositories (see [TriBITS Repository](#)).

- Defines the `PROJECT_NAME` CMake variable (defined in [<projectDir>/ProjectName.cmake](#))
- Defines a set of native Repositories (see below) that define packages and TPLs.
- Allows for extra Repositories to be added on before or after the set of native Repositories (specified in [<projectDir>/cmake/ExtraRepositoriesList.cmake](#) or by CMake variables)
- Defines a default CDash server and default project name on the server (the project name on the CDash server must be the same as `${PROJECT_NAME}`).

For more details on the definition of a TriBITS Project, see:

- [TriBITS Project Core Files](#)
- [TriBITS Project Core Variables](#)

TriBITS Project Core Files The core files making up a TriBITS Project (where `<projectDir> = ${PROJECT_SOURCE_DIR}`) are:

```
<projectDir>/
  ProjectName.cmake      # Defines PACKAGE_NAME
  CMakeLists.txt         # Base project CMakeLists.txt file
  CTestConfig.cmake      # [Optional] Needed for CDash submits
  Version.cmake          # [Optional] Dev mode, Project version, VC branch
  cmake/
    NativeRepositoriesList.cmake # [Optional] Used for some meta-projects
    ExtraRepositoriesList.cmake  # [Optional] Lists repos and VC URLs
    ProjectDependenciesSetup.cmake # [Optional] Project deps overrides
    CallbackDefineProjectPackaging.cmake # [Optional] CPack settings
    tribits/      # [Optional] Or provide ${PROJECT_NAME}_TRIBITS_DIR
    ctest/
      CTestCustom.cmake.in # [Optional] Custom ctest settings
```

These TriBITS Project files are documented in more detail below:

- [<projectDir>/ProjectName.cmake](#)
- [<projectDir>/CMakeLists.txt](#)
- [<projectDir>/CTestConfig.cmake](#)
- [<projectDir>/Version.cmake](#)
- [<projectDir>/cmake/NativeRepositoriesList.cmake](#)
- [<projectDir>/cmake/ExtraRepositoriesList.cmake](#)
- [<projectDir>/cmake/ProjectDependenciesSetup.cmake](#)
- [<projectDir>/cmake/CallbackDefineProjectPackaging.cmake](#)
- [<projectDir>/cmake/tribits/](#)
- [<projectDir>/cmake/ctest/CTestCustom.cmake.in](#)

<projectDir>/ProjectName.cmake: [Required] At a minimum provides a `SET()` statement to set the local variable `PROJECT_NAME`. This file is the first file read by a number of tools in order to get the TriBITS project's name. This file is read first in every context that involves processing the TriBITS project's files, including processes and tools that just need to build a package and TPL dependency tree (see *Package Enable/Disable Logic*). Being this is the first file read in for a TriBITS project and that it is read in first at the top level scope in every context, this is a good file to put other universal static project options in that affect dependency handling. Note that this is a project, not a repository file so no general repository-specific settings should go in this file. A simple example of this file is [TribitsExampleProject/PackageName.cmake](#):

```
# Must set the project name as a variable at very beginning before including anything
SET(PROJECT_NAME TribitsExProj)
```

<projectDir>/CMakeLists.txt: [Required] The top-level CMake project file. This is the first file that the cmake executable processes that starts everything off and is the base level scope for local CMake variables. Due to a number of CMake limitations and quarks, a project's top-level CMakeLists.txt file is not as clean as one might otherwise hope would be but it is not too bad. A simple, but representative, example is [TribitsExampleProject/CMakeLists.txt](#):

```
#####
#
#           TribitsExampleProject
#
#####

# Make CMake set WIN32 with CYGWIN for older CMake versions. CMake requires
# this to be in the top-level CMakeLists.txt file and not an include file :-(
SET(CMAKE_LEGACY_CYGWIN_WIN32 1 CACHE BOOL "" FORCE)

#
# A) Define your project name and set up major project options
#
# NOTE: Don't set options that would impact what packages get defined or
# enabled/disabled in this file as that would not impact other tools that
# don't process this file.
#

# Get PROJECT_NAME (must be in file for other parts of system to read)
INCLUDE("${CMAKE_CURRENT_SOURCE_DIR}/ProjectName.cmake")

# CMake requires that you declare the CMake project in the top-level file and
# not in an include file :-(
PROJECT(${PROJECT_NAME} NONE)

# Turn on export dependency generation for WrapExteranl package
SET(${PROJECT_NAME}_GENERATE_EXPORT_FILE_DEPENDENCIES_DEFAULT ON)

#
# B) Pull in the TriBITS system and execute
#

SET(${PROJECT_NAME}_TRIBITS_DIR "" CACHE STRING "TriBITS base directory (required)"
INCLUDE("${${PROJECT_NAME}_TRIBITS_DIR}/TriBITS.cmake")

# CMake requires this be in the top file and not in an include file :-(
CMAKE_MINIMUM_REQUIRED(VERSION ${TRIBITS_CMAKE_MINIMUM_REQUIRED})

# Do all of the processing for this Tribits project
TRIBITS_PROJECT()
```

A couple of CMake and TriBITS quarks that that above example CMakeLists.txt addresses are worth some discussion. First, to avoid duplication, the project's ProjectName.cmake file is read in with an INCLUDE() that defines the local variable PROJECT_NAME. Right after this initial include, the built-in CMake command PROJECT(\${PROJECT_NAME} NONE) is run. This command must be explicitly called with NONE so as to

avoid default CMake behavior for defining compilers. The definition of compilers comes later as part of the `TriBITS` system inside of the `TRIBITS_PROJECT()` command (see [Full Processing of TriBITS Project Files](#)).

As noted in the above example file, the only project defaults that should be set in this top-level `CMakeLists.txt` file are those that do not impact the list of package enables/disables. The latter type of defaults should set in other files (see below).

In this example project, a CMake cache variable `${PROJECT_NAME}_TRIBITS_DIR` must be set by the user to define where the base `tribits` source directory is located. With this variable set (i.e. passed into `cmake` command-line use `-DTribitsExProj TRIBITS_DIR=<someDir>`), one just includes a single file to pull in the `TriBITS` system:

```
INCLUDE("${${PROJECT_NAME}_TRIBITS_DIR}/TriBITS.cmake")
```

With the `TriBITS.cmake` file included, the configuration of the project using `TriBITS` occurs with a single call to `TRIBITS_PROJECT()`.

Some projects, like `Trilinos`, actually snapshot the `tribits` directory into their source tree and therefore don't need to have this variable set. In `Trilinos`, the include line is just:

```
INCLUDE(${CMAKE_CURRENT_SOURCE_DIR}/cmake/tribits/TriBITS.cmake)
```

The minimum CMake version must also be declared in the top-level `CMakeLists.txt` file as shown. Explicitly setting the minimum CMake version avoids strange errors that can occur when someone tries to build the project using a version of CMake that is too old. If the given project requires a version of CMake newer than what is required by `TriBITS` itself (as defined in the variable `TRIBITS_CMAKE_MINIMUM_REQUIRED` which was set when the `TriBITS.cmake` file was included), then that version can be passed instead of using `${TRIBITS_CMAKE_MINIMUM_REQUIRED}` (the current minimum version of CMake required by `TriBITS` is given at in [TribitsBuildQuickRef](#)). For example, the `VERA/CMakeLists.txt` file lists as its first line:

```
SET(VERA_TribITS_CMAKE_MINIMUM_REQUIRED 2.8.5)
CMAKE_MINIMUM_REQUIRED(VERSION ${VERA_TribITS_CMAKE_MINIMUM_REQUIRED})
```

<projectDir>/CTestConfig.cmake: [Optional] Specifies the CDash site and project to submit results to when doing an automated build driven by CTest (it is read by the scripting code in `TribitsCTestDriverCore.cmake`). This file only needs to be present when the CTest driver code in `TribitsCTestDriverCore.cmake` is used. This file is also required to use the `TriBITS`-generated dashboard target (see [Dashboard Submissions](#)). An example of this file is [TribitsExampleProject/CTestConfig.cmake](#):

```
INCLUDE(SetDefaultAndFromEnv)

SET(CTEST_NIGHTLY_START_TIME "04:00:00 UTC") # 10 PM MDT or 9 PM MST

IF (NOT DEFINED CTEST_DROP_METHOD)
    SET_DEFAULT_AND_FROM_ENV(CTEST_DROP_METHOD "http")
ENDIF ()

IF (CTEST_DROP_METHOD STREQUAL "http")
    SET_DEFAULT_AND_FROM_ENV(CTEST_DROP_SITE "casl-dev.ornl.gov")
    SET_DEFAULT_AND_FROM_ENV(CTEST_PROJECT_NAME "TribitsExProj")
    SET_DEFAULT_AND_FROM_ENV(CTEST_DROP_LOCATION "/cdash/submit.php?project=TribitsExProj")
    SET_DEFAULT_AND_FROM_ENV(CTEST_TRIGGER_SITE "")
    SET_DEFAULT_AND_FROM_ENV(CTEST_DROP_SITE_CDASH TRUE)
ENDIF ()
```

All of the variables set in this file are directly understood by raw `ctest` and will not be explained here further (see documentation for the standard CMake module `CTest`). The usage of the function `SET_DEFAULT_AND_FROM_ENV()` allows the variables to be overridden both as CMake cache variables and

in the environment. The latter is needed when running using `ctest` as the driver. Given that all of these variables are nicely namespaced, overriding them on the shell environment is not as dangerous as might otherwise be the case but this is what had to be done to get around limitations for older versions of CMake/CTest.

<projectDir>/Version.cmake: If defined, gives the project's version and determines development/release mode (see [Project and Repository Versioning and Release Mode](#)). This file is read in (using `INCLUDE()`) in the project's base-level `<projectDir>/CMakeLists.txt` file scope so local variables set in this file are seen by the entire CMake project. For example, [TribitsExampleProject/Version.cmake](#), this looks like:

```
SET(${REPOSITORY_NAME}_VERSION 1.1)
SET(${REPOSITORY_NAME}_MAJOR_VERSION 01)
SET(${REPOSITORY_NAME}_MAJOR_MINOR_VERSION 010100)
SET(${REPOSITORY_NAME}_VERSION_STRING "1.1 (Dev)")
SET(${REPOSITORY_NAME}_ENABLE_DEVELOPMENT_MODE_DEFAULT ON) # Change to 'OFF' for a
```

Note that the prefix `${REPOSITORY_NAME}_` is used instead of hard-coding the project name. This is so that the same `Version.txt` file can be used as the `<repoDir>/Version.cmake` file and have the repository name be flexible. TriBITS sets `REPOSITORY_NAME = ${PROJECT_NAME}` when it reads in this file at the project-level scope.

It is strongly recommended that every TriBITS project contain a `Version.cmake` file, even if a release has never occurred. Otherwise, the project needs to define the variable `${PROJECT_NAME}_ENABLE_DEVELOPMENT_MODE_DEFAULT` at the global project scope (perhaps in `<projectDir>/ProjectName.cmake`) to get right development mode of behavior (see [\\${PROJECT_NAME}_ENABLE_DEVELOPMENT_MODE](#)).

<projectDir>/cmake/NativeRepositoriesList.cmake: [Optional] If present, this file gives the list of native repositories to this TriBITS project. The file must contain a `SET()` statement defining the variable `${PROJECT_NAME}_NATIVE_REPOSITORIES` which is just a flat list of repository names that must also be directory names under `<projectDir>/.` For example, if this file contains:

```
SET(${PROJECT_NAME}_NATIVE_REPOSITORIES Repo0 Repo1)
```

then the directories `<projectDir>/Repo0` and `<projectDir>/Repo1` must exist and must be valid TriBITS repositories (see *TriBITS Repository*).

There are no examples for the usage of this file in any of the TriBITS examples or test projects. However, support for this file is maintained for backward compatibility since there are some TriBITS projects that use it. It is recommended instead to define multiple repositories using the [<projectDir>/cmake/ExtraRepositoriesList.cmake](#) file as it allows for more flexibility in how extra repositories are specified and how they are accessed.

If this file `NativeRepositoriesList.cmake` does not exist, then TriBITS sets `${PROJECT_NAME}_NATIVE_REPOSITORIES` equal to `"."`, or the base project directory (i.e. `<projectDir>/.`). In this case, the file `<projectDir>/PackagesList.cmake` and `<projectDir>/TPLsList.cmake` must exist. However, if the project has no native packages or TPLs, then these files be set up to list no packages or TPLs. This is the case for meta-projects like VERA that have only extra repositories specified in the file [<projectDir>/cmake/ExtraRepositoriesList.cmake](#).

<projectDir>/cmake/ExtraRepositoriesList.cmake: [Optional] If present, this file defines a list of extra repositories that are added on to the project's native repositories. The list of repositories is defined using the macro [TRIBITS_PROJECT_DEFINE_EXTRA_REPOSITORIES\(\)](#). For example, the extra repos file:

```
TRIBITS_PROJECT_DEFINE_EXTRA_REPOSITORIES (
  ExtraRepo1  ""  GIT  someurl.com:/ExtraRepo1  ""  Continuous
  ExtraRepo2  packages/SomePackage/Blah  GIT  someurl2.com:/ExtraRepo2  NOPACKAGES
  ExtraRepo3  ""  HG  someurl3.com:/ExtraRepo3  ""  Continuous
  ExtraRepo4  ""  SVN  someurl4.com:/ExtraRepo4  ""  Nightly
)
```


shows the specification of both TriBITS Repositories and non-TriBITS VC Repositories. In the above file, the repositories ExtraRepo1, ExtraRepo3, and ExtraRepo4 are VC repositories that are cloned into directories under <projectDir> of the same names from the URLs someurl.com:/ExtraRepo1, someurl3.com:/ExtraRepo3, and someurl4.com:/ExtraRepo4, respectively. However, the repository ExtraRepo2 is **not** a [TriBITS Repository](#) because it is marked as NOPACKAGES. In this case, it gets cloned as the directory:

```
<projectDir>/packages/SomePackage/Blah
```

However, the code in the tools checkin-test.py and TribitsCTetsDriverCore.cmake will consider this repository and directory and any changes to this repository will be listed as changes to somePackage.

<projectDir>/cmake/ProjectDependenciesSetup.cmake: [Optional] If present, this file is included a single time as part of the generation of the project's dependency data-structure (see [Reduced Package Dependency Processing](#)). It gets included at the top project level scope after all of the <repoDir>/cmake/RepositoryDependenciesSetup.cmake files have been included but before all of the package <packageDir>/cmake/Dependencies.cmake files are included. Any local variables set in this file have project-wide scope. The primary purpose for this file is to set variables that will impact the processing of project's package's Dependencies.cmake files.

The typical usage of this file is to set the default CDash email base address that will be the default for all of the defined packages (see [CDash regression email addresses](#)). For example, to set the default email address for all of the packages, one would set in this file:

```
SET_DEFAULT(${PROJECT_NAME}_PROJECT_MASTER_EMAIL_ADDRESSES
  projectx-regressions@somemailserver.org)
```

The repository email address variables

\${REPOSITORY_NAME}_REPOSITORY_EMAIL_URL_ADDRESSES_BASE and
 \${REPOSITORY_NAME}_REPOSITORY_MASTER_EMAIL_ADDRESSES possibly set in the just processed <repoDir>/cmake/RepositoryDependenciesSetup.cmake files can also be overridden here. The CASL VERA meta-project uses this file to override several of the repository-specific email addresses for its constituent CDash email addresses.

In general, variables that affect how package dependencies are defined or affect package and TPL enable/disable logic should be defined in this file.

<projectDir>/cmake/CallbackDefineProjectPackaging.cmake: [Optional] If exists, defines the CPack settings for the project (see [Official CPack Documentation](#) and [Online CPack Wiki](#)). This file must define a macro called TRIBITS_PROJECT_DEFINE_PACKAGING() which is then invoked by TriBITS. The file:

[TribitsExampleProject](#)/cmake/CallbackDefineProjectPackaging.cmake

provides a good example which is:

```
MACRO (TRIBITS_PROJECT_DEFINE_PACKAGING)

  TRIBITS_COPY_INSTALLER_RESOURCE(TribitsExProj_README
    "${TribitsExProj_SOURCE_DIR}/README"
    "${TribitsExProj_BINARY_DIR}/README.txt")
  TRIBITS_COPY_INSTALLER_RESOURCE(TribitsExProj_LICENSE
    "${TribitsExProj_SOURCE_DIR}/LICENSE"
    "${TribitsExProj_BINARY_DIR}/LICENSE.txt")

  SET(CPACK_PACKAGE_DESCRIPTION "TribitsExampleProject just shows you how to use T
  SET(CPACK_PACKAGE_FILE_NAME "tribitsexproj-setup-${TribitsExProj_VERSION}")
  SET(CPACK_PACKAGE_INSTALL_DIRECTORY "TribitsExProj ${TribitsExProj_VERSION}")
  SET(CPACK_PACKAGE_REGISTRY_KEY "TribitsExProj ${TribitsExProj_VERSION}")
  SET(CPACK_PACKAGE_NAME "tribitsexproj")
```

```

SET(CPACK_PACKAGE_VENDOR "Sandia National Laboratories")
SET(CPACK_PACKAGE_VERSION "${TribitsExProj_VERSION}")
SET(CPACK_RESOURCE_FILE_README "${TribitsExProj_README}")
SET(CPACK_RESOURCE_FILE_LICENSE "${TribitsExProj_LICENSE}")
SET(${PROJECT_NAME}_CPACK_SOURCE_GENERATOR_DEFAULT "TGZ;TBZ2")
SET(CPACK_SOURCE_FILE_NAME "tribitsexproj-source-${TribitsExProj_VERSION}")
SET(CPACK_COMPONENTS_ALL ${TribitsExProj_PACKAGES} Unspecified)

ENDMACRO ()

```

The CPack variables that should be defined at the project-level should be described in the [Official CPack Documentation](#).

Settings that are general for all distributions (like non-package repository files to exclude from the tarball) should be set at the in the file `<repoDir>/cmake/CallbackDefineRepositoryPackaging.cmake`.

<projectDir>/cmake/tribits/: [Optional] The typical location of the `tribits` source tree for projects that choose to snapshot or checkout TriBITS into their source tree. Trilinos, for example, currently snapshots the TriBITS source tree into this directory.

<projectDir>/cmake/ctest/CTestCustom.cmake.in: [Optional] If this file exists, it is processed using a `CONFIGURE_FILE()` command to write the file `CTestCustom.cmake` in the project base build tree. This file is picked up automatically by `ctest` (see [CTest documentation](#)). This file is typically used to change the maximum size of test output. For example, the [TribitsExampleProject](#)/cmake/ctest/CTestCustom.cmake.in“ looks like:

```

# Allow full output to go to CDash
SET(CTEST_CUSTOM_MAXIMUM_PASSED_TEST_OUTPUT_SIZE 0)
SET(CTEST_CUSTOM_MAXIMUM_FAILED_TEST_OUTPUT_SIZE 0)
# WARNING! This could be a lot of output and could overwhelm CDash and the
# MySQL DB so this might not be a good idea!

```

which sets the output size for each test submitted to CDash be unlimited (which is not really recommended). These variables used by Trilinos at one time were:

```

SET(CTEST_CUSTOM_MAXIMUM_PASSED_TEST_OUTPUT_SIZE 50000)
SET(CTEST_CUSTOM_MAXIMUM_FAILED_TEST_OUTPUT_SIZE 5000000)

```

which sets the max output for passed and failed tests to 50000k and 5000000k, respectively.

For documentation of the options one can change for CTest, see [This Online Wiki Page](#).

TriBITS Project Core Variables The following local variables are defined in the top-level Project `CMakeLists.txt` file scope and are therefore accessible by all files processed by TriBITS:

`PROJECT_NAME`

The name of the TriBITS Project. This exists to support, among other things, the ability for subordinate units (Repositories and Packages) to determine the Project in which is participating. This is typically read from a `SET()` statement in the project's `<projectDir>/ProjectName.cmake` file.

`PROJECT_SOURCE_DIR`

The absolute path to the base Project source directory. This is set automatically by TriBITS given the directory passed into `cmake` at configure time at the beginning of the `TRIBITS_PROJECT()` macro.

`PROJECT_BINARY_DIR`

The absolute path to the base Project binary/build directory. This is set automatically by TriBITS and is the directory where `cmake` is run from and is set at the beginning of the `TRIBITS_PROJECT()` macro

`${PROJECT_NAME}_SOURCE_DIR`

Set to `${PROJECT_SOURCE_DIR}` automatically by TriBITS at the beginning of the `TRIBITS_PROJECT()` macro.

`${PROJECT_NAME}_BINARY_DIR`

Set to `${PROJECT_BINARY_DIR}` automatically by TriBITS at the beginning of the `TRIBITS_PROJECT()` macro.

`${PACKAGE_NAME}_ENABLE_TESTS`

CMake cache variables that if set to ON, then tests for all explicitly enabled packages will be turned on.

`${PACKAGE_NAME}_ENABLE_EXAMPLES`

CMake cache variables that if set to ON, then examples for all explicitly enabled packages will be turned on.

The following internal project-scope local CMake variables are defined by TriBITS for the project's repositories.:

`${PROJECT_NAME}_NATIVE_REPOSITORIES`

The list of Native Repositories for a given TriBITS project (i.e. Repositories that are always present when configuring the Project and are managed in the same VC repo typically). If the file `${PROJECT_SOURCE_DIR}/NativeRepositoriesList.cmake` exists, then the list of native repositories will be read from that file. If the file `NativeRepositoriesList.cmake` does not exist, then the project is assumed to also be a repository and the list of native repositories is just the local project directory `${PROJECT_SOURCE_DIR}/..`. In this case, the `${PROJECT_SOURCE_DIR}/` must contain at a minimum a `PackagesList.cmake`, and a `TPsList.cmake` file (see [TriBITS Repository](#)).

`${PROJECT_NAME}_EXTRA_REPOSITORIES`

The list of Extra Repositories that the project is being configured with. The packages in these repositories are *not* listed in the main project dependency files but are listed in the dependency files in other contexts. This list of repositories either comes from the project's `ExtraRepositoriesList.cmake` file or comes from the CMake variables `${PROJECT_NAME}_EXTRA_REPOSITORIES`. See [Enabling extra repositories with add-on packages](#) for details.

`${PROJECT_NAME}_ALL_REPOSITORIES`

Concatenation of all the repos listed in `${PROJECT_NAME}_NATIVE_REPOSITORIES` and `${PROJECT_NAME}_EXTRA_REPOSITORIES` in the order that the project is being configured with.

TriBITS Repository

A TriBITS Repository is the basic unit of ready-made composition between different collections of software that use the TriBITS CMake build and system.

In short, a TriBITS Repository:

- Is a named collection of related TriBITS Packages and TPLs (defined in [<repoDir>/PackagesList.cmake](#) and [<repoDir>/TPLsList.cmake](#) respectively)
- Defines the base source and binary directories for the Repository
`${REPOSITORY_NAME}_SOURCE_DIR` and `${REPOSITORY_NAME}_BINARY_DIR`.
- [Optional] Defines a common set of initializations and other hooks for a all the packages in the repository.

For more details on the definition of a TriBITS Repository, see:

- [TriBITS Repository Core Files](#)
- [TriBITS Repository Core Variables](#)

TriBITS Repository Core Files The core files making up a TriBITS Repository (where `<reposDir> = ${${REPOSITORY_NAME}_SOURCE_DIR}`) are:

```
<repoDir>/
  PackagesList.cmake
  TPLsList.cmake
  Copyright.txt # [Optional] Only needed if creating version header file
  Version.cmake # [Optional] Info inserted into ${REPO_NAME}_version.h
cmake/
  RepositoryDependenciesSetup.cmake # [Optional]
  CallbackSetupExtraOptions.cmake # [Optional] Called after tribits options
  CallbackDefineRepositoryPackaging.cmake # [Optional] CPack packaging
```

These TriBITS Repository files are documented in more detail below:

- [<repoDir>/PackagesList.cmake](#)
- [<repoDir>/TPLsList.cmake](#)
- [<repoDir>/Copyright.txt](#)
- [<repoDir>/Version.cmake](#)
- [<repoDir>/cmake/RepositoryDependenciesSetup.cmake](#)
- [<repoDir>/cmake/CallbackSetupExtraOptions.cmake](#)
- [<repoDir>/cmake/CallbackDefineRepositoryPackaging.cmake](#)

<repoDir>/PackagesList.cmake: [Required] Provides the list of top-level packages defined by the repository. This file typically just calls the macro [TRIBITS_DEFINE_REPOSITORY_PACKAGES\(\)](#) to define the list of packages along with their directories and other properties. For example, the file [TribitsExampleProject/PackagesList.cmake](#) looks like:

```
TRIBITS_DEFINE_REPOSITORY_PACKAGES (
  SimpleCxx                packages/simple_cxx                PT
  MixedLanguage            packages/mixed_language            PT
  PackageWithSubpackages   packages/package_with_subpackages PT
  WrapExternal             packages/wrap_external             PT
)

TRIBITS_DISABLE_PACKAGE_ON_PLATFORMS (WrapExternal Windows)
```

Other commands that are appropriate to use this file are [TRIBITS_DISABLE_PACKAGE_ON_PLATFORMS\(\)](#). If the binary directory for any package `<packageName>` needs to be changed from the default, then the variable `<packageName>_SPECIFIED_BINARY_DIR` can be set. One can see an example of this in the file `tribits/PackageList.cmake` which shows

```

TRIBITS_DEFINE_REPOSITORY_PACKAGES (
    TriBITS . PT
)

# Must create subdir for binary dir for the TriBITS package
SET(TriBITS_SPECIFIED_BINARY_DIR tribits)

```

It is perfectly legal for a TriBITS repository to define no packages at all with:

```

TRIBITS_DEFINE_REPOSITORY_PACKAGES ()

```

and this would be the case for a TribITS meta-project that has no native packages, only extra repositories.

<repoDir>/TPLsList.cmake: [Required] Provides the list of TPLs that are listed as TPLs in the repository's SE packages <packageDir>/cmake/Dependencies.cmake files (see *TriBITS TPL*). This file typically just calls the macro `TRIBITS_DEFINE_REPOSITORY_TPLS()` to define the TPLs along with their find modules and other properties. See an example from *TribitsExampleProject*/TPLsList.cmake which shows:

```

TRIBITS_DEFINE_REPOSITORY_TPLS (
    MPI "${PROJECT_NAME}_TRIBITS_DIR"/tpls/FindTPLMPI.cmake" PT
)

```

It is perfectly fine to specify no TPLs for a repository with:

```

TRIBITS_DEFINE_REPOSITORY_TPLS ()

```

but the macro `TRIBITS_DEFINE_REPOSITORY_TPLS()` has to be called, even if there are no TPLs. See [TRIBITS_DEFINE_REPOSITORY_TPLS\(\)](#) for further details.

<repoDir>/Copyright.txt: [Optional] Gives the default copyright and license declaration for all of the software in the TriBITS repository <repoDir>. This file is read into a string and then used to configure the repository's version file (see [Project and Repository Versioning and Release Mode](#)).

<repoDir>/Version.cmake: Contains version information for the repository (and the project also if this is also the base project). For example, *TribitsExampleProject*/Version.cmake, this looks like:

```

SET(${REPOSITORY_NAME}_VERSION 1.1)
SET(${REPOSITORY_NAME}_MAJOR_VERSION 01)
SET(${REPOSITORY_NAME}_MAJOR_MINOR_VERSION 010100)
SET(${REPOSITORY_NAME}_VERSION_STRING "1.1 (Dev)")
SET(${REPOSITORY_NAME}_ENABLE_DEVELOPMENT_MODE_DEFAULT ON) # Change to 'OFF' for a

```

Note that the prefix `${REPOSITORY_NAME}_` is used instead of hard-coding the repository's name to allow flexibility in what a meta-project names a given TriBITS repository.

The local variables in these set statements are processed in the base project directory's local scope and are therefore seen by the entire CMake project. When this file is read in repository mode, the variable `${REPOSITORY_NAME}_ENABLE_DEVELOPMENT_MODE_DEFAULT` is ignored.

<repoDir>/cmake/RepositoryDependenciesSetup.cmake: [Optional] If present, this file is included a single time as part of the generation of the project dependency data-structure (see [Reduced Package Dependency Processing](#)). It gets included at the top project level scope in order with the other repositories listed in `${PROJECT_NAME}_ALL_REPOSITORIES`. Any local variables set in this file have project-wide scope. The primary purpose for this file is to set variables that will impact the processing of project's package's `Dependencies.cmake` files and take care of other enable/disable issues that are not clearly handled by the TriBITS system automatically.

The typical usage of this file is to set the default CDash email base address that will be the default for all of the defined packages (see [CDash regression email addresses](#)). For example, to set the default email address for all of the packages in this repository, one would set in this file:

```
SET_DEFAULT (${REPOSITORY_NAME}_REPOSITORY_MASTER_EMAIL_ADDRESSES
    repox-regressions@somemailserver.org)
```

<repoDir>/cmake/CallbackSetupExtraOptions.cmake: [Optional] If defined, this file is processed (included) for each repo in order right after the basic TriBITS options are defined in the macro

TRIBITS_DEFINE_GLOBAL_OPTIONS_AND_DEFINE_EXTRA_REPOS(). This file must define the macro TRIBITS_REPOSITORY_SETUP_EXTRA_OPTIONS() which is then called by the TriBITS system. This file is only processed when doing a basic configuration of the project and **not** when it is just building up the dependency data-structures as part of other tools (like `checkin-test.py`, `TribitsCTestDriverCore.cmake`, etc.). Any local variables set in this file or macro have project-wide scope.

A few additional variables are defined by the time this file is processed and can be used in the logic in these files. The variables that should already be defined, in addition to all of the basic user TriBITS cache variables, include `CMAKE_HOST_SYSTEM_NAME`, `${PROJECT_NAME}_HOSTNAME`, and `PYTHON_EXECUTABLE`. The types of logic to put in this file includes:

- Setting additional user cache variable options that are used by multiple packages into the TriBITS Repository. For example, Trilinos defines a `Trilinos_DATA_DIR` user cache variable that several Trilinos packages use.
- Disabling packages in the TriBITS Repository when conditions will not allow them to be enabled. For example, Trilinos disables the package `ForTrilinos` when Fortran is disabled and disables `PyTrilinos` when Python support is disabled.

An example of this file is:

[TribitsExampleProject](#)/cmake/CallbackSetupExtraOptions.cmake

which currently looks like:

```
MACRO (TRIBITS_REPOSITORY_SETUP_EXTRA_OPTIONS)

    ASSERT_DEFINED (${PROJECT_NAME}_ENABLE_EXPORT_MAKEFILES)
    ASSERT_DEFINED (${PROJECT_NAME}_ENABLE_INSTALL_CMAKE_CONFIG_FILES)

    IF (${PROJECT_NAME}_ENABLE_EXPORT_MAKEFILES OR
        ${PROJECT_NAME}_ENABLE_INSTALL_CMAKE_CONFIG_FILES
        )
        MESSAGE (
            "\n***"
            "\n*** Warning: Setting ${PROJECT_NAME}_ENABLE_WrapExternal=OFF"
            " because ${PROJECT_NAME}_ENABLE_EXPORT_MAKEFILES or"
            " ${PROJECT_NAME}_ENABLE_INSTALL_CMAKE_CONFIG_FILES is on!"
            "\n***\n"
        )
        SET (${PROJECT_NAME}_ENABLE_WrapExternal OFF)
    ENDIF ()

ENDMACRO ()
```

<repoDir>/cmake/CallbackDefineRepositoryPackaging.cmake: [Optional] If this file exists, then this file defines extra CPack-related options that are specific to the TriBITS Repository. This file must define the macro `TRIBITS_REPOSITORY_DEFINE_PACKAGING()` which is called by TriBITS. This file is processed as the top project-level scope so any local variables set have project-wide effect. This file is processed before the project's [<projectDir>/cmake/CallbackDefineProjectPackaging.cmake](#) so any options defined in the repositories file are overridden by the project. This file typically just involves setting extra excludes to remove files from the tarball. The file:

[TribitsExampleProject/cmake/CallbackDefineRepositoryPackaging.cmake](#)

provides a good example which is:

```
MACRO (TRIBITS_REPOSITORY_DEFINE_PACKAGING)

    ASSERT_DEFINED (${REPOSITORY_NAME}_SOURCE_DIR)
    APPEND_SET (CPACK_SOURCE_IGNORE_FILES
        "${${REPOSITORY_NAME}_SOURCE_DIR}/cmake/ctest/"
    )

ENDMACRO ()
```

TriBITS Repository Core Variables The following local variables are defined automatically by TriBITS before processing a given TriBITS repositories files (e.g. `PackagesList.cmake`, `TPLsList.cmake`, etc.):

`REPOSITORY_NAME`

The name of the current TriBITS repository.

`REPOSITORY_DIR`

Path of the current Repository relative to the Project directory. This is typically just the repository name but can be an arbitrary directory if specified through a `ExtraRepositoriesList.cmake` file.

The following base project-scope local variables are available once the list of TriBITS repositories are defined:

`${REPOSITORY_NAME}_SOURCE_DIR`

The absolute path to the base of a given Repository source directory. CMake code, for example in a packages's `CMakeLists.txt` file, typically refers to this by the raw name like `RepoX_SOURCE_DIR`. This makes such CMake code independent of where the various TriBITS repos are in relation to each other or the Project.

`${REPOSITORY_NAME}_BINARY_DIR`

The absolute path to the base of a given Repository binary directory. CMake code, for example in packages, refer to this by the raw name like `RepoX_SOURCE_DIR`. This makes such CMake code independent of where the various TriBITS repos are in relation to each other or the Project.

TriBITS Package

A TriBITS Package:

- Typically defines a set of libraries and/or header files and/or executables and/or tests with CMake build targets for building these and exports the list of include directories, libraries, and targets that are created (along with CMake dependencies).
- Is declared in its parent repository's [<repoDir>/PackagesList.cmake](#) file.
- Defines dependencies on upstream TPLs and/or other SE packages by just naming the dependencies in the file [<packageDir>/cmake/Dependencies.cmake..](#)
- Can optionally have subpackages listed in the argument `SUBPACKAGES_DIRS_CLASSIFICATIONS_OPTREQS` to [TRIBITS_DEFINE_PACKAGE_DEPENDENCIES\(\)](#).

- Is the fundamental unit of software partitioning and aggregation and must have a unique package name that is globally unique, not only within its defined repository, but across all possible repositories that might be coupled together some day using TriBITS.
- Is the unit of testing as driven by `TribitsCTestDriverCore.cmake` and displayed on CDash.

WARNING: As noted above, one must be very careful to pick package names that will be globally unique

For more details on the definition of a TriBITS Package (or subpackage), see:

- [TriBITS Package Core Files](#)
- [TriBITS Package Core Variables](#)

TriBITS Package Core Files The core files that make up TriBITS Package (where `<packageDir>` = `${PACKAGE_NAME}_SOURCE_DIR`) are:

```
<packageDir>/
CMakeLists.txt  # Only processed if the package is enabled
cmake/
  Dependencies.cmake  # Always processed if the package is listed in the
                      # enclosing Repository
```

NOTE: Before a TriBITS Package's files are described in more detail, it is important to note that all of the package's files that define its behavior and tests should strictly be contained under the package's base source directory `<packageDir>/` if at all possible. While this is not a requirement for the basic TriBITS build system, the approach for automatically detecting when a package has changed by looking at what files have changed (which is used in `checkin-test.py` and `TribitsCTestDriverCore.cmake`) requires that the package's files be listed under `<packageDir>/` (see [Pre-push Testing using checkin-test.py](#)). Without this, these development testing tools will not be able to effectively determine what needs to be rebuilt and retested which can lead to pushing broken software.

These TriBITS Package files are documented in more detail below:

- [<packageDir>/cmake/Dependencies.cmake](#)
- [<packageDir>/CMakeLists.txt](#)

<packageDir>/cmake/Dependencies.cmake: [Required] Defines the dependencies of a given SE package using the macro `TRIBITS_DEFINE_PACKAGE_DEPENDENCIES()`. This file is processed at the top-level project scope (using an `INCLUDE()`) so any local variables set will be seen by the entire project. This file is always processed, including when just building the project's [<Project>PackageDependencies.xml](#) file.

An example of a `Dependencies.cmake` file for a package with optional and required dependencies is for the mock Panzer package in [MockTrilinos](#):

```
TRIBITS_DEFINE_PACKAGE_DEPENDENCIES(
  LIB_REQUIRED_PACKAGES Teuchos Sacado Phalanx Intrepid Thyra
  Tpetra Epetra EpetraExt
  LIB_OPTIONAL_PACKAGES Stokhos
  TEST_OPTIONAL_PACKAGES Stratimikos
  LIB_REQUIRED_TPLS MPI Boost
)
```

An example of a package with subpackages is `PackageWithSubpackages` in [TribitsExampleProject](#) with the `Dependencies.cmake` file:

```

TRIBITS_DEFINE_PACKAGE_DEPENDENCIES (
  SUBPACKAGES_DIRS_CLASSIFICATIONS_OPTREQS
    SubpackageA   A   PT   REQUIRED
    SubpackageB   B   PT   REQUIRED
    SubpackageC   C   PT   REQUIRED
)

```

The last case defines three subpackages which creates three new SE packages with names `PackageWithSubpackagesSubpackageA`, `PackageWithSubpackagesSubpackageB`, and `PackageWithSubpackagesSubpackageC`.

<packageDir>/CMakeLists.txt: [Required] The package's top-level `CMakeLists.txt` file that defines the libraries, include directories, and contains the tests for the package.

The basic structure of this file for a **package without subpackages** is shown in:

[TribitsExampleProject/packages/simple_cxx/CMakeLists.txt](#)

which is:

```

#
# A) Define the package
#
TRIBITS_PACKAGE( SimpleCxx  ENABLE_SHADOWING_WARNINGS  CLEANED )

#
# B) Platform-specific checks
#
INCLUDE(CheckFor__int64)
CHECK_FOR__INT64(HAVE_SIMPLECXX__INT64)

#
# C) Set up package-specific options
#
TRIBITS_ADD_DEBUG_OPTION()
TRIBITS_ADD_SHOW_DEPRECATED_WARNINGS_OPTION()

#
# D) Add the libraries, tests, and examples
#
ADD_SUBDIRECTORY(src)
TRIBITS_ADD_TEST_DIRECTORIES(test)
TRIBITS_ADD_EXAMPLE_DIRECTORIES(example)

#
# E) Do standard postprocessing
#
TRIBITS_PACKAGE_POSTPROCESS()

```

The first command at the top of the file in [TRIBITS_PACKAGE\(\)](#) where the package name is passed in in addition to a few other options. TriBITS obviously already knows the package name. The purpose for repeating it is as documentation for the developer's sake. Then a set of platform configure-time tests is typically performed (if there are any). In this example, the existence of the C++ `__int64` data-type is checked using the module `CheckFor__int64.cmake` (which is in the `cmake/` directory of this package. (CMake has great support for configure-time tests, see [Configure-time System Tests](#).) This is followed by package-specific options. In this case, the standard TriBITS options for debug checking and deprecated warnings are added using the standard macros [TRIBITS_ADD_DEBUG_OPTION\(\)](#) and

[TRIBITS_ADD_SHOW_DEPRECATED_WARNINGS_OPTION\(\)](#). After all of this up front stuff (which will be present in any moderately complex CMake-configured project) the source and the test subdirectories are added that actually define the library and the tests. In this case, the standard [TRIBITS_ADD_TEST_DIRECTORIES\(\)](#) macro is used which only conditionally adds the tests for the package.

The final command in the package's `CMakeLists.txt` file must always be [TRIBITS_PACKAGE_POSTPROCESS\(\)](#). This is needed in order to perform some necessary post-processing by TriBITS.

It is also possible to for the package's top-level `CMakeLists.txt` to be the only such file in a package. Such an example can be seen in the example project *TribitsHelloWorld*.

When a TriBITS package is broken up into subpackages (see [TriBITS Subpackage](#)), its `CMakeLists.txt` file looks a little different. The basic structure of this file for a **package with subpackages** is shown in:

[TribitsExampleProject](#)/packages/package_with_subpackages/CMakeLists.txt

which contains:

```
#
# A) Forward declare the package so that certain options are also defined for
# subpackages
#
TRIBITS_PACKAGE_DECL(PackageWithSubpackages)

#
# B) Define the common options for the package first so they can be used by
# subpackages as well.
#
TRIBITS_ADD_DEBUG_OPTION()

#
# C) Process the subpackages
#
TRIBITS_PROCESS_SUBPACKAGES()

#
# D) Define the package now and perform standard postprocessing
#
TRIBITS_PACKAGE_DEF()
TRIBITS_PACKAGE_POSTPROCESS()
```

What is different about `CMakeLists.txt` files for packages without subpackages is that the [TRIBITS_PACKAGE\(\)](#) command is broken up into two parts [TRIBITS_PACKAGE_DECL\(\)](#) and [TRIBITS_PACKAGE_DEF\(\)](#). In between these two commands, the parent package can define the common package options and then calls the command [TRIBITS_PROCESS_SUBPACKAGES\(\)](#) which fully processes the packages. If the parent package has libraries and/or tests/example of its own, it can define those after calling [TRIBITS_PACKAGE_DEF\(\)](#), just like with a regular package. However, it is rare for a package broken up into subpackages to have its own libraries and/or tests and examples. As always, the final command called inside of the `CMakeLists.txt` is [TRIBITS_PACKAGE_POSTPROCESS\(\)](#).

TriBITS Package Core Variables The following locally scoped variables are defined when the files for a given TriBITS Package (or any SE package for that matter) are being processed:

`PACKAGE_NAME`

The name of the current TriBITS SE package. This is set automatically by TriBITS before the package's `CMakeLists.txt` file is processed. **WARNING:** The TriBITS package name must be globally unique across all possible repositories that might be coupled together at some point using TriBITS!

`PACKAGE_SOURCE_DIR`

The absolute path to the base package's base source directory. This is set automatically by TriBITS in the macro [TRIBITS_PACKAGE\(\)](#).

`PACKAGE_BINARY_DIR`

The absolute path to the base package's base binary/build directory. This is set automatically by TriBITS in the macro [TRIBITS_PACKAGE\(\)](#).

`PACKAGE_NAME_UC`

This is set to the upper-case version of `${PACKAGE_NAME}`. This is set automatically by TriBITS in the macro [TRIBITS_PACKAGE\(\)](#).

Once all of the TriBITS SE package's `Dependencies.cmake` files have been processed, the following top-level (non-cache) local variables are defined:

`${PACKAGE_NAME}_SOURCE_DIR`

The absolute path to the base of a given package's source directory. CMake code, for example in other packages, refer to this by the raw name like `PackageX_SOURCE_DIR`. This makes such CMake code independent of where the package is in relation to other packages. This variable is defined for all processed packages, independent of whether they are enabled.

`${PACKAGE_NAME}_BINARY_DIR`

The absolute path to the base of a given package's binary directory. CMake code, for example in other packages, refer to this by the raw name like `PackageX_BINARY_DIR`. This makes such CMake code independent of where the package is in relation to other packages. This variable is only defined if the package is enabled.

`${PACKAGE_NAME}_PARENT_REPOSITORY`

The name of the package's parent repository. This can be used by a package to access information about its parent repository. For example, the variable `${${PACKAGE_NAME}_PARENT_REPOSITORY}_SOURCE_DIR` can be dereferenced.

In addition, the following user-settable cache variables are defined before an SE Package's `CMakeLists.txt` file is processed:

`${PROJECT_NAME}_ENABLE_${PACKAGE_NAME}`

Set to ON if the package is to be enabled.

`${PACKAGE_NAME}_ENABLE_TESTS`

Set to ON if the package's tests are to be enabled. This will enable a package's tests and all of its subpackage's tests.

`${PACKAGE_NAME}_ENABLE_EXAMPLES`

Set to ON if the package's examples are to be enabled. This will enable a package's examples and all of its subpackage's examples.

The above variables can be set by the user or may be set automatically as part of the [Package Dependencies and Enable/Disable Logic](#).

Currently, a Package can refer to its containing Repository and refer to its source and binary directories. This is so that it can refer to repository-level resources (e.g. like the `Trilinos_version.h` file for Trilinos packages). This may be undesirable because it will make it very hard to pull a package out of one Repository and place it in another repository for a different use. However, a package can indirectly refer to its own repository without concern for what it is called by reading the variable `${PACKAGE_NAME}_PARENT_REPOSITORY`.

TriBITS Subpackage

A TriBITS Subpackage:

- Typically defines a set of libraries and/or header files and/or executables and/or tests with CMake build targets for building these and exports the list of include directories, libraries, and targets that are created (along with CMake dependencies).
- Is declared in its parent packages's `<packageDir>/cmake/Dependencies.cmake` file in a call to `TRIBITS_DEFINE_PACKAGE_DEPENDENCIES()` using the argument `SUBPACKAGES_DIRS_CLASSIFICATIONS_OPTREQS`.
- Defines dependencies on upstream TPLs and/or other SE packages by just naming the dependencies in the file `cmake/Dependencies.cmake` using the macro `TRIBITS_DEFINE_PACKAGE_DEPENDENCIES()`.
- Can **NOT** have its own subpackages defined (only top-level packages can have subpackages).
- Is enabled or disabled along with all other subpackages in the parent package automatically if it's parent package is enabled or disabled with `${PROJECT_NAME}_ENABLE_${PARENT_PACKAGE_NAME}` set to ON or OFF respectively.
- Has tests turned on automatically if `${PARENT_PACKAGE_NAME}_ENABLE_TESTS==ON`.

The contents of a TriBITS Subpackage are almost identical to those of a TriBITS Package. The differences are described below.

For more details on the definition of a TriBITS Package (or subpackage), see:

- [TriBITS Subpackage Core Files](#)
- [TriBITS Subpackage Core Variables](#)

TriBITS Subpackage Core Files The set of core files for a subpackage are identical to the [TriBITS Package Core Files](#). The core files that make up a TriBITS Subpackage (where `<packageDir> = ${${PARENT_PACKAGE_NAME}_SOURCE_DIR}` and `<spkgDir>` is the subpackage directory listed in the `SUBPACKAGES_DIRS_CLASSIFICATIONS_OPTREQS` to `TRIBITS_DEFINE_PACKAGE_DEPENDENCIES()`) are:

```
<packageDir>/<spkgDir>/
  CMakeLists.txt  # Only processed if this subpackage is enabled
cmake/
  Dependencies.cmake  # Always processed if the parent package
                     # is listed in the enclosing Repository
```

These TriBITS Subpackage files are documented in more detail below:

- `<packageDir>/<spkgDir>/cmake/Dependencies.cmake`
- `<packageDir>/<spkgDir>/CMakeLists.txt`
- [How is TriBITS Subpackage is different from a TriBITS Package?](#)

`<packageDir>/<spkgDir>/cmake/Dependencies.cmake`: The contents of this file for subpackages is identical as for top-level packages. It just contains a call to the macro `TRIBITS_DEFINE_PACKAGE_DEPENDENCIES()` to define this SE package's upstream TPL and SE package dependencies. A simple example is for SubpackageB declared in `package_with_subpackages/cmake/Dependencies.cmake` shown shown in:

```
TribitsExampleProject/packages/package_with_subpackages/B/cmake/Dependneices.cmake
```

which is:

```
TRIBITS_DEFINE_PACKAGE_DEPENDENCIES (
  LIB_REQUIRED_PACKAGES PackageWithSubpackagesSubpackageA
)
```

What this shows is that subpackages must list their dependencies on each other (if such dependencies exist) using the full SE package name `${PARENT_PACKAGE_NAME}${SUBPACKAGE_NAME}` or in this case `PackageWithSubpackages + SubpackageA = PackageWithSubpackagesSubpackageA`.

Note that the parent SE package depends on its subpackages, not the other way around. For example, the `PackageWithSubpackages` parent SE package depends its SE subpackages `PackageWithSubpackagesSubpackageA`, `PackageWithSubpackagesSubpackageC`, and `PackageWithSubpackagesSubpackageC`. As such all (direct) dependencies for a subpackage must be listed in its own `Dependencies.cmake` file. For example, the `PackageWithSubpackages` subpackage `SubpackageA` depends on the `SimpleCxx` package and is declared as such as shown in:

[TribitsExampleProject/packages/package_with_subpackages/A/cmake/Dependencies.cmake](#)

which is:

```
TRIBITS_DEFINE_PACKAGE_DEPENDENCIES (
  LIB_REQUIRED_PACKAGES SimpleCxx
)
```

What this means is that any TPL or library dependencies listed in the parent package's [<packageDir>/cmake/Dependencies.cmake](#) file are **NOT** dependencies of its subpackages. For example, if [package_with_subpackages/cmake/Dependencies.cmake](#) were changed to be:

```
TRIBITS_DEFINE_PACKAGE_DEPENDENCIES (
  LIB_REQUIRED_TPLS Boost
  SUBPACKAGES_DIRS_CLASSIFICATIONS_OPTREQS
  SubpackageA A PT REQUIRED
  ...
)
```

then the Boost TPL would **NOT** be a dependency of the SE package `PackageWithSubpackagesSubpackageA` but instead would be listed as a dependency of the parent SE package `PackageWithSubpackages`. (And in this case, this TPL dependency is pretty worthless since the SE package `PackageWithSubpackages` does not even define any libraries or tests of its own.)

<packageDir>/<spkgDir>/CMakeLists.txt: [Required] The subpackage's top-level `CMakeLists.txt` file that defines the libraries, include directories, and contains the tests for the subpackage. The contents of a subpackage's top-level `CMakeLists.txt` is almost identical to a top-level package's `<packageDir>/CMakeLists.txt` file. The primary difference is that the commands `TRIBITS_PACKAGE()` and `TRIBITS_PACKAGE_POSTPROCESS()` are replaced with `TRIBITS_SUBPACKAGE()` and `TRIBITS_SUBPACKAGE_POSTPROCESS()` as shown in the file:

[TribitsExampleProject/packages/package_with_subpackages/A/CMakeLists.txt](#)

which contains:

```
#
# A) Define the subpackage
#
TRIBITS_SUBPACKAGE (SubpackageA)
```

```

#
# B) Set up subpackage-specific options
#
# Typically there are none or are few as must are picked up from the parent
# package's CMakeLists.txt file!

#
# C) Add the libraries, tests, and examples
#

INCLUDE_DIRECTORIES (${CMAKE_CURRENT_SOURCE_DIR})
TRIBITS_ADD_LIBRARY (pws_a
    SOURCES A.cpp
    HEADERS A.hpp
    NOINSTALLHEADERS
)

TRIBITS_ADD_TEST_DIRECTORIES (tests)

#
# D) Do standard postprocessing
#
TRIBITS_SUBPACKAGE_POSTPROCESS ()

```

Unlike [TRIBITS_PACKAGE\(\)](#), [TRIBITS_SUBPACKAGE\(\)](#) does not take any extra arguments. Those extra settings are assumed to be defined by the top-level parent package. Like top-level packages, subpackages are free to define user-setable options and configure-time tests but typically don't. The idea is that subpackages should be lighter weight than top-level packages. Other than using [TRIBITS_SUBPACKAGE\(\)](#) and [TRIBITS_SUBPACKAGE_POSTPROCESS\(\)](#), a subpackage can be layed out just like any other package and can call on any other commands to add libraries, add executables, add test, etc.

TriBITS Subpackage Core Variables The core variables associated with a subpackage are identical to the [TriBITS Package Core Variables](#). The only difference is that a subpackage may need to refer to its parent package where a top-level package does not have a parent package. The extra variables that are defined when processing a subpackages files are:

PARENT_PACKAGE_NAME

The name of the parent package.

PARENT_PACKAGE_SOURCE_DIR

The absolute path to the parent package's source directory. This is only defined for a subpackage.

PARENT_PACKAGE_BINARY_DIR

The absolute path to the parent package's binary directory. This is only defined for a subpackage.

How is TriBITS Subpackage is different from a TriBITS Package? A common question this is natural to ask is how a TriBITS Subpackage is different from a TriBITS Package? They contain the same basic files (i.e. a `CMake/Dependencies.cmake`, a top-level `CMakeList.txt` file, source files, test files, etc.). They both are included in the list of TriBITS SE Packages and therefore can both be enabled/disabled by the user or in automatic dependency logic. The primary difference is that a subpackage is meant to involve less overhead in defining and is to be used to partition the parent package's software into chunks according to software engineering packaging principles. Also, the dependency logic treats a parent package's subpackages as part of

itself so when the parent package is explicitly enabled or disabled, it is identical to explicitly enabling or disabling all of its subpackages. Other differences and issues between packages as subpackages are discussed throughout this guide.

TriBITS TPL

A TriBITS TPL:

- Defines a set of pre-built libraries and/or header files and/or executables and/or some other resources used by one or more TriBITS Packages.
- Is listed as an explicit optional or required dependency in one or more TriBITS SE package's `Dependencies.cmake` files using the macro [TRIBITS_DEFINE_PACKAGE_DEPENDENCIES\(\)](#).
- Publishes the include directories and/or libraries and/or executables provided by the TPL.

Using a TriBITS TPL is to be preferred over using a raw CMake `FIND_PACKAGE(<someCMakePackage>)` because the TriBITS system guarantees that only a single unique version of TPL will be used by multiple packages and by declaring a TPL using TriBITS, automatical enable/disable logic will be applied as described in [Package Dependencies and Enable/Disable Logic](#).

For each TPL referenced in a `TPLsList.cmake` file using the macro [TRIBITS_DEFINE_REPOSITORY_TPLS\(\)](#), there should exist a file, typically called `FindTPL${TPL_NAME}.cmake`, that once processed, produces the variables `${TPL_NAME}_LIBRARIES` and `${TPL_NAME}_INCLUDE_DIRS`. Most `FindTPL${TPL_NAME}.cmake` files just use the the function [TRIBITS_TPL_DECLARE_LIBRARIES\(\)](#) to define the TriBITS TPL. A simple example of such a file is the standard `FindTPLPETSC.cmake` module which is:

```
INCLUDE(TribitsTplDeclareLibraries)

TRIBITS_TPL_DECLARE_LIBRARIES( PETSC
    REQUIRED_HEADERS petsc.h
    REQUIRED_LIBS_NAMES petsc
)
```

Some concrete `FindTPL${TPL_NAME}.cmake` files actually do use `FIND_PACKAGE()` and a standard CMake package find module to fill in the guts of finding a TPL.

Note that the TriBITS system does not require the usage of the function [TRIBITS_TPL_DECLARE_LIBRARIES\(\)](#) and does not even care about the TPL module name `FindTPL${TPL_NAME}.cmake`. All that is required is that some CMake file fragment exist that once included, will define the variables `${TPL_NAME}_LIBRARIES` and `${TPL_NAME}_INCLUDE_DIRS`. However, to be user friendly, such a CMake file should respond to the same variables as accepted by the standard [TRIBITS_TPL_DECLARE_LIBRARIES\(\)](#) function.

The only core variables related to an enabled TPL `${TPL_NAME}_LIBRARIES` and `${TPL_NAME}_INCLUDE_DIRS` as defined in [TRIBITS_TPL_DECLARE_LIBRARIES\(\)](#) need to be defined. For more details, see [TRIBITS_DEFINE_REPOSITORY_TPLS\(\)](#).

3.2 Processing of TriBITS Files: Ordering and Details

One of the most important things to know about TriBITS is what files it processes, in what order, and in what context. This is critical to being able to understand what impact (if any) setting a variable or otherwise changing the CMake runtime state will have on configuring a CMake project which uses TriBITS. While the different files that make up a [TriBITS Project](#), [TriBITS Repository](#), [TriBITS Package](#), and [TriBITS TPL](#) were defined in the section [TriBITS Project Structure](#), that material did not fully describe the context and in what order these files are processed by the TriBITS framework.

The TriBITS system processes the project's files in one of two use cases. The first use case is in the basic configuration of the project with a standard `cmake` command invocation in order to set up the build files in the binary directory (see [Full TriBITS Project Configuration](#)). The second use case is in reading the project's dependency-related files in order to build a package dependency datastructure (e.g. the `<Project>PackageDependencies.xml` file, see [Reduced Package Dependency Processing](#)). The second use case of reading the project's dependency files is largely a subset of the first.

Another factor that is important to understand is the scoping in which the various files are processed (with `INCLUDE()` or `ADD_SUBDIRECTORY()`). This scoping has a large impact on the configuration of the project and what effect the processing of files and setting variables have on the project as a whole. Some of the strange scoping rules for CMake are discussed in [CMake Language Overview and Gotchas](#) and should be understood before trying to debug issues with processing. Many of the basic files are processed (included) in the base project `<projectDir>/CMakeLists.txt` scope and therefore any local variables set in these files are accessible to the entire CMake project (after the file is processed, of course). Other files get processed inside of functions which have their own local scope and therefore only impact the rest of the project in more purposeful ways.

Full TriBITS Project Configuration

The first use case to describe is the full processing of all of the TriBITS project's files starting with the base `<projectDir>/CMakeLists.txt` file. This begins with the invocation of the command:

```
$ cmake [options] <projectDir>
```

Below, is a short pseudo-code algorithm for the TriBITS framework processing and callbacks that begin in the `<projectDir>/CMakeLists.txt` and proceed through the call to `TRIBITS_PROJECT()`.

Full Processing of TriBITS Project Files:

1. Read `<projectDir>/ProjectName.cmake` (sets `PROJECT_NAME`)
2. Call `PROJECT({PROJECT_NAME} NONE)` (sets `{PROJECT_NAME}_SOURCE_DIR` and `{PROJECT_NAME}_BINARY_DIR`)
3. Execute `TRIBITS_PROJECT()`:
 - 1) Set `PROJECT_SOURCE_DIR` and `PROJECT_BINARY_DIR`
 - 2) For each `<optFilei>` in `{{PROJECT_NAME}_CONFIGURE_OPTIONS_FILE}`:
 - * `INCLUDE(<optFilei>)`
 - 3) Set variables `CMAKE_HOST_SYSTEM_NAME` and `{PROJECT_NAME}_HOSTNAME` (both of these can be overridden in the cache by the user)
 - 4) Find Python (sets `PYTHON_EXECUTABLE`)
 - 5) `INCLUDE(<projectDir>/Version.cmake)`
 - 6) Define primary TriBITS options and read in the list of extra repositories (calls `TRIBITS_DEFINE_GLOBAL_OPTIONS_AND_DEFINE_EXTRA_REPOS()`)
 - * `INCLUDE(<projectDir>/cmake/ExtraRepositoriesList.cmake)`
 - 7) For each `<repoDir>` in all defined TriBITS repositories:
 - * `INCLUDE(<repoDir>/cmake/CallbackSetupExtraOptions.cmake)`
 - * Call `TRIBITS_REPOSITORY_SETUP_EXTRA_OPTIONS()`
 - 9) Call `TRIBITS_READ_PACKAGES_PROCESS_DEPENDENCIES_WRITE_XML()`:
 - a) For each `<repoDir>` in all defined TriBITS repositories:
 - * `INCLUDE(<repoDir>/PackagesList.cmake)`
 - * `INCLUDE(<repoDir>/TPLsList.cmake)`
 - b) For each `<repoDir>` in all defined TriBITS repositories:
 - * `INCLUDE(<repoDir>/cmake/RepositoryDependenciesSetup.cmake)`
 - c) `INCLUDE(<projectDir>/cmake/ProjectDependenciesSetup.cmake)`
 - d) For each `<packageDir>` in all defined top-level packages:
 - * `INCLUDE(<packageDir>/cmake/Dependencies.cmake)`

- Sets all package-specific options (see [TriBITS Package Cache Variables](#))
- * For each <spkgDir> in all subpackages for this package:
 - * INCLUDE (<packageDir>/<spkgDir>/cmake/Dependencies.cmake)
 - Sets all subpackage-specific options
- 10) Adjust SE packae and TPLs enable/disable
(see [Package Dependencies and Enable/Disable Logic](#))
- 11) [Probe and set up the environment](#) (finds MPI, compilers, etc.)
(see [TriBITS Environment Probing and Setup](#))
- 12) For each enabled TPL, INCLUDE (FindTPL<tplName>.cmake (see [TriBITS TPL](#)))
- 13) For each <repoDir> in all defined TriBITS repositories:
 - * Read <repoDir>/Copyright.txt
 - * INCLUDE (<repoDir>/Version.cmake)
 - (see [Project and Repository Versioning and Release Mode](#))
- 14) For each <packageDir> in all enabled top-level packages
 - * ADD_SUBDIRECTORY (<packageDir>/CMakeLists.txt)
 - * For each <spkgDir> in all enabled subpackages for this package:
 - * ADD_SUBDIRECTORY (<packageDir>/<spkgDir>/CMakeLists.txt)
- 15) For each <repoDir> in all defined TriBITS repositories:
 - * INCLUDE (<repoDir>/cmake/CallbackDefineRepositoryPackaging.cmake)
 - * Call TRIBITS_REPOSITORY_DEFINE_PACKAGING ()
- 17) INCLUDE (<projectDir>/cmake/CallbackDefineProjectPackaging.cmake)
 - * Call TRIBITS_PROJECT_DEFINE_PACKAGING ()

The TriBITS Framework obviously does a lot more than what is described above but the basic trace of major operations and ordering and the processing of project, repository, package, and subpackage files should be clear. All of this information should also be clear when enabling [File Processing Tracing](#).

Reduced Package Dependency Processing

In addition to the full processing that occurs as part of the [Full TriBITS Project Configuration](#), there are also TriBITS tools that only process a subset of project's file. This reduced processing is performed in order to build up the project's package dependencies data-structure (see [TriBITS Environment Probing and Setup](#)) and to write the file <Project>PackageDependencies.xml. For example, the tool `checkn-test.py` and the script `TribitsCTestDriverCore.cmake` both drive this type of processing. In particular, the CMake -P script `TribitsDumpDepsXmlScript.cmake` reads all of the project's dependency-related files and dumps out the <Project>PackageDependencies.xml file a defined set of native and extra repositories defined for the project. This reduced processing is given below.

Reduced Dependency Processing of TriBITS Project:

1. Read <projectDir>/ProjectName.cmake (sets PROJECT_NAME)
2. INCLUDE (<projectDir>/cmake/ExtraRepositoriesList.cmake)
3. Call TRIBITS_READ_PACKAGES_PROCESS_DEPENDENCIES_WRITE_XML ():
 - a) For each <repoDir> in all defined TriBITS repositories:
 - * INCLUDE (<repoDir>/PackagesList.cmake)
 - * INCLUDE (<repoDir>/TPLsList.cmake)
 - b) For each <repoDir> in all defined TriBITS repositories:
 - * INCLUDE (<repoDir>/cmake/RepositoryDependenciesSetup.cmake)
 - c) INCLUDE (<projectDir>/cmake/ProjectDependenciesSetup.cmake)
 - d) For each <packageDir> in all defined top-level packages:
 - * INCLUDE (<packageDir>/cmake/Dependencies.cmake)
 - Sets all package-specific options (see [TriBITS Package Cache Variables](#))

- * For each <spkgDir> in all subpackages for this package:
 - * INCLUDE (<packageDir>/<spkgDir>/cmake/Dependencies.cmake)
 - Sets all subpackage-specific options

When comparing the above reduced dependency processing to the [Full Processing of TriBITS Project Files](#) it is important to note that that several files are **not** processed in these cases. The files that are not processed include <projectDir>/Version.cmake, <repoDir>/Version.cmake and <repoDir>/cmake/CallbackSetupExtraOptions.cmake. Therefore, you can't put anything in these files that would impact the definition of TriBITS repositories, packages, TPLs, etc. Anything that would affect the dependencies data-structure that gets written out as <Project>PackageDependencies.xml must be contained in the files that are processed shown above.

Debugging issues with *Reduced Dependency Processing of TriBITS Project Files* is more difficult because one can not easily turn on *File Processing Tracing* like they can when doing the full CMake configure. However, options may be added to the various tools to show this file processing and help debug problems.

File Processing Tracing

In order to aid in debugging problems with configuration, TriBITS defines the CMake cache option `${PROJECT_NAME}_TRACE_FILE_PROCESSING`. When enabled, TriBITS will print out when any of the project-related, repository-related, or package-related file is being processed by TriBITS. When `${PROJECT_NAME}_TRACE_FILE_PROCESSING=ON`, lines starting with `-- File Trace:` are printed in the `cmake STDOUT` for files that TriBITS automatically processes where there may be any confusion about what files are processed and when.

For example, for [TribitsExampleProject](#), the configure file trace for the configure command:

```
$ cmake \
-DTribitsExProj_TRIBITS_DIR=<tribitsDir> \
-DTribitsExProj_ENABLE_MPI=ON \
-DTribitsExProj_ENABLE_ALL_PACKAGES=ON \
-DTribitsExProj_ENABLE_TESTS=ON \
-DTribitsExProj_TRACE_FILE_PROCESSING=ON \
-DTribitsExProj_ENABLE_CPACK_PACKAGING=ON \
-DTribitsExProj_DUMP_CPACK_SOURCE_IGNORE_FILES=ON \
<tribitsDir>/doc/examples/TribitsExampleProject \
| grep "^-- File Trace:"
```

looks something like:

```
-- File Trace: PROJECT      INCLUDE      [...] /Version.cmake
-- File Trace: REPOSITORY  INCLUDE      [...] /cmake/CallbackSetupExtraOptions.cmake
-- File Trace: REPOSITORY  INCLUDE      [...] /PackagesList.cmake
-- File Trace: REPOSITORY  INCLUDE      [...] /TPLsList.cmake
-- File Trace: PACKAGE     INCLUDE      [...] /packages/simple_cxx/cmake/Dependencies.cmake
-- File Trace: PACKAGE     INCLUDE      [...] /packages/mixed_language/cmake/Dependencies.cmake
-- File Trace: PACKAGE     INCLUDE      [...] /packages/package_with_subpackages/cmake/Dependencies.cmake
-- File Trace: PACKAGE     INCLUDE      [...] /packages/package_with_subpackages/A/cmake/Dependencies.cmake
-- File Trace: PACKAGE     INCLUDE      [...] /packages/package_with_subpackages/B/cmake/Dependencies.cmake
-- File Trace: PACKAGE     INCLUDE      [...] /packages/package_with_subpackages/C/cmake/Dependencies.cmake
-- File Trace: PACKAGE     INCLUDE      [...] /packages/wrap_external/cmake/Dependencies.cmake
-- File Trace: PROJECT     CONFIGURE    [...] /cmake/ctest/CTestCustom.cmake.in
-- File Trace: REPOSITORY  READ        [...] /Copyright.txt
-- File Trace: REPOSITORY  INCLUDE      [...] /Version.cmake
    "${TPL_MPI_FILE_TRACE}"
-- File Trace: PACKAGE     ADD_SUBDIR   [...] /packages/simple_cxx/CMakeLists.txt
-- File Trace: PACKAGE     ADD_SUBDIR   [...] /packages/simple_cxx/test/CMakeLists.txt
-- File Trace: PACKAGE     ADD_SUBDIR   [...] /packages/mixed_language/CMakeLists.txt
```



```
-- File Trace: PACKAGE      ADD_SUBDIR [...] /packages/mixed_language/test/CMakeLists.txt
-- File Trace: PACKAGE      ADD_SUBDIR [...] /packages/package_with_subpackages/CMakeLists.txt
-- File Trace: PACKAGE      ADD_SUBDIR [...] /packages/package_with_subpackages/A/CMakeLists.txt
-- File Trace: PACKAGE      ADD_SUBDIR [...] /packages/package_with_subpackages/A/test/CMakeLists.txt
-- File Trace: PACKAGE      ADD_SUBDIR [...] /packages/package_with_subpackages/B/CMakeLists.txt
-- File Trace: PACKAGE      ADD_SUBDIR [...] /packages/package_with_subpackages/B/test/CMakeLists.txt
-- File Trace: PACKAGE      ADD_SUBDIR [...] /packages/package_with_subpackages/C/CMakeLists.txt
-- File Trace: PACKAGE      ADD_SUBDIR [...] /packages/package_with_subpackages/C/test/CMakeLists.txt
-- File Trace: REPOSITORY    INCLUDE    [...] /cmake/CallbackDefineRepositoryPackaging.cmake
-- File Trace: PROJECT      INCLUDE    [...] /cmake/CallbackDefineProjectPackaging.cmake
```

However, every file that TriBITS processes is not printed in this file trace if it should be obvious that the file is being processed. For example, the package's configured header file created using [TRIBITS_CONFIGURE_FILE\(\)](#) does not result in a file trace print statement because this is an unconditional command that is explicitly called in one of the the package's `CMakeLists.txt` files so it should be clear that this file is being processed.

3.3 Coexisting Projects, Repositories, and Packages

Certain simplifications are allowed when defining TriBITS projects, repositories and packages. The known allowed simplifications are described below.

TriBITS Repository == TriBITS Project: It is allowed for a TriBITS Project and a TriBITS Repository to be the same source directory. In this case, the repository name and the project name are the same as well. This is quite common. This is the case, for example, with the `Trilinos` and the [TribitsExampleProject](#) projects and repositories. In this case, the Project's and the Repository's `Version.cmake` and `Copyright.txt` files are one and the same, as they should be (see [Project and Repository Versioning and Release Mode](#)).

TriBITS Package == TriBITS Repository: It is also allowed for a TriBITS Repository to have only one package and to have that package be the base repository directory and have the same names. The TriBITS Repository and the single TriBITS Package would typically have the same name in this case (but that is actually not required but is confusing if one does not make it so). For example, in the TriBITS test project `MockTrilinos`, the repository and package `extraRepoOnePackage` are one in the same. In this case, the file `extraRepoOnePackage/PackagesList.cmake` looks like:

```
TRIBITS_DEFINE_REPOSITORY_PACKAGES (
    extraRepoOnePackage      .      ST
)
```

This is used in the real TriBITS repository [DataTransferKit](#).

However, to maximize flexibility, it is recommended that a TriBITS package and TriBITS repository not share the same directory.

TriBITS Package, TriBITS Repository, TriBITS Package sharing the same source directory: In the extreme, it is possible to collapse a single TriBITS package, repository, and project into the same base source directory. However, in this case, the TriBITS Project name and the TriBITS Package name can not be the same and some modifications and tricks are needed to allow this to work. One example of this is the TriBITS project and TriBITS package themselves, which are both rooted in the base `tribits` directory. There are a few restrictions and modifications needed to get this to work:

- The Project and Package names can not be the same: In the case of TriBITS, the project name is `TriBITSProj` (as defined in `tribits/ProjectName.cmake`) and the package name is `TriBITS` (as defined in `tribits/PackagesList.cmake`).
- The base `CMakeLists.txt` file must be modified to allow it to be processed both as the base project file and as the package file: In the case of `tribits/CMakeLists.txt`, a big if statement based in the local variable `TRIBITS_PROCESSED_BASED_PROJECT` is used.

- The TriBITS package’s binary directory must be modified. Because of directory level targets like `${PROJECT_NAME}_libs` and `${PACKAGE_NAME}_libs`, a subdirectory for package’s the binary directory must be created. This is simply done by overriding the binary directory name `${PACKAGE_NAME}_SPECIFIED_BINARY_DIR`. In the case of TriBITS, this is set to `tribits` in the `tribits/PackagesList.cmake` file.

Other than those modifications, a TriBITS project, repository, and package can all be rooted in the same source directory. However, to do so is a little messing and is not recommended. It was only done this way with the base TriBITS directory in order to maintain backward compatibility.

However, one possible use case for collapsing a project, repository, and package into a single base source directory would be to support the stand-alone build of a TriBITS package as its own entity that uses and installation of the TriBITS CMake modules. If a given upstream TriBITS package has no required upstream TriBITS package dependencies and minimal TPL dependencies (or only uses “standard” TriBITS TPLs already defined in the `tribits/tpls/` directory), then creating a stand-alone project build of a loan TriBITS package requires fairly little extra overhead.

3.4 Standard TriBITS TPLs

ToDo: Fill in!

3.5 Where to set variables?

A TriBITS project, repository, package have a number of files in which variables can be set and commands can be called in order to affect how the project is defined and configured. With so many files that can be included by TriBITS, it can be difficult to know where the right place is to set a given set of variables. The primary considerations for where to set a variable depend on:

ToDo: Describe considerations on where to set variables ...

4 Example TriBITS Projects

In this section, a few different example TriBITS projects and packages are previewed. All of these examples exist in the TriBITS source tree directory `tribits` itself so they are available to all users of TriBITS. These examples also provide a means to test the TriBITS system itself.

The first example covered in detail is [TribitsExampleProject](#). This first example covers all the basics for setting up a simple multi-package TriBITS project. The second example outlined is *MockTrilinos* which mostly exists to test the TriBITS system itself. The last example mentioned is the the TriBITS package itself which allows the TriBITS system to be tested and installed from any TriBITS project that lists it, including the `TriBITSProj` project itself (see [Coexisting Projects, Repositories, and Packages](#)).

The `tribits/doc/examples/` directory contains some other example TriBITS projects and repositories as well that are referred to in this and other documents.

4.1 TribitsHelloWorld

This is the simplest possible TriBITS project that you can imagine. It contains only a single TriBITS package and no frills at all. However, it does show how minimal a [TriBITS Project](#) (which is also a [TriBITS Repository](#)) and a [TriBITS Package](#) can be and still show the value of TriBITS over raw CMake. For example, this can be embedded in to a larger TriBITS meta-project and be seamlessly built along with any other such TriBITS-based software.

4.2 TribitsExampleProject

Here, the example project TribitsExampleProject that is provided with the TriBITS directory tree is outlined. From this simple example, one can quickly see how the basic structural elements a TriBITS example project are put together.

ToDo: Fill in!

4.3 MockTrilinos

ToDo: Fill in!

4.4 The TriBITS Package Itself

ToDo: Fill in!

5 Package Dependencies and Enable/Disable Logic

ToDo: Fill in!

The following TriBITS repository-related variables alter what packages in a given TriBITS repository get enabled implicitly or not:

`${REPOSITORY_NAME}_NO_IMPLICIT_PACKAGE_ENABLE`

If set to ON, then the packages in Repository `${REPOSITORY_NAME}` will not be implicitly enabled in any of the package adjustment logic.

`${REPOSITORY_NAME}_NO_IMPLICIT_PACKAGE_ENABLE_EXCEPT`

List of packages in the Repository `${REPOSITORY_NAME}` that will be allowed to be implicitly enabled. Only checked if

`${REPOSITORY_NAME}_NO_IMPLICIT_PACKAGE_ENABLE` is true.

The above variables typically are defined in the outer TriBITS Project's `PackageName.cmake` file in order to adjust how its listed repositories are handled.

ToDo: Fill in!

5.1 <Project>PackageDependencies.xml

ToDo: Fill in!

6 TriBITS Automated Testing

Much of the value provided by the TriBITS system is related to the support of testing of a complex project. Many different types of testing is required in a complex project and development effort. In addition a large project with lots of repositories and packages provides a number of testing and development challenges but also provides a number of opportunities to do testing in an efficient way; especially pre-push and post-push continuous integration (CI) testing. In addition, a number of post-push automated nightly test cases must be managed. TriBITS takes full advantage of the features of raw CMake, CTest, and CDash in support of testing and where gaps exist, TriBITS provides tools and customizations.

The following subsections describe several aspects to the TriBITS support for testing. ToDo: outline the following subsections.

6.1 Testing categories for Repositories, Packages, and Tests

ToDo: Define repo category Continuous, Nightly, and Experimental which also map to CDash tracks.

ToDo: Define SE package test group PT, ST, and EX.

ToDo: Define test category BASIC, CONTINUOUS, NIGHTLY, WEEKLY, and PERFORMANCE.

ToDo: Discuss the proper usage of these test categories and why NIGHTLY testing should be the default.

ToDo: Fill in!

6.2 Pre-push Testing using checkin-test.py

ToDo: Describe the checkin-test.py script

ToDo: Describe the system for mapping changed files to changed packages.

6.3 TriBITS Package-by-Package CTest/Dash Driver

ToDo: Fill in!

6.4 TriBITS CDash Customizations

ToDo: Fill in!

CDash regression email addresses

Every TriBITS Package has a regression email address associated with it that gets uploaded to a CDash project on a CDash server that is used to determine what email address to use when a package has configure, build, or test failures. Because of the complex organizational nature of different projects and different integration models, a single static email address for a given package in every project build is not practical.

The TriBITS system allows for a Package's regression email to be specified in the following order of precedence:

- 1) `$(REPOSITORY_NAME)_REPOSITORY_OVERRIDE_PACKAGE_EMAIL_LIST` (typically defined in `<projectDir>/cmake/ProjectDependenciesSetup.cmake`): Defines a single email address for all packages for the repository `$(REPOSITORY_NAME)` and overrides all other package email regression specification variables. This is typically used by a meta-project to redefine the regression email addresses for the packages in an externally developed repository.
- 2) `REGRESSION_EMAIL_LIST` (defined in `<packageDir>/cmake/Dependencies.cmake`): Package-specific email address specified in the packages's `Dependencies.cmake` file using `TRIBITS_DEFINE_PACKAGE_DEPENDENCIES()`.
- 3) `$(REPOSITORY_NAME)_REPOSITORY_EMAIL_URL_ADDRESSES_BASE` (set in `<repoDir>/cmake/RepositoryDependenciesSetup.cmake`): A base email address specified at the Repository level creating package-specific email addresses (e.g. `<lower-case-package-name>-regression@some.repo.gov`, where `$(REPOSITORY_NAME)_REPOSITORY_EMAIL_URL_ADDRESSES_BASE=some.repo.gov`). This variable is used, for example, by the Trilinos project to provide automatic regression email addresses for packages.
- 4) `$(REPOSITORY_NAME)_REPOSITORY_MASTER_EMAIL_ADDRESSES` (set in `<repoDir>/cmake/RepositoryDependenciesSetup.cmake`): A single email address for all packages specified at the Repository level (e.g. `my-repo-regression@some.repo.gov`). This variable is used for smaller repositories with smaller development groups who just want all regression emails for the repository's packages going to a single email address. This reduces the overhead of managing a bunch of individual package email addresses but at the expense of spamming too many people with CDash failure emails.
- 5) `$(PROJECT_NAME)_PROJECT_EMAIL_URL_ADDRESSES_BASE` (set in `<projectDir>/cmake/ProjectDependenciesSetup.cmake`): A base email address specified at the Project level

creating package-specific email addresses (e.g.

`<lower-case-package-name>-regression@some.project.gov`, where `_${PROJECT_NAME}_PROJECT_EMAIL_URL_ADDRESSES_BASE=some.project.gov`). If not already set, this variable will be set to `_${REPOSITORY_NAME}_REPOSITORY_EMAIL_URL_ADDRESSES_BASE` for the first repository processed that has this set. This behavior is used, for example by the Trilinos project to automatically assign email addresses for add-on packages and was added to maintain backward compatibility.

6) `_${PROJECT_NAME}_PROJECT_MASTER_EMAIL_ADDRESSES` (set in [<projectDir>/cmake/ProjectDependenciesSetup.cmake](#)): A single default email address for all packages specified at the Project level (e.g. `my-project-regression@some.project.gov`). If not already set, this variable will be set to `_${REPOSITORY_NAME}_REPOSITORY_MASTER_EMAIL_ADDRESSES` for the first repository processed that has this set. Every meta-project should set this variable so that it will be the default email address for any new package added.

WARNING: If any of the email lists or URL string variables listed above are set to "OFF" or "FALSE" (or some other value that CMake interprets as false, see CMake Language Overview and Gotchas) then the variables are treated as empty and not set.

If a TriBITS project does not use CDash, then no email address needed to be assigned to packages at all (which will be the case if none of the above variables are set).

As a general rule, repository-level settings override project-level settings and package-level settings override both. Also, a project can redefine a repository's regression email list settings by resetting the variables in the project's [<projectDir>/cmake/ProjectDependenciesSetup.cmake](#) file.

All of the email dependency management logic must be accessible by just running the macro:

```
TRIBITS_READ_PACKAGES_PROCESS_DEPENDENCIES_WRITE_XML()
```

The above email address configuration variables are read from the Repository and Project files

[<repoDir>/cmake/RepositoryDependenciesSetup.cmake](#) and

[<projectDir>/cmake/ProjectDependenciesSetup.cmake](#), respectively. The

`RepositoryDependenciesSetup.cmake` files are read first in the specified repository order followed up by reading the `ProjectDependenciesSetup.cmake` file. In this way, the project can override any of the repository settings.

Here is a short review of the precedence order for how regression email addresses are selected for a given package:

- 1) Package-specific email list is selected if defined (unless an override is in place).
- 2) Repository-level option is selected over a project-level option.
- 3) Default email form with repository or project address base is selected over single repository or project email address.
- 4) If none of the above are selected, then no email address is assigned.

What the above setup does is it results in the TriBITS system (in the `TribitsCTestDriverCore.cmake` file called under `ctest`) creating a file called `CDashSubprojectDependencies.xml` that gets sent to the CDash server. CDash then takes this file and creates, or updates, a set of CDash users and sets up a mapping of Labels (which are used for TriBITS package names) to CDash user emails addresses. CDash is automatically set up to process this XML file and create and updates CDash users. It is not, however, set up to remove labels from existing users. Therefore, if you change a TriBITS package's CDash regression email list (using one of the methods described above), then you need to manually remove the associated labels from the old email address. CDash will not remove them for you.

Therefore, to change the mapping of CDash regression email addresses to TriBITS packages, you must perform the actions:

- 1) Change the TriBITS CMake files as described above that will result in the desired email addresses in the `CDashSubprojectDependencies.xml` file. You can debug this by running the `checkin-test.py` script and seeing what gets written in the generated [<Project>PackageDependencies.xml](#) file in the `CHECKIN` directory.

2) Log onto the CDash server using an administrator account and then remove the auto-generated account for the CDash user email address for which labels are being removed (i.e. no longer associated with a TriBITS package). This is needed since CDash seems to be unable to remove labels from an existing CDash user (however this might be fixed in a current version of CDash).

3) The next time a CDash submit is performed by the `TribitsCTestDriverCore.cmake` script, the CDash user associated with the mail list with labels being removed will get automatically recreated with the right list of labels (according to the current `CDashSubprojectDependencies.xml` file). Also, any new CDash users for new email addresses will be created.

Hopefully that should be enough clues to manage the mapping of CDash regression email lists to TriBITS packages.

7 Multi-Repository Support

ToDo: Discuss 'egdist', `ExtraRepositoriesList.cmake`, and the rep clone script.

7.1 Multi-Repository Almost Continuous Integration

ToDo: Fill in!

8 Development Workflows

In this section, the typical development workflows for a TriBITS project are described. First, the [Basic Development Workflow](#) for a single-repository TriBITS project is described. This is followed up with a slightly more complex [Multi-Repository Development Workflow](#).

8.1 Basic Development Workflow

ToDo: Fill in!

8.2 Multi-Repository Development Workflow

ToDo: Fill in!

9 Howtos

ToDo: Fill in!

9.1 How to Add a new TriBITS Package

ToDo: Fill in!

9.2 How to Add a new TriBITS Package with Subpackages

ToDo: Fill in!

9.3 How to Add a new TriBITS TPL

ToDo: Fill in!

10 Additional Topics

In this section, a number of miscellaneous topics and TriBITS features are discussed. These features and topics are either not considered primary fetures of TriBITS (but can be very useful in many situations) or don't neatly fit into one of the other sections.

10.1 TriBITS System Project Dependencies

The basic TriBITS system itself which is used to configure, build, test, create tarballs, and install software that uses the TriBITS system has no dependencies other than a basic installation of CMake (which typically includes the executables `cmake`, `ctest`, and `cpack`). Great effort has been expended to implement all of the core functionality of TriBITS just using raw CMake. That means that anyone who needs to configure, build, and install the software just needs a compable CMake implementation. TriBITS is purposely maintained to require an older version of CMake. At the time of this writing, the mimimum required version of CMake needed to use TriBITS is CMake 2.8.1 (relased in March 2010, see [CMake Release Wiki](#)). CMake is becoming iniquitous enough that many clients will already have a current-enough version of CMake installed by default on their systems and will therefore not need to download or install any extra software when building and installing a project that uses TriBITS (assuming the necessary compilers etc. required by the project are also installed). If a current-enough version of CMake is not installed on a given system, it is easy to download the source code and all it needs is a basic C++ compiler to build and install.

However, note that a specific TriBITS project is free to use any newer CMake features it wants and therefore these projects will require newer versions of CMake than what is required by TriBITS (see discussion of `CMAKE_MINIMUM_REQUIRED()` in [<projectDir>/CMakeLists.txt](#)). But also note that specific TriBITS projects and packages will also require additional tools like compilers, Python, Perl, or many other such dependencies. It is just that TriBITS itself does not require any of these. The goal of TriBITS is not to amke the portability of software that uses it any worse than it already is but instead to make it easier in most cases (that after all is the whole goal of CMake).

While the core TriBITS functionality is just written using raw CMake, the more sophisticated development tools needed to implement the full TriBITS development environment requires Python 2.4 (or higher, but not Python 3.x). Python is needed for tools like `checkin-test.py` and `egdist`. In addition, these python tools are used in `TribitsCTestDriverCore.cmake` to drive automated testing and submittals to CDash. In addition, git is the chosen version control tool for TriBITS and all of the VC related functionality requires git support. But none of this is required for doing the most basic building, testing, or installation of a TriBITS project.

10.2 Project-Specific Build Quick Reference

If a project that uses TriBITS is going to have a significnat user base that will configure, build, and test the project, then having some documentation that explains how to do this would be useful. For this purpose, TriBITS provides a mechanism to quickly create a project-specific build quick reference document in restructured text (RST) format and with HTML and LaTeX/PDF outputs. These documents are generally created in the base project source tree and given then name `<Project>BuildQuickRef.[rst,html,pdf]`. This document consists of two parts. One part is a generic template document:

```
tribits/doc/build_quick_ref/TribitsBuildQuickRefBody.rst
```

provided in the TriBITS source tree that uses the place-holder `<Project>` for the for the real project name. The second part is a project-specific template file:

```
<projectBaseDir>/cmake/<Project>BuildQuickRefTemplate.rst
```

which provides the outer RST doucment (with title, authors, abstract, introduction, other introductory sections). From these two files, the script:

```
tribits/doc/build_quick_ref/create-project-build-quickref.py
```


is used to replace `<Project>` in the `TribitsBuildQuickRefBody.rst` file with the real project name (read from the project's `ProjectName.cmake` file by default) and then generates the read-only files:

```
<projectBaseDir>/
  <Project>BuildQuickRef.rst
  <Project>BuildQuickRef.html
  <Project>BuildQuickRef.pdf
```

To see a simple example of this, see:

```
tribits/doc/examples/TribitsExampleProject/cmake/create-build-quickref.sh
```

A project-indepenent version of this file is provided in the [TribitsBuildQuickRef.\[rst,html,pdf\]](#) which is referred to many times in this developers guide.

10.3 Project and Repository Versioning and Release Mode

TriBITS has built-in support for project and repository versioning and release mode control. When the project contains the file `<projectDir>/Version.cmake`, it is used to define the project's official version. The idea is that when it is time to branch for a release, the only file that needs to be changed is the file is [<projectDir>/Version.cmake](#)

Each TriBITS repository can also contain a `<repoDir>/Version.cmake` file that sets variables which TriBITS packages in that repository can use to derive development and release version information. If the TriBITS repository also contains a `<repoDir>/Copyright.txt` file, then the information in `<repoDir>/Version.cmake` and `<repoDir>/Copyright.txt` are used to configure a repository version header file:

```
${${REPOSITORY_NAME}_BINARY_DIR}/${REPOSITORY_NAME}_version.h
```

The configured header file `${REPOSITORY_NAME}_version.h` gives the repository version number in several formats, which allows C/C++ code (or any software that uses the C preprocessor) to write conditional code like:

```
#if Trilinos_MAJOR_MINOR_VERSION > 100200
  /* Contains feature X */
  ...
#else
  /* Does not contain feature X */
  ...
#endif
```

Of course when the TriBITS project and the TriBITS repository are the same directory, the `<projectDir>/Version.cmake` and `<repoDir>/Version.cmake` files are the same file, which works just fine.

10.4 TriBITS Environment Probing and Setup

Part of the TriBITS Framework is to probe the environment, set up the compilers, and get ready to compile code. This was mentioned in the step “Probe and set up the environment” in [Full Processing of TriBITS Project Files](#). This is executed by the TriBITS macro `TRIBITS_SETUP_ENV()`. Some of the things this macro does are:

Probe and set up the environment:

- Set `CMAKE_BUILD_TYPE`
- Set up for MPI (MPI compilers, etc.)

- Set up C, C++, and Fortran compiler
- Find Perl (sets `PERL_EXECUTABLE`)
- Determine mixed language C/Fortran linking
- Set up C++11, OpenMP, and Windows issues
- Find Doxygen
- Perform some other configure-time tests (see output)

At the completion of this part of the processing, the TriBITS CMake project is ready to compile code.

10.5 Configure-time System Tests

CMake has very nice support for defining configure-time checks of the system to help in configuring the project. One can check for whether a header file exists or not, if the compiler supports a given data-type or language feature or perform almost any other type of check that one can imagine that can be done using the configured compilers, libraries, system tools, etc.

ToDo: Fill in!

10.6 Creating Source Distributions

ToDo: Fill in!

10.7 Regulated Backward Compatibility and Deprecated Code

ToDo: Fill in!

10.8 Wrapping Externally Configured/Built Software as a TriBITS Package

ToDo: Fill in!

10.9 TriBITS Dashboard Driver

ToDo: Fill in!

11 References

SCALE <http://scale.ornl.gov/>

12 TriBITS Detailed Reference Documentation

The following subsections contain detailed reference documentation for the various TriBITS variables and functions and macros that are used by TriBITS.

12.1 TriBITS Global Project Settings

TriBITS defines a number of global project-level settings that can be set by the user and can have their default determined by each individual TriBITS project. If a given TriBITS project does not define its own default, a reasonable default is set by the TriBITS system automatically. These options are defined and are set, for the most part, in the internal TriBITS function

`TRIBITS_DEFINE_GLOBAL_OPTIONS_AND_DEFINE_EXTRA_REPOS()` in the TriBITS CMake code file `TribitsGlobalMacros.cmake` which gets called inside of the `TRIBITS_PROJECT()` macro. That function and that file are the definitive source the options that a TriBITS project takes and what the default values are but we strive to document them here as well. Many of these global options (i.e. cache variables) such as `${PROJECT_NAME}_<SOME_OPTION>` allow the project to define a default by setting a local variable `${PROJECT_NAME}_<SOME_OPTION>_DEFAULT` as:

```
SET(${PROJECT_NAME}_<SOME_OPTION>_DEFAULT <someDefault>)
```

either in its top-level `CMakeLists.txt` file or in its `ProjectName.cmake` file. If `${PROJECT_NAME}_<SOME_OPTION>_DEFAULT` is not set by the project, then TriBITS provides a reasonable default value. The TriBITS code for this looks like:

```
IF ("${${PROJECT_NAME}_<SOME_OPTION>_DEFAULT}" STREQUAL "")
  SET(${PROJECT_NAME}_<SOME_OPTION>_DEFAULT <someDefault>)
ENDIF()

ADVANCED_SET( ${PROJECT_NAME}_<SOME_OPTION>
  ${PROJECT_NAME}_<SOME_OPTION>_DEFAULT)
CACHE BOOL "[documentation]."
)
```

where `<SOME_OPTION>` is the option name like `TEST_CATEGORIES` and `<someDefault>` is the default set by TriBITS if the project does not define a default. In this way, if the project sets the variable `${PROJECT_NAME}_<SOME_OPTION>_DEFAULT` before this code executes, then `${PROJECT_NAME}_<SOME_OPTION>_DEFAULT` will be used as the default for the cache variable `${PROJECT_NAME}_<SOME_OPTION>` which, of course, can be overridden by the user when calling `cmake` in a number of ways.

Most of these global options that can be overridden externally by setting the cache variable `${PROJECT_NAME}_<SOME_OPTION>` should be documented in the [Project-Specific Build Quick Reference](#) document. A generic version of this document is found in [TribitsBuildQuickRef.\[rst,html,pdf\]](#). Some of the more unusual options that might only be of interest to developers mentioned below may not be documented in `<Project>BuildQuickRef.[rst,html,pdf]`.

The global project-level TriBITS options for which defaults can be provided by a given TriBITS project are:

- [\\${PROJECT_NAME}_DISABLE_ENABLED_FORWARD_DEP_PACKAGES](#)
- [\\${PROJECT_NAME}_ENABLE_Fortran](#)
- [\\${PROJECT_NAME}_INSTALL_LIBRARIES_AND_HEADERS](#)
- [\\${PROJECT_NAME}_ENABLE_EXPORT_MAKEFILES](#)
- [\\${PROJECT_NAME}_ENABLE_INSTALL_CMAKE_CONFIG_FILES](#)
- [\\${PROJECT_NAME}_GENERATE_EXPORT_FILE_DEPENDENCIES](#)
- [\\${PROJECT_NAME}_ELEVATE_ST_TO_PT](#)
- [\\${PROJECT_NAME}_ENABLE_CPACK_PACKAGING](#)
- [\\${PROJECT_NAME}_EXCLUDE_DISABLED_SUBPACKAGES_FROM_DISTRIBUTION](#)
- [\\${PROJECT_NAME}_CPACK_SOURCE_GENERATOR](#)

- `_${PROJECT_NAME}_TEST_CATEGORIES`
- `MPI_EXEC_MAX_NUMPROCS`

These options are described below.

`_${PROJECT_NAME}_DISABLE_ENABLED_FORWARD_DEP_PACKAGES`

If `_${PROJECT_NAME}_DISABLE_ENABLED_FORWARD_DEP_PACKAGES` is ON (the TriBITS default value), then any explicitly enabled packages that have disabled upstream required packages or TPLs will be disabled. If OFF, then an configure error will occur (for more details see [TribitsBuildQuickRef.*](#)). A project define a different default value by setting:

```
SET (${PROJECT_NAME}_DISABLE_ENABLED_FORWARD_DEP_PACKAGES_DEFAULT FALSE)
```

`_${PROJECT_NAME}_ENABLE_Fortran`

If `_${PROJECT_NAME}_ENABLE_Fortran` is ON, then Fortran support for the project will be enabled and the Fortran compiler(s) must be found. By default, TriBITS sets this to ON for non-Windows systems (i.e. WIN32 is not set by CMake) but is OFF for a Windows system. A project always requires Fortran, for example, it can set the default:

```
SET (${PROJECT_NAME}_ENABLE_Fortran_DEFAULT TRUE)
```

If a project does not have any native Fortran code a good default would be:

```
SET (${PROJECT_NAME}_ENABLE_Fortran_DEFAULT OFF)
```

NOTE: It is usually not a good idea to always force off Fortran, or any compiler, because extra repositories and packages might be added by someone that might require the compiler and we don't want to unnecessarily limit the generality of a given TriBITS build. Setting the default for all platforms should be sufficient.

`_${PROJECT_NAME}_INSTALL_LIBRARIES_AND_HEADERS`

If `_${PROJECT_NAME}_INSTALL_LIBRARIES_AND_HEADERS` is set to ON, then any defined libraries or header files that are listed in calls to [TRIBITS_ADD_LIBRARY\(\)](#) will be installed (unless options are passed into [TRIBITS_ADD_LIBRARY\(\)](#) that disable installs). If set to OFF, then headers and librareis will be installed by default and only `INSTALLABLE` executables added with [TRIBITS_ADD_EXECUTABLE\(\)](#) will be installed. However, as described in [TribitsBuildQuickRef.*](#), shared libraries will still be always be installed if enabled since they are needed by the installed executables. The TriBITS default is to set this to ON.

For a TriBITS project that primarily is delivering libraries (e.g. Trilinos), then it makes sense to leave the TriBITS default or explicitly set:

```
SET (${PROJECT_NAME}_INSTALL_LIBRARIES_AND_HEADERS_DEFAULT ON)
```

For a TriBITS project that is primarily delivering executablrs (e.g. VERA), then it makes sense to set the default to:

```
SET (${PROJECT_NAME}_INSTALL_LIBRARIES_AND_HEADERS_DEFAULT OFF)
```

`_${PROJECT_NAME}_ENABLE_EXPORT_MAKEFILES`

If `_${PROJECT_NAME}_ENABLE_EXPORT_MAKEFILES` is ON, then `Makefile.export.<PACKAGE_NAME>` will get created at configure time in the build tree and installed into the install tree. See [TribitsBuildQuickRef.*](#) for details. The TriBITS default is ON but a project can decide to turn this off by default by setting:

```
SET (${PROJECT_NAME}_ENABLE_EXPORT_MAKEFILES_DEFAULT OFF)
```

A project might want to disable the generation of export makefiles by default if its main purpose is to provide executables. There is no reason to provide an export makefile if libraries and headers are not actually installed (see [\\${PROJECT_NAME}_INSTALL_LIBRARIES_AND_HEADERS](#))

`${PROJECT_NAME}_ENABLE_INSTALL_CMAKE_CONFIG_FILES`

If `${PROJECT_NAME}_ENABLE_INSTALL_CMAKE_CONFIG_FILES` is set to ON, then `<PACKAGE_NAME>Config.cmake` files are created at configure time in the build tree and installed into the install tree. These files are used by external CMake projects to pull in the list of compilers, compiler options, include directories and libraries. The TriBITS default is ON. A project can change the default by setting, for example:

```
SET (${PROJECT_NAME}_ENABLE_INSTALL_CMAKE_CONFIG_FILES_DEFAULT OFF)
```

A project would want to turn off the creation and installation of `<PACKAGE_NAME>Config.cmake` files if it was only installing and providing executables. See [TriBITSBuildQuickRef.*](#) for details.

`${PROJECT_NAME}_GENERATE_EXPORT_FILE_DEPENDENCIES`

If `${PROJECT_NAME}_GENERATE_EXPORT_FILE_DEPENDENCIES` is ON, then the data-structures needed to generate `Makefile.export.<PACKAGE_NAME>` and `<PACKAGE_NAME>Config.cmake` are created. These data structures are also needed in order to generate export makefiles on demand using the function [TRIBITS_WRITE_FLEXIBLE_PACKAGE_CLIENT_EXPORT_FILES\(\)](#). The default in TriBITS is to turn this ON automatically by default if `${PROJECT_NAME}_ENABLE_EXPORT_MAKEFILES` or `${PROJECT_NAME}_ENABLE_INSTALL_CMAKE_CONFIG_FILES` are ON. Else, by default, TriBITS sets this to OFF. The only reason for the project to override the default is to set it to ON as with:

```
SET(${PROJECT_NAME}_GENERATE_EXPORT_FILE_DEPENDENCIES_DEFAULT ON)
```

is so that the necessary data-structures are generated in order to use the function [TRIBITS_WRITE_FLEXIBLE_PACKAGE_CLIENT_EXPORT_FILES\(\)](#).

`${PROJECT_NAME}_ELEVATE_ST_TO_PT`

If `${PROJECT_NAME}_ELEVATE_ST_TO_PT` is set to ON, then all ST SE packages will be elevated to PT packages. The TriBITS default is obviously OFF. The default can be changed by setting:

```
SET (${PROJECT_NAME}_ELEVATE_ST_TO_PT_DEFAULT ON)
```

There are projects, especially meta-projects, where the distinction between PT and ST code is not helpful or the assignment of PT and ST packages in a repository is not appropriate. An example project like this CASL VERA. Changing the default to ON allows any packages to be considered in pre-push testing.

`${PROJECT_NAME}_ENABLE_CPACK_PACKAGING`

If `${PROJECT_NAME}_ENABLE_CPACK_PACKAGING` is ON, then CPack support is enabled and some TriBITS code is avoided that is needed to set up data-structures that are used by the built-in CMake target `package_source`. The TriBITS default is OFF with the idea that the average developer or user will not be wanting to create source distributions with CPack. However, this default can be changed by setting:

```
SET (${PROJECT_NAME}_ENABLE_CPACK_PACKAGING ON)
```

`${PROJECT_NAME}_EXCLUDE_DISABLED_SUBPACKAGES_FROM_DISTRIBUTION`

If `${PROJECT_NAME}_EXCLUDE_DISABLED_SUBPACKAGES_FROM_DISTRIBUTION` is `TRUE`, then the directories for subpackages that are not enabled are left out of the source tarball. This reduces the size of the tarball as much as possible but does require that the TriBITS packages and subpackages be properly set up to allow disabled subpackages from being excluded. The TriBITS default is `TRUE` but this can be changed by setting:

```
SET (${PROJECT_NAME}_EXCLUDE_DISABLED_SUBPACKAGES_FROM_DISTRIBUTION_DEFAULT FALSE)
```

`${PROJECT_NAME}_CPACK_SOURCE_GENERATOR`

The variable `${PROJECT_NAME}_CPACK_SOURCE_GENERATOR` determines the CPack source generation types that are created when the `package_source` target is run. The TriBITS default is set to `TGZ`. However, this default can be overridden by setting, for example:

```
SET (${PROJECT_NAME}_CPACK_SOURCE_GENERATOR_DEFAULT "TGZ;TBZ2")
```

This variable should generally be set in the file:

```
<projectDir>/cmake/CallbackDefineProjectPackaging.cmake
```

instead of in the base-level `CMakeLists.txt` file so that it goes along with rest of the project-specific CPack packaging options.

`${PROJECT_NAME}_TEST_CATEGORIES`

The cache variable `${PROJECT_NAME}_TEST_CATEGORIES` determines what tests defined using [TRIBITS_ADD_TEST\(\)](#) and [TRIBITS_ADD_ADVANCED_TEST\(\)](#) will be added for `ctest` to run (see *TriBITS Automated Testing*) for discussion of test categories). The TriBITS default is `NIGHTLY` for a standard local build. The `checkin-test.py` script sets this to `BASIC`. A TriBITS project can override the default for a basic configure using, for example:

```
SET (${PROJECT_NAME}_TEST_CATEGORIES BASIC)
```

The justification for having the default test category be `NIGHTLY` instead of `BASIC` is that when someone is enabling a package to develop on it or install it, we want them by default to be seeing the full version of the test suite (shy of the `WEEKLY` tests which can be very expensive) for the packages they are explicitly enabling. Typically they will not be enabling forward (downstream) dependent packages so the cost of running the test suite should not be too prohibitive. This all depends on how good of a job the development teams do in making their test suites run fast and keeping the cost of running the tests down. See the section [TriBITS Automated Testing](#) for a more detailed discussion.

`${PROJECT_NAME}_ENABLE_DEVELOPMENT_MODE`

The variable `${PROJECT_NAME}_ENABLE_DEVELOPMENT_MODE` switches the TriBITS project from development mode to release mode. The default for this variable `${PROJECT_NAME}_ENABLE_DEVELOPMENT_MODE_DEFAULT` should be set in the project's [<projectDir>/Version.cmake](#) file and switched from `ON` to `OFF` when creating a release (see [Project and Repository Versioning and Release Mode](#)). When `${PROJECT_NAME}_ENABLE_DEVELOPMENT_MODE = ON`, several other variables are given defaults appropriate for development mode. For example, `${PROJECT_NAME}_ASSERT_MISSING_PACKAGES` is set to `ON` by default in development mode but is set to `OFF` by default in release mode. In addition, strong compiler warnings are enabled by default in development mode but are disabled by default in release mode. This variable also affects the behavior of [TRIBITS_SET_ST_FOR_DEV_MODE\(\)](#).

MPI_EXEC_MAX_NUMPROCS

The variable `MPI_EXEC_MAX_NUMPROCS` gives the maximum number of processes for an MPI test that will be allowed as defined by `TRIBITS_ADD_TEST()` and `TRIBITS_ADD_ADVANCED_TEST()`. The TriBITS default is set to be 4 (for no good reason really but it needs to stay that way for backward compatibility). This default can be changed by setting:

```
SET(MPI_EXEC_MAX_NUMPROCS_DEFAULT <newDefaultMax>)
```

While this default can be changed for the project as a whole on all platforms, it is likely better to change this default on a machine-by-machine basis to correspond to the load that can be accommodated by a given machine (or class of machines). For example if a given machine has 64 cores, a reasonable number for `MPI_EXEC_MAX_NUMPROCS_DEFAULT` is 64.

12.2 TriBITS Macros and Functions

The following subsections give detailed documentation for the CMake macros and functions that make up the core TriBITS system. These are what are used by TriBITS project developers in their `CMakeLists.txt` and other files. All of these functions and macros should be available when processing the project's and package's variables files if used properly. Therefore, no explicit `INCLUDE()` statements should be needed other than the initial include of the `TribitsProject.cmake` file in the top-level `<projectDir>/CMakeLists.txt` file so the command `TRIBITS_PROJECT()` can be executed.

TRIBITS_ADD_ADVANCED_TEST()

Function that creates an advanced test defined by stringing together one or more executables and/or commands that is run as a separate CMake `-P` script with very flexible pass/fail criteria.

This function allows you to add a single CTest test as a single unit that is actually a sequence of one or more separate commands strung together in some way to define the final pass/fail. You will want to use this function to add a test instead of `TRIBITS_ADD_TEST()` when you need to run more than one command, or you need more sophisticated checking of the test result other than just grepping `STDOUT` (i.e. by running programs to examine output files).

Usage:

```
TRIBITS_ADD_ADVANCED_TEST(  
  <testName>  
  TEST_0 (EXEC <execTarget0> | CMND <cmndExec0>) ...  
  [TEST_1 (EXEC <execTarget1> | CMND <cmndExec1>) ...]  
  ...  
  [TEST_N (EXEC <execTargetN> | CMND <cmndExecN>) ...]  
  [OVERALL_WORKING_DIRECTORY (<overallWorkingDir> | TEST_NAME)]  
  [FAIL_FAST]  
  [KEYWORDS <keyword1> <keyword2> ...]  
  [COMM [serial] [mpi]]  
  [OVERALL_NUM_MPI_PROCS <overallNumProcs>]  
  [CATEGORIES <category0> <category1> ...]  
  [HOST <host0> <host1> ...]  
  [XHOST <host0> <host1> ...]  
  [HOSTTYPE <hosttype0> <hosttype1> ...]  
  [XHOSTTYPE <hosttype0> <hosttype1> ...]  
  [FINAL_PASS_REGULAR_EXPRESSION <regex> | FINAL_FAIL_REGULAR_EXPRESSION <regex>]  
  [ENVIRONMENT <var1>=<value1> <var2>=<value2> ...]  
)
```

Each atomic test case is either a package-built executable or just a basic command. An atomic test command block of arguments takes the form:

```

TEST_<idx>
  (EXEC <exeRootName> [NOEXEPREFIX] [NOEXESUFFIX] [ADD_DIR_TO_NAME]
    [DIRECTORY <dir>]
    | CMND <cmdExec>)
  [ARGS <arg1> <arg2> ... <argn>]
  [MESSAGE "<message>"]
  [WORKING_DIRECTORY <workingDir>]
  [NUM_MPI_PROCS <numProcs>]
  [OUTPUT_FILE <outputFile>]
  [NO_ECHO_OUTPUT]]
  [PASS_ANY
    | PASS_REGULAR_EXPRESSION "<regex>"
    | PASS_REGULAR_EXPRESSION_ALL "<regex1>" "<regex2>" ... "<regexn>"
    | FAIL_REGULAR_EXPRESSION "<regex>"
    | STANDARD_PASS_OUTPUT
  ]

```

By default, each and every atomic test or command needs to pass (as defined below) in order for the overall test to pass.

Sections:

- [Overall Arguments \(TRIBITS_ADD_ADVANCED_TEST\(\)\)](#)
- [TEST_<idx> Test Blocks and Arguments \(TRIBITS_ADD_ADVANCED_TEST\(\)\)](#)
- [Overall Pass/Fail \(TRIBITS_ADD_ADVANCED_TEST\(\)\)](#)
- [Argument Parsing and Ordering \(TRIBITS_ADD_ADVANCED_TEST\(\)\)](#)
- [Implementation Details \(TRIBITS_ADD_ADVANCED_TEST\(\)\)](#)
- [Setting Additional Test Properties \(TRIBITS_ADD_ADVANCED_TEST\(\)\)](#)
- [Disabling Tests Externally \(TRIBITS_ADD_ADVANCED_TEST\(\)\)](#)
- [Debugging and Examining Test Generation \(TRIBITS_ADD_ADVANCED_TEST\(\)\)](#)

Overall Arguments (TRIBITS_ADD_ADVANCED_TEST())

Below are given some overall arguments. Remaining overall arguments that control overall pass/fail are described in [Overall Pass/Fail \(TRIBITS_ADD_ADVANCED_TEST\(\)\)](#). (NOTE: All of these arguments must be listed outside of the TEST_<idx> blocks, see [Argument Parsing and Ordering \(TRIBITS_ADD_ADVANCED_TEST\(\)\)](#)).

<testName>

The name of the test (which will have `${PACKAGE_NAME}_` prepended to the name) that will be used to name the output CMake script file as well as the CTest test name passed into `ADD_TEST()`. This must be the first argument.

OVERALL_WORKING_DIRECTORY <overallWorkingDir>

If specified, then the working directory <overallWorkingDir> will be created and all of the test commands by default will be run from within this directory. If the value <overallWorkingDir>=TEST_NAME is given, then the working directory will be given the name `${PACKAGE_NAME}_<testName>`. If the directory <overallWorkingDir> exists before the test runs, it will be deleted and created again. Therefore, if you want to preserve the contents of this directory between test runs you need to copy the files it somewhere else. This is a good option to use if the commands create intermediate files and you want to make sure they get deleted before a set of test cases runs again.

FAIL_FAST

If specified, then the remaining test commands will be aborted when any test command fails. Otherwise, all of the test cases will be run.

RUN_SERIAL

If specified then no other tests will be allowed to run while this test is running. This is useful for devices (like cuda cards) that require exclusive access for processes/threads. This just sets the CTest test property RUN_SERIAL using the built-in CMake function SET_TESTS_PROPERTIES().

COMM [serial] [mpi]

If specified, selects if the test will be added in serial and/or MPI mode. See the COMM argument in the script [TRIBITS_ADD_TEST\(\)](#) for more details.

OVERALL_NUM_MPI_PROCS <overallNumProcs>

If specified, gives the default number of processes that each executable command runs on. If <numProcs> is greater than $\{\text{MPI_EXEC_MAX_NUMPROCS}\}$ then the test will be excluded. If not specified, then the default number of processes for an MPI build will be $\{\text{MPI_EXEC_DEFAULT_NUMPROCS}\}$. For serial builds, this argument is ignored.

CATEGORIES <category0> <category1> ...

Gives the test categories for which this test will be added. See [TRIBITS_ADD_TEST\(\)](#) for more details.

HOST <host0> <host1> ...

The list of hosts for which to enable the test (see [TRIBITS_ADD_TEST\(\)](#)).

XHOST <host0> <host1> ...

The list of hosts for which **not** to enable the test (see [TRIBITS_ADD_TEST\(\)](#)).

HOSTTYPE <hosttype0> <hosttype1> ...

The list of host types for which to enable the test (see [TRIBITS_ADD_TEST\(\)](#)).

XHOSTTYPE <hosttype0> <hosttype1> ...

The list of host types for which **not** to enable the test (see [TRIBITS_ADD_TEST\(\)](#)).

ENVIRONMENT <var1>=<value1> <var2>=<value2> ...

If passed in, the listed environment variables will be set before calling the test. This is set using the built-in test property ENVIRONMENT.

TEST_<idx> Test Blocks and Arguments (TRIBITS_ADD_ADVANCED_TEST())

Each test command block TEST_<idx> runs either a package-built test executable or some general command executable and is defined as either EXEC <exeRootName> or CMND <cmdExec> with the arguments:

EXEC <exeRootName> [NOEXEPREFIX] [NOEXESUFFIX] [ADD_DIR_TO_NAME]
[DIRECTORY <dir>]

If specified, then <exeRootName> gives the root name of an executable target that will be run as the command. The full executable name and path is determined in exactly the same way it is in the [TRIBITS_ADD_TEST\(\)](#) function (see [Determining the Executable or Command to Run \(TRIBITS_ADD_TEST\(\)\)](#)). If this is an MPI build, then the executable will be run with MPI using NUM_MPI_PROCS <numProcs> or OVERALL_NUM_MPI_PROCS <overallNumProcs> (if NUM_MPI_PROCS is not set for this test case). If the number of maximum MPI processes allowed is less than this number of MPI processes, then the test will *not* be run. Note that EXEC

`<exeRootName>` when `NOEXEPREFIX` and `NOEXESUFFIX` are specified is basically equivalent to `CMND <cmndExec>` except that in an MPI build, `<exeRootName>` is always run using MPI. In this case, you can pass in `<exeRootName>` to any command you would like and it will get run with MPI in MPI mode just like any other command.

`CMND <cmndExec>`

If specified, then `<cmndExec>` gives the executable for a command to be run. In this case, MPI will never be used to run the executable even when configured in MPI mode (i.e. `TPL_ENABLE_MPI=ON`). If you want to run an arbitrary command using MPI, use `EXEC <fullPathToCmndExec> NOPREFIX NOEXESUFFIX` instead.

By default, the output (stdout/stderr) for each test command is captured and is then echoed to stdout for the overall test. This is done in order to be able to grep the result to determine pass/fail.

Other miscellaneous arguments for each `TEST_<idx>` block include:

`DIRECTORY <dir>`

If specified, then the executable is assumed to be in the directory given by relative `<dir>`. See [TRIBITS_ADD_TEST\(\)](#).

`MESSAGE "<message>"`

If specified, then the string in `"<message>"` will be printed before this test command is run. This allows adding some documentation about each individual test invocation to make the test output more understandable.

`WORKING_DIRECTORY <workingDir>`

If specified, then the working directory `<workingDir>` will be created and the test will be run from within this directory. If the value `<workingDir> = TEST_NAME` is given, then the working directory will be given the name `${PACKAGE_NAME}_<testName>`. If the directory `<workingDir>` exists before the test runs, it will be deleted and created again. Therefore, if you want to preserve the contents of this directory between test runs you need to copy it somewhere else. Using `WORKING_DIRECTORY`` for individual test commands allows creating independent working directories for each test case. This would be useful if a single ```OVERALL_WORKING_DIRECTORY` was not sufficient for some reason.

`NUM_MPI_PROCS <numProcs>`

If specified, then `<numProcs>` is the number of processors used for MPI executables. If not specified, this will default to `<overallNumProcs>` from `OVERALL_NUM_MPI_PROCS <overallNumProcs>`.

`OUTPUT_FILE <outputFile>`

If specified, then stdout and stderr for the test case will be sent to `<outputFile>`.

`NO_ECHO_OUTPUT`

If specified, then the output for the test command will not be echoed to the output for the entire test command.

By default, an atomic test line is assumed to pass if the executable returns a non-zero value. However, a test case can also be defined to pass based on:

`PASS_ANY`

If specified, the test command ``i`` will be assumed to pass regardless of the return value or any other output. This would be used when a command that is to follow will determine pass or fail based on output from this command in some way.

PASS_REGULAR_EXPRESSION "<regex>"

If specified, the test command 'i' will be assumed to pass if it matches the given regular expression. Otherwise, it is assumed to fail.

PASS_REGULAR_EXPRESSION_ALL "<regex1>" "<regex2>" ... "<regexn>"

If specified, the test command 'i' will be assumed to pass if the output matches all of the provided regular expressions. Note that this is not a capability of raw ctest and represents an extension provided by TriBITS.

FAIL_REGULAR_EXPRESSION "<regex>"

If specified, the test command 'i' will be assumed to fail if it matches the given regular expression. Otherwise, it is assumed to pass.

STANDARD_PASS_OUTPUT

If specified, the test command 'i' will be assumed to pass if the string expression "Final Result: PASSED" is found in the output for the test.

All of the arguments for a test block TEST_<idx> must appear directly below their TEST_<idx> argument and before the next test block (see [Argument Parsing and Ordering \(TRIBITS_ADD_ADVANCED_TEST\(\)\)](#)).

Overall Pass/Fail (TRIBITS_ADD_ADVANCED_TEST())

By default, the overall test will be assumed to pass if it prints:

```
"OVERALL FINAL RESULT: TEST PASSED"
```

However, this can be changed by setting one of the following optional arguments:

FINAL_PASS_REGULAR_EXPRESSION <regex>

If specified, the test will be assumed to pass if the output matches <regex>. Otherwise, it will be assumed to fail.

FINAL_FAIL_REGULAR_EXPRESSION <regex>

If specified, the test will be assumed to fail if the output matches <regex>. Otherwise, it will be assumed to fail.

Argument Parsing and Ordering (TRIBITS_ADD_ADVANCED_TEST())

The basic tool used for parsing the arguments to this function is the macro [PARSE_ARGUMENTS\(\)](#) which has a certain set of behaviors. The parsing using [PARSE_ARGUMENTS\(\)](#) is actually done in two phases. There is a top-level parsing listing the "overall" arguments listed in [Overall Arguments \(TRIBITS_ADD_ADVANCED_TEST\(\)\)](#) that also pulls out the test blocks and then there is a second level of parsing using [PARSE_ARGUMENTS\(\)](#) for each of the TEST_<idx> blocks. Because of this usage, there are a few restrictions that one needs to be aware of when using [TRIBITS_ADD_ADVANCED_TEST\(\)](#). This short section tries to explain the behaviors and what is allowed and what is not allowed.

For the most part, the overall argument and the arguments inside of any individual TEST_<idx> block can be listed in any order but there are restrictions related to the grouping of overall arguments and TEST_<idx> blocks which are as follows:

- The <testName> argument must be the first listed (it is the only positional argument).
- The test cases TEST_<idx> must be listed in order (i.e. TEST_0 ... TEST_1 ...) and the test cases must be consecutive integers (i.e. can't jump from TEST_5 to TEST_7).
- All of the arguments for a test case must appear directly below its TEST_<idx> keyword and before the next TEST_<idx+1> keyword or before any trailing overall keyword arguments.

- None of the overall arguments (e.g. CATEGORIES) can be inside listed inside of a TEST_<idx> block but otherwise can be listed before or after all of the TEST_<idx> blocks.

Other than that, the keyword arguments and options can appear in any order.

ToDo: Add some examples of bad argument ordering and what will happen.

Implementation Details (TRIBITS_ADD_ADVANCED_TEST())

Since raw CTest does not support the features provided by this function, the way an advanced test is implemented is that a CMake script with the name `${PACKAGE_NAME}_<testName>.cmake` gets created in the current binary directory that then gets added to CTest using:

```
ADD_TEST(${PACKAGE_NAME}_<testName>
  cmake [other options] -P ${PACKAGE_NAME}_<testName>.cmake)
```

This CMake script then runs the various test cases and checks the pass/fail for each case to determine overall pass/fail and implement other functionality.

Setting Additional Test Properties (TRIBITS_ADD_ADVANCED_TEST())

After this function returns, if the test gets added using `ADD_TEST()` then additional properties can be set and changed using `SET_TEST_PROPERTIES(${PACKAGE_NAME}_<testName> ...)`. Therefore, any test properties that are not directly supported by this function and passed through the argument list to this wrapper function can be set in the outer `CMakeLists.txt` file after the call to `TRIBITS_ADD_ADVANCED_TEST()`.

Disabling Tests Externally (TRIBITS_ADD_ADVANCED_TEST())

The test can be disabled externally by setting the CMake cache variable

`${FULL_TEST_NAME}_DISABLE=TRUE`. This allows tests to be disabled on a case-by-case basis. This is the *exact* name that shows up in 'ctest -N' when running the test.

Debugging and Examining Test Generation (TRIBITS_ADD_ADVANCED_TEST())

In order to see if the test gets added and to debug some issues in test creation, one can set the cache variable `${PROJECT_NAME}_VERBOSE_CONFIGURE=ON`. This will result in the printout of some information about the test getting added or not.

Likely the best way to debugging test generation using this function is to examine the generated file `${PACKAGE_NAME}_<testName>.cmake` in the current binary directory (see [Implementation Details \(TRIBITS_ADD_ADVANCED_TEST\(\)\)](#)).

TRIBITS_ADD_DEBUG_OPTION()

Add the standard option `${PACKAGE_NAME}_ENABLE_DEBUG` for the package.

Usage:

```
TRIBITS_ADD_DEBUG_OPTION()
```

This option is given the default `${PROJECT_NAME}_ENABLE_DEBUG` and if true, will set the variable `HAVE_${PACKAGE_NAME}_UC_DEBUG` (to be used in the package's configured header file).

TRIBITS_ADD_EXAMPLE_DIRECTORIES()

Macro called to conditionally add a set of example directories for an SE package.

Usage:

```
TRIBITS_ADD_EXAMPLE_DIRECTORIES(<dir1> <dir2> ...)
```

This macro only needs to be called from the top most CMakeList.txt file for which all subdirectories are all “examples”.

This macro can be called several times within a package and it will have the right effect.

Currently, really all it does macro does is to call `ADD_SUBDIRECTORY(<dir>)` if `${PACKAGE_NAME}_ENABLE_EXAMPLES` or `${PARENT_PACKAGE_NAME}_ENABLE_EXAMPLES` are true. However, this macro may be extended in the futgure in order to modify behavior related to adding tests and examples in a uniform way..

TRIBITS_ADD_EXECUTABLE()

Function used to create an executable (typically for a test or example), using the built-in CMake command `ADD_EXECUTABLE()`.

Usage:

```
TRIBITS_ADD_EXECUTABLE(  
  <exeRootName> [NOEXEPREFIX] [NOEXESUFFIX] [ADD_DIR_TO_NAME]  
  SOURCES <src0> <src1> ...  
  [CATEGORIES <category0> <category1> ...]  
  [HOST <host0> <host1> ...]  
  [XHOST <host0> <host1> ...]  
  [HOSTTYPE <hosttype0> <hosttype1> ...]  
  [XHOSTTYPE <hosttype0> <hosttype1> ...]  
  [DIRECTORY <dir>]  
  [DEPLIBS <lib0> <lib1> ...]  
  [COMM [serial] [mpi]]  
  [LINKER_LANGUAGE (C|CXX|Fortran)]  
  [DEFINES -D<define0> -D<define1> ...]  
  [INSTALLABLE]  
)
```

Sections:

- [Formal Arguments \(TRIBITS_ADD_EXECUTABLE\(\)\)](#)
- [Executable and Target Name \(TRIBITS_ADD_EXECUTABLE\(\)\)](#)
- [Additional Executable and Source File Properties \(TRIBITS_ADD_EXECUTABLE\(\)\)](#)
- [Install Target \(TRIBITS_ADD_EXECUTABLE\(\)\)](#)

Formal Arguments (TRIBITS_ADD_EXECUTABLE())

`<exeRootName>`

The root name of the exectuable (and CMake target) (see [Executable and Target Name \(TRIBITS_ADD_EXECUTABLE\(\)\)](#)).

`NOEXEPREFIX`

If passed in, then `${PACKAGE_NAME}_` is not added the beginning of the executable name (see [Executable and Target Name \(TRIBITS_ADD_EXECUTABLE\(\)\)](#)).

`NOEXESUFFIX`

If passed in, then `${${PROJECT_NAME}_CMAKE_EXECUTABLE_SUFFIX}` and not added to the end of the executable name (see [Executable and Target Name \(TRIBITS_ADD_EXECUTABLE\(\)\)](#)).

`ADD_DIR_TO_NAME`

If passed in, the directory path relative to the package base directory (with “/” replaced by “_”) is added to the executable name (see [Executable and Target Name \(TRIBITS_ADD_EXECUTABLE\(\)\)](#)). This provides a simple way to create unique test executable names inside of a given TriBITS package. Only test executables in the same directory would need to have unique `<execRootName>` passed in.

SOURCES `<src0> <src1> ...`

Gives the source files that will be compiled into the built executable. By default, these sources are assumed to be in the current working directory or gives the relative path to the current working directory. If `<srci>` is an absolute path, then that full file path is used. This list of sources (with adjusted directory path) are passed into `ADD_EXECUTABLE(<fullExeName> ...)`. After calling this function, the properties of the source files can be altered using `SET_SOURCE_FILE_PROPERTIES()`.

DIRECTORY `<dir>`

If specified, then the sources for the executable listed in `SOURCES <src0> <src1> ...` are assumed to be in the relative or absolute directory `<dir>` instead of the current source directory. This directory path is prepended to each source file name `<srci>` unless `<srci>` is an absolute path.

CATEGORIES `<category0> <category1> ...`

Gives the test categories for which this test will be added. See [TRIBITS_ADD_TEST\(\)](#) for more details.

HOST `<host0> <host1> ...`

The list of hosts for which to enable the test (see [TRIBITS_ADD_TEST\(\)](#)).

XHOST `<host0> <host1> ...`

The list of hosts for which **not** to enable the test (see [TRIBITS_ADD_TEST\(\)](#)).

HOSTTYPE `<hosttype0> <hosttype1> ...`

The list of host types for which to enable the test (see [TRIBITS_ADD_TEST\(\)](#)).

XHOSTTYPE `<hosttype0> <hosttype1> ...`

The list of host types for which **not** to enable the test (see [TRIBITS_ADD_TEST\(\)](#)).

DEPLIBS `<lib0> <lib1> ...`

Specifies extra libraries that will be linked to the executable using `TARGET_LINK_LIBRARY()`. Note that regular libraries (i.e. not “TESTONLY”) defined in the current SE package or any upstream SE packages do **NOT** need to be listed! TriBITS automatically links these libraries to the executable! The only libraries that should be listed in this argument are either TESTONLY libraries, or other libraries that are built external from this CMake project and are not provided through a proper TriBITS TPL. The latter usage is not recommended. External TPLs should be handled as a declared TriBITS TPL. For a TESTONLY library, the include directories will automatically be added using:

```
INCLUDE_DIRECTORIES(${<libi>_INCLUDE_DIRS})
```

where `<libi>_INCLUDE_DIRS` was set by:

```
TRIBITS_ADD_LIBRARY(<libi> ... TESTONLY ...)
```

Therefore, to link to a defined TESTONLY library in any upstream enabled package, one just needs to pass in the library name through `DEPLIBS ... <libi> ...` and that is it!

COMM `[serial] [mpi]`

If specified, selects if the test will be added in serial and/or MPI mode. See the `COMM` argument in the script `TRIBITS_ADD_TEST()` for more details.

`LINKER_LANGUAGE (C|CXX|Fortran)`

If specified, overrides the linker language used by setting the target property `LINKER_LANGUAGE`. By default, CMake chooses the compiler to be used as the linker based on file extensions. The most typical use case is when Fortran-only or C-only sources are passed in through `SOURCES` but a C++ linker is needed because there are upstream C++ libraries.

`DEFINES -D<define0> -D<define1> ...`

Add the listed defines using `ADD_DEFINITIONS()`. These should only affect the listed sources for the built executable and not other compiles in this directory due to the `FUNCTION` scoping.

`INSTALLABLE`

If passed in, then an install target will be added to install the built executable into the `${CMAKE_INSTALL_PREFIX}/bin/` directory (see [Install Target \(TRIBITS_ADD_EXECUTABLE\(\)\)](#)).

Executable and Target Name (`TRIBITS_ADD_EXECUTABLE()`)

By default, the full name of the executable and target name `<fullExecName> =`

`${PACKAGE_NAME}_<exeRootName>`

If `ADD_DIR_TO_NAME` is set, then the directory path relative to the package base directory (with “/” replaced with “_”), or `<relDirName>`, is added to the executable name to form `<fullExecName> =`

`${PACKAGE_NAME}_<relDirName>_<exeRootName>`

If the option `NOEXEPREFIX` is passed in, the prefix `${PACKAGE_NAME}_` is removed.

CMake will add the executable suffix `${PROJECT_NAME}_CMAKE_EXECUTABLE_SUFFIX` the actual executable file if the option `NOEXESUFFIX` is not passed in but this suffix is never added to the target name.

The reason that a default prefix is prepended to the executable and target name is because the primary reason to create an executable is typically to create a test or an example that is private to the package. This prefix helps to namespace the executable and its target so as to avoid name clashes with targets in other packages. It also helps to avoid clashes if the executable gets installed into the install directory (if `INSTALLABLE` is specified).

Additional Executable and Source File Properties (`TRIBITS_ADD_EXECUTABLE()`)

Once `ADD_EXECUTABLE(<fullExeName> ...)` is called, one can set and change properties on the `<fullExeName>` executable target using `SET_TARGET_PROPERTIES()` as well as properties on any of the source files listed in `SOURCES` using `SET_SOURCE_FILE_PROPERTIES()` just like in any CMake project.

Install Target (`TRIBITS_ADD_EXECUTABLE()`)

If `INSTALLABLE` is passed in, then an install target `INSTALL(TARGETS <fullExeName> ...)` is added to install the built executable into the `${CMAKE_INSTALL_PREFIX}/bin/` directory (actual install directory path is determined by `${PROJECT_NAME}_INSTALL_RUNTIME_DIR`).

`TRIBITS_ADD_EXECUTABLE_AND_TEST()`

Add an executable and a test (or several tests) all in one shot.

Usage:


```

TRIBITS_ADD_EXECUTABLE_AND_TEST (
  <exeRootName> [NOEXEPREFIX] [NOEXESUFFIX] [ADD_DIR_TO_NAME]
  SOURCES <src0> <src1> ...
  [NAME <testName> | NAME_POSTFIX <testNamePostfix>]
  [CATEGORIES <category0> <category1> ...]
  [HOST <host0> <host1> ...]
  [XHOST <xhost0> <xhost1> ...]
  [XHOST_TEST <xhost0> <xhost1> ...]
  [HOSTTYPE <hosttype0> <hosttype1> ...]
  [XHOSTTYPE <xhosttype0> <xhosttype1> ...]
  [XHOSTTYPE_TEST <xhosttype0> <xhosttype1> ...]
  [DIRECTORY <dir>]
  [DEFINES -DS<someDefine>]
  [DEPLIBS <lib0> <lib1> ... ]
  [COMM [serial] [mpi]]
  [ARGS "<arg0> <arg1> ..." "<arg2> <arg3> ..." ...]
  [NUM_MPI_PROCS <numProcs>]
  [LINKER_LANGUAGE (C|CXX|Fortran)]
  [STANDARD_PASS_OUTPUT
    | PASS_REGULAR_EXPRESSION "<regex0>;<regex1>;..." ]
  [FAIL_REGULAR_EXPRESSION "<regex0>;<regex1>;..." ]
  [WILL_FAIL]
  [ENVIRONMENT <var0>=<value0> <var1>=<value1> ...]
  [INSTALLABLE]
  [TIMEOUT <maxSeconds>]
)

```

This function takes a fairly common set of arguments to [TRIBITS_ADD_EXECUTABLE\(\)](#) and [TRIBITS_ADD_TEST\(\)](#) but not the full set passed to `TRIBITS_ADD_TEST()`. See the documentation for [TRIBITS_ADD_EXECUTABLE\(\)](#) and [TRIBITS_ADD_TEST\(\)](#) to see which arguments are accepted by which functions.

Arguments that are specific to this function and not contained in `TRIBITS_ADD_EXECUTABLE()` or `TRIBITS_ADD_TEST()` include:

```
XHOST_TEST <xhost0> <xhost1> ...
```

When specified, this disables just running the tests for the named hosts `<xhost0>`, `<xhost0>` etc. but still builds the executable for the test.

```
XHOSTTYPE_TEST <xhosttype0> <hosttype1> ...
```

When specified, this disables just running the tests for the named host types `<hosttype0>`, `<hosttype0>`, ..., but still builds the executable for the test.

This is the function to use for simple test executables that you want to run that either takes no arguments or just a simple set of arguments passed in through `ARGS`.

TRIBITS_ADD_LIBRARY()

Function used to add a CMake library and target using `ADD_LIBRARY()`.

Usage:

```

TRIBITS_ADD_LIBRARY (
  <libName>
  [HEADERS <h0> <h1> ...]
  [NOINSTALLHEADERS <nih0> <hih1> ...]
  [SOURCES <src0> <src1> ...]
  [DEPLIBS <deplib0> <deplib1> ...]
)

```

```
[IMPORTEDLIBS <ideplib0> <ideplib1> ...]
[TESTONLY]
[NO_INSTALL_LIB_OR_HEADERS]
[CUDALIBRARY]
)
```

Sections:

- [Formal Arguments \(TRIBITS_ADD_LIBRARY\(\)\)](#)
- [Include Directories \(TRIBITS_ADD_LIBRARY\(\)\)](#)
- [Install Targets \(TRIBITS_ADD_LIBRARY\(\)\)](#)
- [Additional Library and Source File Properties \(TRIBITS_ADD_LIBRARY\(\)\)](#)
- [Miscellaneous Notes \(TRIBITS_ADD_LIBRARY\(\)\)](#)

Formal Arguments (TRIBITS_ADD_LIBRARY())

<libName>

Required name of the library. This is the name passed to

ADD_LIBRARY(<libName> ...). The name is *not* prefixed by the package name. CMake will of course add any standard prefix or post-fix to the library file name appropriate for the platform and if this is a static or shared library build.

HEADERS <h0> <h1> ...

List of public header files for using this library. By default, these header files are assumed to be in the current source directory. They can also contain the relative path or absolute path to the files if they are not in the current source directory. List of headers is passed into ADD_LIBRARY(...) as well (which is not strictly needed but is helpful for some build tools, like MS Visual Studio). By default, these headers will be installed as well (see [Include Directories \(TRIBITS_ADD_LIBRARY\(\)\)](#)).

NOINSTALLHEADERS <nih0> <hih1> ...

List of private header files which are used by this library. These headers are not installed and do not need to be passed in for any purpose other than to pass them into ADD_LIBRARY() as some build tools like to have these listed (e.g. MS Visual Studio).

SOURCES <src0> <src1> ...

List of source files passed into ADD_LIBRARY() that are compiled into header files and included in the library. The compiler used to compile the files is determined automatically based on the file extension (see CMake documentation).

DEPLIBS <deplib0> <deplib1> ...

List of dependent libraries that are built in the current SE package that this library is dependent on. These libraries are passed into TARGET_LINK_LIBRARIES(<libName> ...) so that CMake knows about the dependency. You should **not** list libraries in other upstream SE packages or libraries built externally from this TriBITS CMake project. The TriBITS system automatically handles linking to libraries in upstream TriBITS packages and external libraries need to be listed in IMPORTEDLIBS instead.

IMPORTEDLIBS <ideplib0> <ideplib1> ...

List of dependent libraries built externally from this TriBITS CMake project. These libraries are passed into `TARGET_LINK_LIBRARIES(<libName> ...)` so that CMake knows about the dependency. These libraries are added to the `${PACKAGE_NAME}_LIBRARIES` so that downstream SE packages will also have these libraries and the link line also and these libraries will show up in the generated `Makefile.export.${PACKAGE_NAME}` and `${PACKAGE_NAME}Config.cmake` files if they are generated.

TESTONLY

If passed in, then `<libName>` will **not** be added to `${PACKAGE_NAME}_LIBRARIES` and an install target for the library will not be added. In this case, the current include directories will be set in the global variable `<libName>_INCLUDE_DIR` which will be used in [TRIBITS_ADD_EXECUTABLE\(\)](#) when a test-only library is linked in.

NO_INSTALL_LIB_OR_HEADERS

If specified, then no install targets will be added for the library `<libName>` or the header files listed in `HEADERS`.

CUDALIBRARY

If specified then `CUDA_ADD_LIBRARY()` is used instead of `ADD_LIBRARY()` where `CUDA_ADD_LIBRARY()` is assumed to be defined by the standard `FindCUDA.cmake` module as processed using the standard TriBITS `FindTPLCUDA.cmake` file. For this option to work, this SE package must have an enabled direct or indirect dependency on the TriBITS CUDA TPL or a configure-time error will occur about not finding `CUDA_ALL_LIBRARY()`.

Include Directories (TRIBITS_ADD_LIBRARY())

Any base directories for these header files listed in `HEADERS` or `NOINSTALLHEADERS` should be passed into `INCLUDE_DIRECTORIES()` *before* calling this function. These include directories will then be added to current packages list of include directories `${PACKAGE_NAME}_INCLUDE_DIRS`.

Install Targets (TRIBITS_ADD_LIBRARY())

By default, an install target for the library is created using `INSTALL(TARGETS <libName> ...)` to install into the directory `${CMAKE_INSTALL_PREFIX}/lib/` (actual install directory is given by `${PROJECT}_INSTALL_LIB_DIR`). However, this install target will not get created if `${PROJECT_NAME}_INSTALL_LIBRARIES_AND_HEADERS=FALSE` and `BUILD_SHARD_LIBS=OFF`. But when `BUILD_SHARD_LIBS=ON`, the install target will get created. Also, this install target will *not* get created if `TESTONLY` or `NO_INSTALL_LIB_OR_HEADERS` are passed in.

By default, an install target for the headers listed in `HEADERS` will get created using `INSTALL(FILES <h1> <h2> ...)`, but only if `TESTONLY` and `NO_INSTALL_LIB_OR_HEADERS` are not passed in as well. These headers get installed into the flat directory `${CMAKE_INSTALL_PREFIX}/include/` (the actual install directory is given by `${PROJECT_NAME}_INSTALL_INCLUDE_DIR`). Note that an install target will *not* get created for the headers listed in `NOINSTALLHEADERS`.

Additional Library and Source File Properties (TRIBITS_ADD_LIBRARY())

Once `ADD_LIBRARY(<libName> ... <src0> <src1> ...)` is called, one can set and change properties on the `<libName>` library target using `SET_TARGET_PROPERTIES()` as well as properties on any of the source files listed in `SOURCES` using `SET_SOURCE_FILE_PROPERTIES()` just like in any CMake project.

Miscellaneous Notes (TRIBITS_ADD_LIBRARY())

WARNING: Do **NOT** use `ADD_DEFINITIONS()` to add defines `-D<someDefine>` to the compile command line that will affect a header file! These defines are only set locally in this directory and child directories. These defines will **NOT** be set when code in peer directories (e.g. a downstream TriBITS package) compiles code that may include these header files. To add defines, please use a configured header file (see [TRIBITS_CONFIGURE_FILE\(\)](#)).

TRIBITS_ADD_OPTION_AND_DEFINE()

Add an option and a define variable in one shot.

Usage:

```
TRIBITS_ADD_OPTION_AND_DEFINE( <userOptionName>  <macroDefineName>
    "<docStr>"  <defaultValue> )
```

This macro sets the user cache BOOL variable <userOptionName> and if it is true, then sets the global (internal cache) macro define variable <macroDefineName> to ON, and otherwise sets it to OFF. This is designed to make it easy to add a user-enabled option to a configured header file and have the define set in one shot. This would require that the package's configure file (see [TRIBITS_CONFIGURE_FILE\(\)](#)) have the line:

```
#cmakedefine <macroDefineName>
```

TRIBITS_ADD_SHOW_DEPRECATED_WARNINGS_OPTION()

Add the standard option `${PACKAGE_NAME}_SHOW_DEPRECATED_WARNINGS` for the package.

Usage:

```
TRIBITS_ADD_SHOW_DEPRECATED_WARNINGS_OPTION()
```

This option is given the default `"${PROJECT_NAME}_SHOW_DEPRECATED_WARNINGS"`. This option is then looked for in [TRIBITS_CONFIGURE_FILE\(\)](#) to add macros to add deprecated warnings to deprecated parts of a package.

TRIBITS_ADD_TEST()

Add a test or a set of tests for a single executable or command.

Usage:

```
TRIBITS_ADD_TEST(
    <exeRootName>  [NOEXEPREFIX]  [NOEXESUFFIX]
    [NAME <testName> | NAME_POSTFIX <testNamePostfix>]
    [DIRECTORY <directory>]
    [ADD_DIR_TO_NAME]
    [ARGS "<arg0> <arg1> ..." "<arg2> <arg3> ..." ...
    | POSTFIX_AND_ARGS_0 <postfix0> <arg0> <arg1> ...
    | POSTFIX_AND_ARGS_1 ... ]
    [COMM [serial] [mpi]]
    [NUM_MPI_PROCS <numProcs>]
    [CATEGORIES <category0> <category1> ...]
    [HOST <host0> <host1> ...]
    [XHOST <host0> <host1> ...]
    [HOSTTYPE <hosttype0> <hosttype1> ...]
    [XHOSTTYPE <hosttype0> <hosttype1> ...]
    [STANDARD_PASS_OUTPUT
    | PASS_REGULAR_EXPRESSION "<regex0>;<regex1>;..." ]
    [FAIL_REGULAR_EXPRESSION "<regex0>;<regex1>;..." ]
    [WILL_FAIL]
    [ENVIRONMENT <var0>=<value0> <var1>=<value1> ...]
    [TIMEOUT <maxSeconds>]
)
```

Sections:

- [Formal Arguments \(TRIBITS_ADD_TEST\(\)\)](#)
- [Determining the Executable or Command to Run \(TRIBITS_ADD_TEST\(\)\)](#)
- [Determining the Full Test Name \(TRIBITS_ADD_TEST\(\)\)](#)
- [Adding Multiple Tests \(TRIBITS_ADD_TEST\(\)\)](#)
- [Determining Pass/Fail \(TRIBITS_ADD_TEST\(\)\)](#)
- [Setting additional test properties \(TRIBITS_ADD_TEST\(\)\)](#)
- [Debugging and Examining Test Generation \(TRIBITS_ADD_TEST\(\)\)](#)
- [Disabling Tests Externally \(TRIBITS_ADD_TEST\(\)\)](#)

Formal Arguments (TRIBITS_ADD_TEST())

`<exeRootName>`

The name of the executable or path to the executable to run for the test (see [Determining the Executable or Command to Run \(TRIBITS_ADD_TEST\(\)\)](#)). This name is also the default root name for the test (see [Determining the Full Test Name \(TRIBITS_ADD_TEST\(\)\)](#)).

`NOEXEPREFIX`

If specified, then the prefix `${PACKAGE_NAME}_` is not assumed to be prepended to `<exeRootName>`.

`NOEXESUFFIX`

If specified, then the postfix `${PROJECT_NAME}_CMAKE_EXECUTABLE_SUFFIX` is not assumed to be post-pended to `<exeRootName>`.

`NAME <testRootName>`

If specified, gives the root name of the test. If not specified, then `<testRootName>` is taken to be `<exeRootName>`. The actual test name will always be prefixed as `${PACKAGE_NAME}_<testRootName>` passed into the call to the built-in CMake command `ADD_TEST (. . .)`. The main purpose of this argument is to allow multiple tests to be defined for the same executable. CTest requires all test names to be globally unique in a single project.

`NAME_POSTFIX <testNamePostfix>`

If specified, gives a postfix that will be added to the standard test name based on `<exeRootName>` (appended as `_<NAME_POSTFIX>`). If the `NAME <testRootName>` argument is given, this argument is ignored.

`DIRECTORY <dir>`

If specified, then the executable is assumed to be in the directory given by `<dir>`. The directory `<dir>` can either be a relative or absolute path. If not specified, the executable is assumed to be in the current binary directory.

`ADD_DIR_TO_NAME`

If specified, then the directory name that this test resides in will be added into the name of the test after the package name is added and before the root test name (see below). The directory will have the package's base directory stripped off so only the unique part of the test directory will be used. All directory separators will be changed into underscores.

`RUN_SERIAL`

If specified then no other tests will be allowed to run while this test is running. This is useful for devices (like cuda cards) that require exclusive access for processes/threads. This just sets the CTest test property `RUN_SERIAL` using the built-in CMake function `SET_TESTS_PROPERTIES()`.

`ARGS "<arg0> <arg1> ..." "<arg2> <arg3> ..." ...`

If specified, then a set of arguments can be passed in quotes. If multiple groups of arguments are passed in different quoted clusters of arguments then a different test will be added for each set of arguments. In this way, many different tests can be added for a single executable in a single call to this function. Each of these separate tests will be named `${TEST_NAME}_xy` where `xy = 00, 01, 02`, and so on. **WARNING:** When defining multiple tests it is preferred to use the `POSTFIX_AND_ARGS_<IDX>` form instead. **WARNING:** Multiple arguments passed to a single test invocation must be quoted or multiple tests taking single arguments will be created instead! See [Adding Multiple Tests \(TRIBITS_ADD_TEST\(\)\)](#) for more details and examples.

`POSTFIX_AND_ARGS_<IDX> <postfix> <arg0> <arg1> ...`

If specified, gives a sequence of sets of test postfix names and arguments lists for different tests (up to `POSTFIX_AND_ARGS_19`). For example, a set of three different tests with argument lists can be specified as:

```
POSTIFX_AND_ARGS_0 postfix0 --arg1 --arg2="dummy"
POSTIFX_AND_ARGS_1 postfix1  --arg2="fly"
POSTIFX_AND_ARGS_2 postfix2  --arg2="bags"
```

This will create three different test cases with the postfix names `postfix0`, `postfix1`, and `postfix2`. The indexes must be consecutive starting a 0 and going up to (currently) 19. The main advantages of using these arguments instead of just 'ARGS' are that you can give meaningful name to each test case and you can specify multiple arguments without having to quote them and you can allow long argument lists to span multiple lines. See [Adding Multiple Tests \(TRIBITS_ADD_TEST\(\)\)](#) for more details and examples.

`COMM [serial] [mpi]`

If specified, selects if the test will be added in serial and/or MPI mode. If the `COMM` argument is missing, the test will be added in both serial and MPI builds of the code.

`NUM_MPI_PROCS <numProcs>`

If specified, gives the number of processes that the test will be defined to run. If `<numProcs>` is greater than `${MPI_EXEC_MAX_NUMPROCS}` then the test will be excluded. If not specified, then the default number of processes for an MPI build will be `${MPI_EXEC_DEFAULT_NUMPROCS}`. For serial builds, this argument is ignored.

`HOST <host0> <host1> ...`

If specified, gives a list of hostnames where the test will be included. The current hostname is determined by the built-in CMake command `SITE_NAME (${PROJECT_NAME}_HOSTNAME)`. On Linux/Unix systems, this is typically the value returned by `'uname -n'`. If this list is given, the value of `${${PROJECT_NAME}_HOSTNAME}` must equal one of the listed host names `<hosti>` or test will not be added. The value of `${PROJECT_NAME}_HOSTNAME` gets printed out in the TribITS cmake output under the section `Probing the environment`.

`XHOST <host0> <host1> ...`

If specified, gives a list of hostnames (see `HOST` argument) where the test will *not* be added. This check is performed after the check for the hostnames in the `HOST` list if it should exist. Therefore, this list exclusion list overrides the 'HOST' inclusion list.

CATEGORIES <category0> <category1> ...

If specified, gives the specific categories of the test. Valid test categories include BASIC, CONTINUOUS, NIGHTLY, WEEKLY and PERFORMANCE. By default, the category is BASIC. When the test category does not match `${PROJECT_NAME}_TEST_CATEGORIES`, then the test is not added. When the CATEGORIES is BASIC it will match `${PROJECT_NAME}_TEST_CATEGORIES` equal to CONTINUOUS, NIGHTLY, and WEEKLY. When the CATEGORIES contains CONTINUOUS it will match `${PROJECT_NAME}_TEST_CATEGORIES` equal to CONTINUOUS, NIGHTLY, and WEEKLY. When the CATEGORIES is NIGHTLY it will match `${PROJECT_NAME}_TEST_CATEGORIES` equal to NIGHTLY and WEEKLY. When the CATEGORIES is PERFORMANCE it will match `${PROJECT_NAME}_TEST_CATEGORIES=PERFORMANCE` only.

HOSTTYPE <hosttype0> <hosttype1> ...

If specified, gives the names of the host system type (given by `CMAKE_HOST_SYSTEM_NAME` which is printed in the TriBITS cmake configue output in the section Probing the environment) to include the test. Typical host system type names include Linux, Darwin etc.

XHOSTTYPE <hosttype0> <hosttype1> ...

If specified, gives the names of the host system type to *not* include the test. This check is performed after the check for the host system names in the HOSTTYPE list if it should exist. Therefore, this list exclusion list overrides the HOSTTYPE inclusion list.

STANDARD_PASS_OUTPUT

If specified, then the standard test output `End Result: TEST PASSED` is greped for to determine success. This is needed for MPI tests on some platforms since the return value is unreliable. This is set using the built-in ctest property `PASS_REGULAR_EXPRESSION`.

PASS_REGULAR_EXPRESSION "<regex0>;<regex1>;..."

If specified, then a test will be assumed to pass only if one of the regular expressions <regex0>, <regex1> etc. match the output. Otherwise, the test will fail. This is set using the built-in test property `PASS_REGULAR_EXPRESSION`. Consult standard CMake documentation.

FAIL_REGULAR_EXPRESSION "<regex0>;<regex1>;..."

If specified, then a test will be assumed to fail if one of the regular expressions <regex0>, <regex1> etc. match the output. Otherwise, the test will pass. This is set using the built-in test property `FAIL_REGULAR_EXPRESSION`.

WILL_FAIL

If passed in, then the pass/fail criteria will be inverted. This is set using the built-in test property `WILL_FAIL`.

ENVIRONMENT <var0>=<value0> <var1>=<value1> ...

If passed in, the listed environment variables will be set before calling the test. This is set using the built-in test property `ENVIRONMENT`.

TIMEOUT <maxSeconds>

If passed in, gives maximum number of seconds the test will be allowed to run before being timed-out. This sets the test property `TIMEOUT`. **WARNING:** Rather than just increasing the timeout for an expensive test, please try to either make the test run faster or relegate the test to being run less often (i.e. set CATEGORIES NIGHTLY or even WEEKLY for extremely expensive tests). Expensive tests are one of the worse forms of technical debt that a project can have!

In the end, this function just calls the built-in CMake commands `ADD_TEST (${TEST_NAME} ...)` and `SET_TESTS_PROPERTIES (${TEST_NAME} ...)` to set up a executable process for `ctest` to run, determine pass/fail criteria, and set some other test properties. Therefore, this wrapper function does not provide any fundamentally new features that are already available in the basic usage of CMake/CTest. However, this wrapper function takes care of many of the details and boiler-plate CMake code that it takes to add such a test (or tests) and enforces consistency across a large project for how tests are defined, run, and named (to avoid test name clashes).

If more flexibility or control is needed when defining tests, then the function `TRIBITS_ADD_ADVANCED_TEST()` should be used instead.

In the following subsections, more details on how tests are defined and run is given.

Determining the Executable or Command to Run (TRIBITS_ADD_TEST())

This function is primarily designed to make it easy to run tests for executables built using the function [TRIBITS_ADD_EXECUTABLE\(\)](#). To set up tests to run arbitrary executables, see below.

By default, the command to run for the executable is determined by first getting the executable name which by default is assumed to be `<fullExeName> =`

```
${PACKAGE_NAME}_<exeRootName>${${PROJECT_NAME}_CMAKE_EXECUTABLE_SUFFIX}
```

which is (by no coincidence) identical to how it is selected in [TRIBITS_ADD_EXECUTABLE\(\)](#). This name can be altered by passing in `NOEXEPREFIX`, `NOEXESUFFIX`, and `ADD_DIR_TO_NAME` as described in [Executable and Target Name \(TRIBITS_ADD_EXECUTABLE\(\)\)](#).

By default, this executable is assumed to be in the current CMake binary directory `${CMAKE_CURRENT_BINARY_DIR}` but the directory location can be changed using the `DIRECTORY <dir>` argument.

If an arbitrary executable is to be run for the test, then pass in `NOEXEPREFIX` and `NOEXESUFFIX` and set `<exeRootName>` to the relative or absolute path of the executable to be run. If `<exeRootName>` is not an absolute path, then `${CMAKE_CURRENT_BINARY_DIR}/<exeRootName>` is set as the executable to run.

Whatever executable path is specified using this logic, if the executable is not found, then when `ctest` goes to run the test, it will mark it as `NOT RUN`.

Determining the Full Test Name (TRIBITS_ADD_TEST())

By default, the base test name is selected to be `<fullTestName> =`

```
${PACKAGE_NAME}_<exeRootName>
```

If `NAME <testRootName>` is passed in, then `<testRootName>` is used instead of `<exeRootName>`.

If `NAME_POSTFIX <testNamePostfix>` is passed in, then the base test name is selected to be `<fullTestName> =`

```
${PACKAGE_NAME}_<exeRootName>_<testNamePostfix>
```

If `ADD_DIR_TO_NAME` is passed in, then the directory name relative to the package directory name is added to the name as well to help disambiguate the test name (see the above).

Let the test name determined by this process be `TEST_NAME`. If no arguments or one set of arguments are passed in through `ARGS`, then this is the test name actually passed in to `ADD_TEST()`. If multiple tests are defined, then this name becomes the base test name for each of the tests. See below.

Finally, for any test that gets defined, if MPI is enabled (i.e. `TPL_ENABLE_MPI=ON`), then the terminal suffix `_MPI_${NUM_MPI_PROCS}` will be added to the end of the test name (even for multiple tests). No such prefix is added for the serial case (i.e. `TPL_ENABLE_MPI=OFF`).

Adding Multiple Tests (TRIBITS_ADD_TEST())

Using this function, one can add executable arguments and can even add multiple tests in one of two ways. One can either pass in 1 or more **quoted** clusters of arguments using:

```
ARGS "<arg0> <arg1> ..." "<arg2> <arg3> ..." ...
```

or can pass in an explicit test name postfix and arguments with:

```
POSTFIX_AND_ARGS_0 <postfix0> <arg0> <arg1> ...
POSTFIX_AND_ARGS_1 <postfix1> <arg2> ...
...
```

If only one short set of arguments needs to be passed in, then passing:

```
ARGS "<arg0> <arg1>"
```

may be preferable since it will not add any postfix name to the test. To add more than one test case using ARGS, you use more than one quoted set of arguments such as with:

```
ARGS "<arg0> <arg1>" "<arg2> <arg2>"
```

which creates 2 tests with the names `<fullTestName>_00` passing arguments `"<arg0> <arg1>"` and `<fullTestName>_01` passing arguments `"<arg2> <arg3>"`. However, when passing multiple sets of arguments it is preferable to **not** use ARGS but instead use:

```
POSTFIX_AND_ARGS_0 test_a <arg0> <arg1>
POSTFIX_AND_ARGS_1 test_b <arg2> <arg2>
```

which also creates the same 2 tests but now with the improved names `<fullTestName>_test_a` passing arguments `"<arg0> <arg1>"` and `<fullTestName>_test_b` passing arguments `"<arg2> <arg3>"`. In this way, the individual tests can be given more understandable names.

The other advantage of the `POSTFIX_AND_ARGS_<IDX>` form is that the arguments `<arg0>`, `<arg1>`, ... do not need to be quoted and can therefore be extended over multiple lines like:

```
POSTFIX_AND_ARGS_0 long_args --this-is-the-first-long-arg=very
--this-is-the-second-long-arg=verylong
```

If you don't use quotes when using ARGS you actually get more than one test. For example, if you pass in:

```
ARGS --this-is-the-first-long-arg=very
--this-is-the-second-long-arg=verylong
```

you actually get two tests, not one test. This is a common mistake that people make when using the ARGS form of passing arguments. This can't be fixed or it will break backward compatibility. If this could be designed fresh, the ARGS argument would only create a single test and the arguments would not be quoted.

Determining Pass/Fail (TRIBITS_ADD_TEST())

The only means to determine pass/fail is to use the built-in test properties `PASS_REGULAR_EXPRESSION` and `FAIL_REGULAR_EXPRESSION` which can only grep STDOUT/STDERR or to check for a 0 return value (or invert these using `WILL_FAIL`). For simple tests, that is enough. However, for more complex executables, one may need to examine the output files to determine pass fail. Raw CMake/CTest can't do this. In this case, one should use [TRIBITS_ADD_ADVANCED_TEST\(\)](#).

Setting additional test properties (TRIBITS_ADD_TEST())

After this function returns, any tests that get added using `ADD_TEST()` can have additional properties set and changed using `SET_TEST_PROPERTIES()`. Therefore, any tests properties that are not directly supported by this function and passed through this wrapper function can be set in the outer `CMakeLists.txt` file after the call to `TRIBITS_ADD_TEST()`.

ToDo: Describe how to use new variable `ADDED_TESTS_OUT` to get the list of tests actually added (if they are added) in order to make it easy to set additional test properties.

Debugging and Examining Test Generation (TRIBITS_ADD_TEST())

In order to see what tests are getting added and to debug some issues in test creation, one can set the cache variable `${PROJECT_NAME}_VERBOSE_CONFIGURE=ON`. This will result in the printout of some information about the test getting added or not.

Also, CMake writes a file `CTestTestfile.cmake` in the current binary directory which contains all of the added tests and test properties that are set. This is the file that is read by `ctest` when it runs to determine what tests to run. In that file, one can see the exact `ADD_TEST()` and `SET_TEST_PROPERTIES()` commands. This is the ultimate way to debug exactly what tests are getting added by this function.

Disabling Tests Externally (TRIBITS_ADD_TEST())

The test can be disabled externally by setting the CMake cache variable

`${FULL_TEST_NAME}_DISABLE=TRUE`. This allows tests to be disabled on a case-by-case basis. This is the *exact* name that shows up in 'ctest -N' when running the test. If multiple tests are added in this function through multiple argument sets to `ARGS` or through multiple `POSTFIX_AND_ARGS<IDX>` arguments, then `${FULL_TEST_NAME}_DISABLE=TRUE` must be set for each test individually.

TRIBITS_ADD_TEST_DIRECTORIES()

Macro called to add a set of test directories for an SE package.

Usage:

```
TRIBITS_ADD_TEST_DIRECTORIES(<dir1> <dir2> ...)
```

This macro only needs to be called from the top most CMakeList.txt file for which all subdirectories are all "tests".

This macro can be called several times within a package and it will have the right effect.

Currently, really all it does macro does is to call `ADD_SUBDIRECTORY(<dir>)` if `${PACKAGE_NAME}_ENABLE_TESTS` or `${PARENT_PACKAGE_NAME}_ENABLE_TESTS` are true. However, this macro may be extended in the future in order to modify behavior related to adding tests and examples in a uniform way..

TRIBITS_ALLOW_MISSING_EXTERNAL_PACKAGES()

Macro used in Dependencies.cmake files to allow some upstream dependent packages to be missing.

Usage:

```
TRIBITS_ALLOW_MISSING_EXTERNAL_PACKAGES(<pack_1> <pack_2> ...)
```

If the missing upstream SE package `<pack_i>` is optional, then the effect will be to simply ignore the missing package and remove it from the dependency list. However, if the missing upstream SE package `<pack_i>` is required, then in addition to ignoring the missing package, the current SE (sub)package will also be hard disabled, i.e. `${PROJECT_NAME}_ENABLE_{CURRENT_PACKAGE}=OFF`.

This function is typically used in packages in external TriBITS repos that are depend on other packages in other external TriBITS repos that might be missing.

NOTE: Using this function effectively turns off error checking for misspelled package names so it is important to only use it when it absolutely is needed.

TRIBITS_CONFIGURE_FILE()

Macro that configures the package's main configured header file (typically called `${PACKAGE_NAME}_config.h` but any name can be used).

Usage:

```
TRIBITS_CONFIGURE_FILE(<packageConfigFile>)
```

This function requires the file:

```
${PACKAGE_SOURCE_DIR}/cmake/<packageConfigFile>.in
```

exists and it creates the file:

```
${CMAKE_CURRENT_BINARY_DIR}/<packageConfigFile>
```

by calling the built-in `CONFIGURE_FILE()` command:

```
CONFIGURE_FILE(  
  ${PACKAGE_SOURCE_DIR}/cmake/<packageConfigFile>.in  
  ${CMAKE_CURRENT_BINARY_DIR}/<packageConfigFile>  
)
```

which does basic substitution of CMake variables (see documentation for built-in `CONFIGURE_FILE()` command for rules on how it performs substitutions).

In addition to just calling `CONFIGURE_FILE()`, this function also aids in creating configured header files adding macros for deprecating code.

Deprecated Code Macros

If `$(PARENT_PACKAGE_NAME)_SHOW_DEPRECATED_WARNINGS` is TRUE (see [TRIBITS_ADD_SHOW_DEPRECATED_WARNINGS_OPTION\(\)](#)), then the local CMake variable `$(PARENT_PACKAGE_NAME_UC)_DEPRECATED_DECLARATIONS` adds a define `<PARENT_PACKAGE_NAME_UC>_DEPRECATED` (where `<PARENT_PACKAGE_NAME_UC>` is the package name in all upper-case letters) add the compiler-specific deprecated warning for an entity. To use this, just add the line:

```
@<PARENT_PACKAGE_NAME_UC>_DEPRECATED_DECLARATIONS@
```

to the `<packageConfigFile>.in` file and it will be expended.

Then C/C++ code can use this macro to deprecate functions, variables, classes, etc., for example, using:

```
<PARENT_PACKAGE_NAME_UC>_DEPRECATED class SomeDepreatedClass { ... }.
```

If the particular compiler does not support deprecated warnings, then this macro is defined to be empty. See [Regulated Backward Compatibility and Deprecated Code](#) for more details.

TRIBITS_COPY_FILES_TO_BINARY_DIR()

Function that copies a list of files from a source directory to a destination directory at configure time, typically so that it can be used in one or more tests. This sets up all of the custom CMake commands and targets to ensure that the files in the destination directory are always up to date just by building the ALL target.

Usage:

```
TRIBITS_COPY_FILES_TO_BINARY_DIR(  
  <targetName>  
  [SOURCE_FILES <file1> <file2> ...]  
  [SOURCE_DIR <sourceDir>]  
  [DEST_FILES <dfile1> <dfile2> ...]  
  [DEST_DIR <destDir>]  
  [TARGETDEPS <targDep1> <targDep2> ...]  
  [EXEDEPS <exeDep1> <exeDep2> ...]  
  [NOEXEPREFIX]  
  [CATEGORIES <category1> <category2> ...]  
)
```

This function has a few valid calling modes:

1) Source files and destination files have the same name:

```
TRIBITS_COPY_FILES_TO_BINARY_DIR(  
  <targetName>  
  SOURCE_FILES <file1> <file2> ...  
  [SOURCE_DIR <sourceDir>]  
  [DEST_DIR <destDir>]  
  [TARGETDEPS <targDep1> <targDep2> ...]  
  [EXEDEPS <exeDep1> <exeDep2> ...]  
  [NOEXEPREFIX]  
  [CATEGORIES <category1> <category2> ...]  
)
```

In this case, the names of the source files and the destination files are the same but just live in different directories.

2) Source files have a prefix different from the destination files:

```
TRIBITS_COPY_FILES_TO_BINARY_DIR(  
  <targetName>  
  DEST_FILES <file1> <file2> ...  
  SOURCE_PREFIX <srcPrefix>  
  [SOURCE_DIR <sourceDir>]  
  [DEST_DIR <destDir>]  
  [EXEDEPS <exeDep1> <exeDep2> ...]  
  [NOEXEPREFIX]  
  [CATEGORIES <category1> <category2> ...]  
)
```

In this case, the source files have the same basic name as the destination files except they have the prefix 'srcPrefix' appended to the name.

3) Source files and destination files have completely different names:

```
TRIBITS_COPY_FILES_TO_BINARY_DIR(  
  <targetName>  
  SOURCE_FILES <sfile1> <sfile2> ...  
  [SOURCE_DIR <sourceDir>]  
  DEST_FILES <dfile1> <dfile2> ...  
  [DEST_DIR <destDir>]  
  [EXEDEPS <exeDep1> <exeDep2> ...]  
  [NOEXEPREFIX]  
  [CATEGORIES <category1> <category2> ...]  
)
```

In this case, the source files and destination files have completely different prefixes.

The individual arguments are:

`SOURCE_FILES <file1> <file2> ...`

Listing of the source files relative to the source directory given by the argument `SOURCE_DIR <sourceDir>`. If omitted, this list will be the same as `DEST_FILES` with the argument `SOURCE_PREFIX <srcPrefix>` appended.

`SOURCE_DIR <sourceDir>`

Optional argument that gives (absolute) the base directory for all of the source files. If omitted, this takes the default value of `${CMAKE_CURRENT_SOURCE_DIR}`.

`DEST_FILES <file1> <file2> ...`

Listing of the destination files relative to the destination directory given by the argument
DEST_DIR <destDir> If omitted, this list will be the same as given by the
SOURCE_FILES list.

DEST_DIR <destDir>

Optional argument that gives the (absolute) base directory for all of the destination files.
If omitted, this takes the default value of `${CMAKE_CURRENT_BINARY_DIR}`

TARGETDEPS <targDep1> <targDep2> ...

Listing of general CMake targets that these files will be added as dependencies to.

EXEDEPS <exeDep1> <exeDep2> ...

Listing of executable targets that these files will be added as dependencies to. By default
the prefix `${PACKAGE_NAME}_` will be appended to the names of the targets. This
ensures that if the executable target is built that these files will also be copied as well.

NOEXEPREFIX

Option that determines if the prefix `${PACKAGE_NAME}_` will be appended to the
arguments in the EXEDEPS list.

TRIBITS_DEFINE_PACKAGE_DEPENDENCIES()

Define the dependencies for a given TriBITS SE package (i.e. a top-level package or a subpackage) in the
package's [<packageDir>/cmake/Dependencies.cmake](#) file.

Usage:

```
TRIBITS_DEFINE_PACKAGE_DEPENDENCIES (
  [LIB_REQUIRED_PACKAGES <pkg1> <pkg2> ...]
  [LIB_OPTIONAL_PACKAGES <pkg1> <pkg2> ...]
  [TEST_REQUIRED_PACKAGES <pkg1> <pkg2> ...]
  [TEST_OPTIONAL_PACKAGES <pkg1> <pkg2> ...]
  [LIB_REQUIRED_TPLS <tpl1> <tpl2> ...]
  [LIB_OPTIONAL_TPLS <tpl1> <tpl2> ...]
  [TEST_REQUIRED_TPLS <tpl1> <tpl2> ...]
  [TEST_OPTIONAL_TPLS <tpl1> <tpl2> ...]
  [REGRESSION_EMAIL_LIST <regression-email-address>]
  [SUBPACKAGES_DIRS_CLASSIFICATIONS_OPTREQS
    <spkg1_name> <spkg1_dir> <spkg1_classifications> <spkg1_optreq>
    <spkg2_name> <spkg2_dir> <spkg2_classifications> <spkg2_optreq>
    ...
  ]
)
```

Every argument in this macro is optional. The arguments that apply a package itself are:

- **LIB_REQUIRED_PACKAGES:** List of upstream packages that must be enabled in order to build and use the libraries (or capabilities) in this package.
- **LIB_OPTIONAL_PACKAGES:** List of additional optional upstream packages that can be used in this package if enabled. These upstream packages need not be enabled in order to use this package but not enabling one or more of these optional upstream packages will result in diminished capabilities of this package.
- **TEST_REQUIRED_PACKAGES:** List of additional upstream packages that must be enabled in order to build and/or run the tests and/or examples in this packages. If any of these upstream packages is not enabled, then there will be no tests or examples defined or run for this package.

- **TEST_OPTIONAL_PACKAGES:** List of additional optional upstream packages that can be used by the tests in this package. These upstream packages need not be enabled in order to run basic tests for this package. Typically, extra tests that depend on optional test packages involve integration testing of some type.
- **LIB_REQUIRED_TPLS:** List of upstream TPLs that must be enabled in order to build and use the libraries (or capabilities) in this package.
- **LIB_OPTIONAL_TPLS:** List of additional optional upstream TPLs that can be used in this package if enabled. These upstream TPLs need not be enabled in order to use this package but not enabling one or more of these optional upstream TPLs will result in diminished capabilities of this package.
- **TEST_REQUIRED_TPLS:** List of additional upstream TPLs that must be enabled in order to build and/or run the tests and/or examples in this packages. If any of these upstream TPLs is not enabled, then there will be no tests or examples defined or run for this package.
- **TEST_OPTIONAL_TPLS:** List of additional optional upstream TPLs that can be used by the tests in this package. These upstream TPLs need not be enabled in order to run basic tests for this package. Typically, extra tests that depend on optional test TPLs involve integration testing of some type.

Only upstream SE packages can be listed (as defined by the order the packages are listed in [TRIBITS_DEFINE_REPOSITORY_PACKAGES\(\)](#) in the `<repoDir>/PackagesList.cmake` file). Otherwise an error will occur and processing will stop. Also, misspelled SE package names are caught as well.

Only direct package dependencies need to be listed. Indirect package dependencies are automatically handled. For example, if this SE package directly depends on PKG2 which depends on PKG1 (but this SE package does not directly depend on anything in PKG1) then this package only needs to list a dependency on PKG2, not PKG1. The dependency on PKG1 will be taken care of automatically by the TriBITS dependency tracking system.

However, currently, all TPL dependencies must be listed, even the indirect ones. This is a requirement that will be dropped in a future version of TriBITS.

The packages listed in LIB_REQUIRED_PACKAGES are implicitly also dependencies in TEST_REQUIRED_PACKAGES. Likewise LIB_OPTIONAL_PACKAGES are implicitly also dependencies in TEST_OPTIONAL_PACKAGES. Same goes for TPL dependencies.

The upstream dependencies within a single list do not need to be listed in any order. For example if PKG2 depends on PKG1, and this given SE package depends on both, one can list:

```
LIB_REQUIRED_PACKAGES PKG2 PKG1
```

or:

```
"LIB_REQUIRED_PACKAGES PKG1 PKG2"
```

Likewise the listing of TPLs order is not important.

If some upstream packages are allowed to be missing, this can be specified by calling the macro [TRIBITS_ALLOW_MISSING_EXTERNAL_PACKAGES\(\)](#).

A top-level package can also have subpackages. In this case, the following variable must be set:

- **SUBPACKAGES_DIRS_CLASSIFICATIONS_OPTREQS:** 2D array with rows listing the subpackages and the columns:
 - **SUBPACKAGE:** The name of the subpackage `<spkg_name>`. The full SE package name is “`#{PARENT_PACKAGE_NAME}<spkg_name>`”. The full SE package name is what is used in listing dependencies in other SE packages.
 - **DIRS:** The subdirectory `<spkg_dir>` relative to the parent package’s base directory. All of the contents of the subpackage should be under this subdirectory. This is assumed by the TriBITS testing support software when mapping modified files to SE packages that need to be tested.

- **CLASSIFICATIONS***: The test group PT, ST, EX and the maturity level EP, RS, PG, PM, GRS, GPG, GPM, and UM, separated by a coma ',' with no spaces in between (e.g. "PT,GPM"). These have exactly the name meaning as for full packages (see [TRIBITS_DEFINE_REPOSITORY_PACKAGES\(\)](#)).
- **OPTREQ**: Determines if the outer parent package has an OPTIONAL or REQUIRED dependence on this subpackage.

Other variables that this macro handles:

- **REGRESSION_EMAIL_LIST**: The email list that is used to send CDash error messages. If this is missing, then the email list that CDash errors go to is determined by other means (see [CDash regression email addresses](#)).

NOTE: All this macro really does is to just define the variables:

- LIB_REQUIRED_DEP_PACKAGES
- LIB_OPTIONAL_DEP_PACKAGES
- TEST_REQUIRED_DEP_PACKAGES
- TEST_OPTIONAL_DEP_PACKAGES
- LIB_REQUIRED_DEP_TPLS
- LIB_OPTIONAL_DEP_TPLS
- TEST_REQUIRED_DEP_TPLS
- TEST_OPTIONAL_DEP_TPLS
- REGRESSION_EMAIL_LIST
- SUBPACKAGES_DIRS_CLASSIFICATIONS_OPTREQS

which are then read by the TriBITS cmake code to build the package dependency graph. The advantage of using this macro instead of just directly setting the variables is that you only need to list the dependencies you have. Otherwise, you need to set all of these variables, even those that are empty. This is a error checking property of the TriBITS system to avoid misspelling the names of these variables.

TRIBITS_DEFINE_REPOSITORY_PACKAGES()

Define the set of packages for a given TriBIT repo. This macro is typically called from inside of a [<repoDir>/PackagesList.cmake](#) file for a given TriBITS repo.

Usage:

```
TRIBITS_DEFINE_REPOSITORY_PACKAGES (
    <pkg0>  <pkg0_dir>  <pkg0_classif>
    <pkg1>  <pkg1_dir>  <pkg1_classif>
    ...
)
```

This macro sets up a 2D array of NumPackages by NumColumns listing out the packages for a TriBITS repository. Each row (with 3 entries) specifies a package which contains the 3 columns (ordered 0-2):

0. **PACKAGE** (<pkgi>): The name of the TriBITS package. This name must be unique across all other TriBITS packages in this or any other TriBITS repo that might be combined into a single TriBITS project meta-build. The name should be a valid identifier (e.g. matches the regex `[a-zA-Z_][a-zA-Z0-9_]*`).

1. **DIR** (<pkgi_dir>): The relative directory for the package. This is relative to the TriBITS repository base directory. Under this directory will be a package-specific 'cmake/' directory with file 'cmake/Dependencies.cmake' and a base-level CMakeLists.txt file. The entire contents of the package including all of the source code and all of the tests should be contained under this directory. The TriBITS testing infrastructure relies on the mapping of changed files to these base directories when deciding what packages are modified and need to be retested (along with downstream packages).
2. **CLASSIFICATION** (<pkgi_classif>): Gives the testing group PT, ST, EX and the maturity level EP, RS, PG, PM, GRS, GPG, GPM, UM. These are separated by a comma with no space in between such as "RS,PT" for a "Research Stable", "Primary Tested" package. No spaces are allowed so that CMake treats this as one field in the array. The maturity level can be left off in which case it is assumed to be UM for "Unspecified Maturity". This classification for individual packages can be changed to EX for specific platforms by calling [TRIBITS_DISABLE_PACKAGE_ON_PLATFORMS\(\)](#).

IMPORTANT: The packages must be listed in increasing order of package dependencies; there are no cyclic package dependencies allowed. That is, package *i* can only list dependencies (in [<packageDir>/cmake/Dependencies.cmake](#)) for packages listed before this package in this list (or in upstream TriBITS repositories). This avoids an expensive package sorting algorithm and makes it easy to flag packages with circular dependencies or misspelling of package names.

NOTE: This macro just sets the variable:

```
${REPOSITORY_NAME}_PACKAGES_AND_DIRS_AND_CLASSIFICATIONS
```

in the current scope. The advantages of using this macro instead of directly setting this variable include:

- Asserts that the variable `REPOSITORY_NAME` is defined and set
- Avoids having to hard-code the assumed repository name `${REPOSITORY_NAME}`. This provides more flexibility for how other TriBITS project name a given TriBITS repo (i.e. the name of repo subdirs).
- Avoid misspelling the name of the variable `${REPOSITORY_NAME}_PACKAGES_AND_DIRS_AND_CLASSIFICATIONS`. If you misspell the name of the macro, it is an immediate error in CMake.

TRIBITS_DEFINE_REPOSITORY_TPLS()

Define the list of TPLs, find modules, and classifications for a given TriBITS repository. This macro is typically called from inside of a TPLsList.cmake file for a given TriBITS repo.

Usage:

```
TRIBITS_DEFINE_REPOSITORY_TPLS (
  <tpl0_name>    <tpl0_findmod>  <tpl0_classif>
  <tpl1_name>    <tpl1_findmod>  <tpl1_classif>
  ...
)
```

This macro sets up a 2D array of NumTPLs by NumColumns listing out the TPLs for a TriBITS repository. Each row (with 3 entries) specifies a package which contains the 3 columns (ordered 0-2):

0. **TPL** (<tpli_name>): The name of the TriBITS TPL <TPL_NAME>. This name must be unique across all other TriBITS TPLs in this or any other TriBITS repo that might be combined into a single TriBITS project meta-build. However, a TPL can be redefined (see below). The name should be a valid identifier (e.g. matches the regex `[a-zA-Z_][a-zA-Z0-9_]*`).

1. **FINDMOD** (<tpli_findmod>): The relative path for the find module, usually with the name FindTPL<TPL_NAME>.cmake. This path is relative to the repository base directory. If just the base path for the find module is given, ending with "/" (e.g. "cmake/tpls/") then the find module will be assumed to be under that this directory with the standard name (e.g. cmake/tpls/FindTPL<TPL_NAME>.cmake). A standard way to write a FindTPL<TPL_NAME>.cmake module is to use the function [TRIBITS_TPL_DECLARE_LIBRARIES\(\)](#).
2. **CLASSIFICATION** (<tpl0_classif>): Gives the testing group PT, ST, EX and the maturity level EP, RS, PG, PM, GRS, GPG, GPM, UM. These are separated by a comma with no space in between such as "RS,PT" for a "Research Stable", "Primary Tested" package. No spaces are allowed so that CMake treats this as one field in the array. The maturity level can be left off in which case it is assumed by default to be UM for "Unspecified Maturity".

A TPL defined in an upstream repo can be listed again, which allows redefining the find module that is used to specify the TPL. This allows downstream repos to add additional requirements on a given TPL. However, the downstream repo's find module file must find the TPL components that are fully compatible with the upstream's find module.

This macro just sets the variable:

```
${REPOSITORY_NAME}_TPLS_FINDMODS_CLASSIFICATIONS
```

in the current scope. The advantages of using this macro instead of directly setting this variable include:

- Asserts that the variable `REPOSITORY_NAME` is defined and set
- Avoids having to hard-code the assumed repository name `${REPOSITORY_NAME}`. This provides more flexibility for how other TriBITS project name a given TriBITS repo (i.e. the name of repo subdirs).
- Avoid misspelling the name of the variable `${REPOSITORY_NAME}_TPLS_FINDMODS_CLASSIFICATIONS`. If you misspell the name of the macro, it is an immediate error in CMake.

TRIBITS_DISABLE_PACKAGE_ON_PLATFORMS()

Disable a package automatically for a list of platforms.

Usage:

```
TRIBITS_DISABLE_PACKAGE_ON_PLATFORMS ( <packageName>
    <hosttype0> <hosttype1> ...)
```

If any of the host-type arguments <hosttypei> matches the `${PROJECT_NAME}_HOSTTYPE` variable for the current platform, then package <packageName> test group classification is changed to EX. Changing the package test group classification to EX results in the package being disabled by default. However, an explicit enable can still enable the package.

TRIBITS_INCLUDE_DIRECTORIES()

This function is to override the standard behavior of `include_directories` for a TriBITS package.

Usage:

```
TRIBITS_INCLUDE_DIRECTORIES (
    [REQUIRED_DURING_INSTALLATION_TESTING] <dir0> <dir1> ...
)
```

If specified, `REQUIRED_DURING_INSTALLATION_TESTING` can appear anywhere in the argument list.

This function allows overriding the default behavior for installation testing, to ensure that include directories will not be inadvertently added to the build lines for tests during installation testing. Normally we want the include directories to be handled as cmake usually does. However during TriBITS installation testing we do not want most of the include directories to be used as the majority of the files should come from the installation we are building against. There is an exception to this and that is when there are test only headers that are needed. For that case we allow people to set `REQUIRED_DURING_INSTALLATION_TESTING` to tell us that this include directory does need to be set for installation testing.

TRIBITS_PACKAGE()

Macro called at the very beginning of a package's top-level CMakeLists.txt file.

Usage:

```
TRIBITS_PACKAGE (
  <packageName>
  [ENABLE_SHADOWING_WARNINGS]
  [DISABLE_STRONG_WARNINGS]
  [CLEANED]
  [DISABLE_CIRCULAR_REF_DETECTION_FAILURE]
)
```

See [TRIBITS_PACKAGE_DECL\(\)](#) for the documentation for the arguments and [TRIBITS_PACKAGE_DECL\(\)](#) and [TRIBITS_PACKAGE\(\)](#) for a description the side-effects (and variables set) after calling this macro.

TRIBITS_PACKAGE_DECL()

Macro called at the very beginning of a package's top-level CMakeLists.txt file when a packages has subpackages.

If the package does not have subpackages, just call [TRIBITS_PACKAGE\(\)](#) which calls this macro.

Usage:

```
TRIBITS_PACKAGE_DECL (
  <packageName>
  [ENABLE_SHADOWING_WARNINGS]
  [DISABLE_STRONG_WARNINGS]
  [CLEANED]
  [DISABLE_CIRCULAR_REF_DETECTION_FAILURE]
)
```

The arguments are:

<packageName>

Gives the name of the Package, mostly just for checking and documentation purposes.
 This much match the name of the package provided in the PackagesLists.cmake or it is an error.

ENABLE_SHADOWING_WARNINGS

If specified, then shadowing warnings will be turned on for supported platforms/compilers. The default is for shadowing warnings to be turned off. Note that this can be overridden globally by setting the cache variable `${PROJECT_NAME}_ENABLE_SHADOWING_WARNINGS`.

DISABLE_STRONG_WARNINGS

If specified, then all strong warnings will be turned off, if they are not already turned off by global cache variables. Strong warnings are turned on by default in development mode.

CLEANED

If specified, then warnings will be promoted to errors for all defined warnings.

DISABLE_CIRCULAR_REF_DETECTION_FAILURE

If specified, then the standard grep looking for RCPNode circular references that causes tests to fail will be disabled. Note that if these warnings are being produced then it means that the test is leaking memory and user like may also be leaking memory.

There are several side-effects of calling this macro:

- The the variables listed the packages set of library targets `${PACKAGE_NAME}_LIB_TARGETS` and all targets `${PACKAGE_NAME}_ALL_TARGETS` and are initialized to empty.
- The local variables `PACKAGE_SOURCE_DIR` and `PACKAGE_BINARY_DIR` are set for this package's use in its CMakeLists.txt files.
- Package-specific compiler options are set up in package-scoped (i.e., the package's subdir and its subdirs) in `CMAKE_<LANG>_FLAG`.
- This packages's cmake subdir `${PACKAGE_SOURCE_DIR}/cmake` is added to `CMAKE_MODULE_PATH` locally so that the package's try-compile modules can be read in with just a raw `INCLUDE()` leaving off the full path and the `*.cmake` extension.

TRIBITS_PACKAGE_DEF()

Macro called after subpackages are processed in order to handle the libraries, tests, and examples of the final package.

Usage:

```
TRIBITS_PACKAGE_DEF()
```

If the package does not have subpackages, just call [TRIBITS_PACKAGE\(\)](#) which calls this macro.

This macro has several side effects:

- The variable `PACKAGE_NAME` is set in the local scope for usage by the package's CMakeLists.txt files.
- The intra-package dependency variables (i.e. list of include directoires, list of libraries, etc.) are initialized to empty.

TRIBITS_PACKAGE_POSTPROCESS()

Macro called at the very end of a package's top-level CMakeLists.txt file. This macro performs some critical post-processing activities before downstream packages are processed.

Usage:

```
TRIBITS_PACKAGE_POSTPROCESS()
```

NOTE: It is unfortunate that a packages's CMakeLists.txt file must call this macro but limitations of the CMake language make it necessary to do so.

TRIBITS_PROCESS_SUBPACKAGES()

Macro that processes subpackages for packages that have them. This is called in the parent packages top-level CMakeLists.txt file.

Usage:

```
TRIBITS_PROCESS_SUBPACKAGES()
```

Must be called after [TRIBITS_PACKAGE_DECL\(\)](#) but before [TRIBITS_PACKAGE_DEF\(\)](#).

TRIBITS_PROJECT()

Defines and processes a TriBITS project.

Usage:

```
TRIBITS_PROJECT()
```

Requires that the project name variable `PROJECT_NAME` be defined before calling this macro. Also, all default values for project settings should be set before calling this (see [TriBITS Global Project Settings](#)). Also, the variable `${PROJECT_NAME}_TRIBITS_DIR` must be set as well.

This macro then adds all of the necessary paths to `CMAKE_MODULE_PATH` and then performs all processing of the TriBITS project files (see ???).

ToDo: Give documentation!

TRIBITS_PROJECT_DEFINE_EXTRA_REPOSITORIES()

Declare a set of extra extra repositories for a project (typically in the project's [<projectDir>/cmake/ExtraRepositoriesList.cmake](#) file).

Usage:

```
TRIBITS_PROJECT_DEFINE_EXTRA_REPOSITORIES (
    <repo0_name> <repo0_dir> <repo0_type> <repo0_url> <repo0_packstat> <repo0_classif>
    <repo1_name> <repo1_dir> <repo1_type> <repo1_url> <repo1_packstat> <repo1_classif>
    ...
)
```

This macro takes in a 2D array with 6 columns, where each row defines an extra repository. The 6 columns (ordered 0-5) are:

0. **REPO_NAME** (<repo_i_name>): The name given to the repository `REPOSITORY_NAME`.
1. **REPO_DIR** (<repo_i_dir>): The relative directory for the repository under the project directory `${PROJECT_SOURCE_DIR}` (or <projectDir>). If this is set to empty quoted string " " , then the relative directory name is assumed to be same as the repository name <repo_i_name>.
2. **REPO_TYPE** (<repo_i_type>): The version control (VC) type of the repo. Value choses include `GIT` and `SVN` (i.e. Subversion). *WARNING:* Only VC repos of type `GIT` can fully participate in the TriBITS development tool workflows. The other VC types are supported for basic cloning and updating using the `TribitsCTestDriverCore.cmake` script.
3. **REPO_URL** (<repo_i_url>): The URL of the VC repo. This info is used to initially obtain the repo source code using the VC tool listed in <repo_i_type>. If the repos don't need to be cloned for needed use cases, then this can be the empty quoted string " " .

4. **REPO_PACKSTAT** (<repoi_packstat>): Determines if the VC repository contains any TriBITS packages or if it just provides directories and files. If the VC repo contains TriBITS packages, then this field is set as the empty quoted string "", then this repository is considered to be a [TriBITS Repository](#) and must therefore contain the files described in [TriBITS Repository Core Files](#). If the listed repository is **not** a TriBITS repository, and just provideds directories and packages, then this field is set as NOPACKAGES.
5. **REPO_CLASSIFICATION** (<repoi_classif>): Gives the testing classification of the repository which also happens to be the CTest/CDash testing mode and the default dashboard track. The valid values are Continuous, Nightly, and Experimental. See [TriBITS Package-by-Package CTest/Dash Driver](#) for a detailed description of repository classifications.

This command is used to put together one or more VC and/or TriBITS repositories to construct a larger project. Files that contain this macro call are what is passed in for the option <Project>_EXTRAREPOS_FILE). Repositories with <repoi_packstat>="" are **not** TriBITS Repositories and are technically not considered at all during the basic configuration of the a TriBITS project. They are only listed in this file so that they can be used in the version control logic for tools that perform version control with the repositories (such as cloning, updating, looking for changed files, etc.).

NOTE: These repositories must be listed in the order of package dependencies. That is, all of the packages listed in repository *i* must have upstream TPL and SE package dependencies listed before this package in this repository or in upstream repositories *i-1*, *i-2*, etc.

NOTE: This module just sets the local variable:

```
${PROJECT_NAME}_EXTRAREPOS_DIR_REPOTYPE_REPOURL_PACKSTAT_CATEGORY
```

in the current scope. The advantages of using this macro instead of directly setting this variable include:

- Asserts that the variable PROJECT_NAME is defined and set.
- Avoids having to hard-code the assumed project name \${PROJECT_NAME}. This provides more flexibility for how other TriBITS project name a given TriBITS repo (i.e. the name of repo subdirs).
- Avoid misspelling the name of the variable
\${PROJECT_NAME}_EXTRAREPOS_DIR_REPOTYPE_REPOURL_PACKSTAT_CATEGORY. If you misspell the name of the macro, it is an immediate error in CMake.

TRIBITS_SET_ST_FOR_DEV_MODE()

Function that allows packages to easily make a feature ST for development builds and PT for release builds by default.

Usage:

```
TRIBITS_SET_ST_FOR_DEV_MODE(<outputVar>)
```

\${<outputVar>} is set to ON or OFF based on the configure state. In development mode (i.e. \${PROJECT_NAME}_ENABLE_DEVELOPMENT_MODE==ON), \${<outputVar>} will be set to ON only if ST code is enabled (i.e. \${PROJECT_NAME}_ENABLE_SECONDARY_TESTED_CODE==ON), otherwise it is set to OFF. In release mode (i.e. \${PROJECT_NAME}_ENABLE_DEVELOPMENT_MODE==OFF) it is always set to ON. This allows some sections of a TriBITS package to be considered ST for development mode reducing testing time which includes only PT code., while still having important functionality available to users by default in a release.

TRIBITS_SUBPACKAGE()

Declare a subpackage.

Usage:

TRIBITS_SUBPACKAGE (<spkgName>)

Once called, the following local variables are in scope:

PARENT_PACKAGE_NAME

The name of the parent package.

SUBPACKAGE_NAME

The local name of the subpackage (does not contain the parent package name).

SUBPACKAGE_FULLNAME

The full project-level name of the subpackage (which includes the parent package name at the beginning).

PACKAGE_NAME

Inside the subpackage, the same as SUBPACKAGE_FULLNAME.

TRIBITS_SUBPACKAGE_POSTPROCESS()

Postprocess after defining a subpackage.

Usage:

```
TRIBITS_SUBPACKAGE_POSTPROCESS ()
```

NOTE: It is unfortunate that a Subpackages's CMakeLists.txt file must call this macro but limitations of the CMake language make it necessary to do so.

TRIBITS_TPL_DECLARE_LIBRARIES()

Function that sets up cache variables for users to specify where to find a TPL's headers and libraries. This function is typically called inside of a file FindTPL<tpl_name>.cmake file.

Usage:

```
TRIBITS_TPL_DECLARE_LIBRARIES (
  <tpl_name>
  [REQUIRED_HEADERS <header1> <header2> ...]
  [MUST_FIND_ALL_HEADERS]
  [REQUIRED_LIBS_NAMES <libname1> <libname2> ...]
  [MUST_FIND_ALL_LIBS]
  [NO_PRINT_ENABLE_SUCCESS_FAIL]
)
```

This function can set up a with header files and/or libraries.

The input arguments to this function are:

- <tpl_name>: Name of the TPL that is listed in a TPLsList.cmake file. Below, this is referred to as the local CMake variable TPL_NAME.
- REQUIRED_HEADERS: List of header files that are searched for the TPL using FIND_PATH().
- MUST_FIND_ALL_HEADERS: If set, then all of the header files listed in REQUIRED_HEADERS must be found in order for TPL_\${TPL_NAME}_INCLUDE_DIRS to be defined.
- REQUIRED_LIBS_NAMES: List of libraries that are searched for when looked for the TPLs libraries with FIND_LIBRARY(...).

- **MUST_FIND_ALL_LIBS:** If set, then all of the library files listed in `REQUIRED_LIBS_NAMES` must be found or the TPL is considered not found!
- **NO_PRINT_ENABLE_SUCCESS_FAIL:** If set, then the final success/fail will not be printed

The following cache variables, if set, will be used by that this function:

- `${TPL_NAME}_INCLUDE_DIRS:PATH`: List of paths to search first for header files defined in `REQUIRED_HEADERS`.
- `${TPL_NAME}_INCLUDE_NAMES:STIRNG`: List of include names to be looked for instead of what is specified in `REQUIRED_HEADERS`.
- `${TPL_NAME}_LIBRARY_DIRS:PATH`: The list of directories to search first for libraies defined in `REQUIRED_LIBS_NAMES`.
- `${TPL_NAME}_LIBRARY_NAMES:STIRNG`: List of library names to be looked for instead of what is specified in `REQUIRED_LIBS_NAMES`.

This function sets global variables to return state so it can be called from anywhere in the call stack. The following cache variables defined that are intended for the user to set and/or use:

- `TPL_${TPL_NAME}_INCLUDE_DIRS`: A list of common-separated full directory paths that contain the TPLs headers. If this variable is set before calling this function, then no headers are searched for and this variable will be assumed to have the correct list of header paths.
- `TPL_${TPL_NAME}_LIBRARIES`: A list of commons-seprated full library names (output from `FIND_LIBRARY(...)`) for all of the libraries found for the TPL. IF this variable is set before calling this function, no libraries are searched for and this varaible will be assumed to have the correct list of libraries to link to.

TRIBITS_WRITE_FLEXIBLE_PACKAGE_CLIENT_EXPORT_FILES()

Utility function for writing `${PACKAGE_NAME}Config.cmake` and/or the `Makefile.export.${PACKAGE_NAME}` for package `PACKAGE_NAME` with some greater flexibility than `TRIBITS_WRITE_PACKAGE_CLIENT_EXPORT_FILES()`

Usage:

```
TRIBITS_WRITE_FLEXIBLE_PACKAGE_CLIENT_EXPORT_FILES (
  PACKAGE_NAME <packageName>
  [EXPORT_FILE_VAR_PREFIX <exportFileVarPrefix>]
  [WRITE_CMAKE_CONFIG_FILE <cmakeConfigFileFullPath>]
  [WRITE_EXPORT_MAKLEFILE <exportMakefileFileFullPath>]
  [WRITE_INSTALL_CMAKE_CONFIG_FILE]
  [WRITE_INSTALL_EXPORT_MAKLEFILE]
)
```

The arguments are:

`PACKAGE_NAME <packageName>`

 Gives the name of the TriBITS package for which the export files should be created for.

`EXPORT_FILE_VAR_PREFIX <exportFileVarPrefix>`

 If specified, then all of the variables in the generated export files will be prefixed with “<exportFileVarPrefix>_” instead of “\${PACKAGE_NAME}_”. This is to provide flexibility.

`WRITE_CMAKE_CONFIG_FILE <cmakeConfigFileFullPath>`

If specified, then the package <packageName>'s cmake configure export file for external CMake client projects will be created in the file <cmakeConfigFileFullPath>. NOTE: the argument should be the full path!

```
WRITE_EXPORT_MAKLEFILE <exportMakefileFileFullPath>
```

If specified, then the package <packageName>'s cmake configure export file for external Makefile client projects will be created in the file <exportMakefileFileFullPath>. NOTE: the argument should be the full path!

```
WRITE_INSTALL_CMAKE_CONFIG_FILE
```

If specified, then the package <packageName>'s install cmake configure export to be installed will be written. The name and location of this file is hard-coded.

```
WRITE_INSTALL_EXPORT_MAKLEFILE
```

If specified, then the package <packageName>'s install export makefile to be installed will be written. The name and location of this file is hard-coded.

NOTE: The arguments to this function may look strange but the motivation is to support very speicalized use cases such as when a TriBITS package needs to generate an export makefile for a given package but name the export makefile differently and use different variable name prefixes. The particular driver use case is when wrapping an external autotools project that depends on Trilinos and needs to read in the Makefile.export.Trilinos file but this file needs to be generated for a subset of enabled packages on the fly during a one-pass configure.

NOTE: This function does *not* contain the the INSTALL() commands because CMake will not allow those to even be present in scripting mode that is used for unit testing this function.

12.3 General Utility Macros and Functions

The following subsections give detailed documentation for some CMake macros and functions which are *not* a core part of the TriBITS system but are included in the TriBITS system that are used inside of the TriBITS system and are provided as a convenience to TriBITS project developers. One will see many of these functions and macros used throughout the implementation of TriBITS and even in the CMakeLists.txt files for projects that use TriBITS.

These macros and functions are *not* prefixed with TRIBITS_. There is really not a large risk to defining and using these non-namespaces utility functions and macros. It turns out that CMake allows you to redefine any macro or function, even built-in ones, inside of your project so even if CMake did add new comamnds that clashed with these names, there would be no conflict. When overriding a built-in command `some_builtin_command()`, you can always access the original built-in command as `_some_builtin_command()`.

ADD_SUBDIRECTORIES()

Macro that adds a list of subdirectories all at once (removed boiler-plate code).

Usage:

```
ADD_SUBDIRECTORIES(<dir1> <dir2> ...)
```

ADVANCED_OPTION()

Macro that sets an option and marks it as advanced (removes boiler-plate and duplication).

Usage:

```
ADVANCED_OPTION(<varName> [other arguments])
```

This is identical to:

```
ADVANCED_OPTION(<varName> [other arguments])
MARK_AS_ADVANCED(<varName>)
```

ADVANCED_SET()

Macro that sets a variable and marks it as advanced (removes boiler-plate and duplication).

Usage:

```
ADVANCED_SET(<varName> [other arguments])
```

This is identical to:

```
ADVANCED_SET(<varName> [other arguments])  
MARK_AS_ADVANCED(<varName>)
```

APPEND_CMNDLINE_ARGS()

Utility function that appends command-line arguments to a variable of command-line options.

Usage:

```
APPEND_CMNDLINE_ARGS(<var> "<extraArgs>")
```

This function just appends the command-line arguments in the string "<extraArgs>" but does not add an extra space if <var> is empty on input.

APPEND_GLOB()

Utility macro that does a `FILE (GLOB ...)` and appends to an existing list (removes boiler-plate code).

Usage:

```
APPEND_GLOB(<fileListVar> <glob0> <glob1> ...)
```

On output, <fileListVar> will have the list of glob files appended.

APPEND_GLOBAL_SET()

Utility macro that appends arguments to a global variable (reduces boiler-plate code and mistakes).

Usage:

```
APPEND_GLOBAL_SET(<varName> <arg0> <arg1> ...)
```

NOTE: The variable <varName> must exist before calling this function. To set it empty initially use [GLOBAL_NULL_SET\(\)](#).

APPEND_SET()

Utility function to append elements to a variable (reduces boiler-plate code).

Usage:

```
APPEND_SET(<varName> <arg0> <arg1> ...)
```

Just calls:

```
LIST(APPEND <varName> <arg0> <arg1> ...)
```

APPEND_STRING_VAR()

Append strings to an existing string variable (reduces boiler-plate code and reduces mistakes).

Usage:

```
APPEND_STRING_VAR (<stringVar> "<string1>" "<string2>" ...)
```

Note that the usage of the characters ' [, '] ' , ' { , ' } ' are taken by CMake to bypass the meaning of ';' to separate string characters.

If you want to ignore the meaning of these special characters and are okay with just adding one string at a time use [APPEND_STRING_VAR_EXT\(\)](#).

APPEND_STRING_VAR_EXT()

Append a single string to an existing string variable, ignoring ';' (reduces boiler-plate code and reduces mistakes).

Usage:

```
APPEND_STRING_VAR_EXT (<stringVar> "<string>")
```

Simply sets `<stringVar> = "${<stringVar>}<string>"`.

APPEND_STRING_VAR_WITH_SEP()

Append strings to a given string variable, joining them using a separator.

Usage:

```
APPEND_STRING_VAR_WITH_SEP (<stringVar> "<sepStr>" "<str0>" "<str>" ...)
```

Each of the strings `<stri>` are appended to `<stringVar>` using the separation string `<sepStr>`.

ASSERT_DEFINED()

Assert that a variable is defined and if not call `MESSAGE (SEND_ERROR ...)`.

Usage:

```
ASSERT_DEFINED (<varName>)
```

This is used to get around the problem of CMake not asserting the defreferencing of undefined variables. For example, how do you know if you did not misspell the name of a variable in an if statement like:

```
IF (SOME_VARIABLE)
...
ENDIF ()
```

? If you misspelled the variable `SOME_VARIABLE` (which you likely did in this case), the the if statement will always be false. To avoid this problem when you always expect the explicitly set, instead do:

```
ASSERT_DEFINED (SOME_VARIABLE)
IF (SOME_VARIABLE)
...
ENDIF ()
```

Now if you misspell the variable, it will asset and stop processing. This is not a perfect solution since you can misspell the variable name in the following if statemnt but typically you would always just copy and paste between the two statements so they are always the same. This is the best we can do in CMake unfortunately.

COMBINED_OPTION()

Set up a bool cache variable (i.e. an option) based on a set of dependent options.

Usage:

```
COMBINED_OPTION( <combinedOptionName>
  DEP_OPTIONS_NAMES <depOpName0> <depOptName1> ...
  DOCSTR "<docstr0>" "<docstr1>" ...
)
```

This sets up a bool cache variable `<combinedOptionName>` which is defaulted to ON if all of the listed dependent option variables `<depOpName0>`, `<depOptName1>`, ... are all ON. However, if `<combinedOptionName>` is set to ON by the user and not all of the dependent option variables are also true, this results in a fatal error and all processing stops.

This is used by a CMake project to by default automatically turn on a feature that requires a set of other features to also be turned on but allows a user to disable the feature if desired.

CONCAT_STRINGS()

Concatenate a set of string arguments.

Usage:

```
CONCAT_STRINGS(<outputVar> "<str0>" "<str1>" ...)
```

On output, `<outputVar>` is set to `"<str0><str1>..."`.

DUAL_SCOPE_APPEND_CMNDLINE_ARGS()

Utility function that appends command-line arguments to a variable of command-line options and sets the result in current scope and parent scope.

Usage:

```
DUAL_SCOPE_APPEND_CMNDLINE_ARGS(<var> "<extraArgs>")
```

Just calls [APPEND_CMNDLINE_ARGS\(\)](#) and then `SET(<var> ${<var>} PARENT_SCOPE)`.

DUAL_SCOPE_PREPEND_CMNDLINE_ARGS()

Utility function that prepends command-line arguments to a variable of command-line options and sets the result in current scope and parent scope.

Usage:

```
DUAL_SCOPE_PREPEND_CMNDLINE_ARGS(<var> "<extraArgs>")
```

Just calls [PREPEND_CMNDLINE_ARGS\(\)](#) and then `SET(<var> ${<var>} PARENT_SCOPE)`.

DUAL_SCOPE_SET()

Macro that sets a variable name both in the current scope and the parent scope.

Usage:

```
DUAL_SCOPE_SET(<varName> [other args])
```

It turns out that when you call `ADD_SUBDIRECTORY(<someDir>)` or enter a `FUNCTION` that `CMake` actually creates a copy of all of the regular non-cache variables in the current scope in order to create a new set of variables for the `CMakeLists.txt` file in `<someDir>`. This means that if you call `SET(SOMEVAR Blah PARENT_SCOPE)` that it will not affect the value of `SOMEVAR` in the current scope. This macro therefore is designed to set the value of the variable in the current scope and the parent scope in one shot to avoid confusion.

Global variables are different. When you move to a subordinate `CMakeLists.txt` file or enter a function, a local copy of the variable is *not* created. If you set the value name locally, it will shadow the global variable. However, if you set the global value with `SET(SOMEVAR someValue CACHE INTERNAL "")`, then the value will get changed in the current subordinate scope and in all parent scopes all in one shot!

GLOBAL_NULL_SET()

Set a variable as a null internal global (cache) variable (removes boiler plate).

Usage:

```
GLOBAL_NULL_SET(<varName>)
```

This just calls:

```
SET(<varName> "" CACHE INTERNAL "")
```

GLOBAL_SET()

Set a variable as an internal global (cache) variable (removes boiler plate).

Usage:

```
GLOBAL_SET(<varName> [other args])
```

This just calls:

```
SET(<varName> [other args] CACHE INTERNAL "")
```

JOIN()

Join a set of strings into a single string using a join string.

Usage:

```
JOIN(<outputStrVar> <sepStr> <quoteElements>
    "<string0>" "<string1>" ...)
```

Arguments:

`<outputStrVar>`

The name of a variable that will hold the output string.

`<sepStr>`

A string to use to join the list of strings.

`<quoteElements>`

If TRUE, then each `<stringi>` is quoted using an escaped quote char `\`. If FALSE then no escaped quote is used.

On output the variable `<outputStrVar>` is set to:

```
"<string0><sepStr><string1><sepStr>..."
```

If `<quoteElements>=TRUE`, then it is set to:

```
"\"<string0>\"<sepStr>\"<string1>\"<sepStr>..."
```

For example, the latter can be used to set up a set of command-line arguments given a CMake array like:

```
JOIN(CMND_LINE_ARGS " " TRUE ${CMND_LINE_ARRAY})
```

WARNING: Be careful to quote string arguments that have spaces because CMake interprets those as array boundaries.

MESSAGE_WRAPPER()

Function that wraps the standard CMake/CTest `MESSAGE()` function call in order to allow unit testing to intercept the call.

Usage:

```
MESSAGE_WRAPPER(<arg0> <arg1> ...)
```

This function takes exactly the same arguments as built-in `MESSAGE()`. When the variable `MESSAGE_WRAPPER_UNIT_TEST_MODE` is set to `TRUE`, then this function will not call `MESSAGE(<arg0> <arg1> ...)` but instead will prepend set to global variable `MESSAGE_WRAPPER_INPUT` that input arguments. To capture just this call's input, first call `GLOBAL_NULL_SET(MESSAGE_WRAPPER_INPUT(MESSAGE_WRAPPER_INPUT))` before calling this function.

This function allows one to unit test other user-defined CMake macros and functions that call this to catch error conditions without stopping the CMake program. Otherwise, this is used to capture print messages to verify that they say the right thing.

MULTILINE_SET()

Function to set a single string by concatenating a list of separate strings

Usage:

```
MULTILINE_SET(<outputStrVar>  
  "<string0>"  
  "<string1>"  
  ...  
)
```

On output, the local variable `<outputStrVar>` is set to:

```
"<string0><string1>..."
```

The purpose of this is to make it easier to set longer strings without going too far to the right.

PARSE_ARGUMENTS()

Parse a set of macro/function input arguments into different lists. This allows the easy implementation of keyword-based user-defined macros and functions.

Usage:

```

PARSE_ARGUMENTS (
  <prefix>  <argNamesList>  <optionNamesList>
  <inputArgsList>
)

```

Arguments to this macro:

<prefix>

Prefix <prefix>_ added the list and option variables created listed in <argNamesList> and <optionNamesList>.

<argNamesList>

Quoted array of list arguments (e.g. "<argName0>;<argName1>;..."). For each variable name <argNamei>, a local variable will be created in the current scope with the name <prefix>_<argNamei> which gives the list of variables parsed out of <inputArgsList>.

<optionNamesList>

Quoted array of list arguments (e.g. "<optName0>;<optName1>;..."). For each variable name <optNamei>, a local variable will be created in the current scope with the name <prefix>_<optNamei> that is either set to TRUE or FALSE depending if <optNamei> appears in <inputArgsList> or not.

<inputArgsList>

List of arguments keyword-based arguments passed in for the outer macro or function to be parsed out into the different argument and option lists.

What this macro does is very simple yet very useful. What it does is to allow you to create your own user-defined keyword-based macros and functions like is used by some built-in CMake commands..

For example, consider the following user-defined macro that uses both positional and keyword-based arguments using PARSE_ARGUMENTS():

```

MACRO (PARSE_SPECIAL_VARS  BASE_NAME)

  PARSE_ARGUMENTS (
    #prefix
    ${BASE_NAME}
    #lists
    "ARG0;ARG1;ARG2"
    #options
    "OPT0;OPT1"
    ${ARGN}
  )

ENDMACRO ()

```

Calling this macro as:

```

PARSE_SPECIAL_VARS (MyVar ARG0 a b ARG2 c OPT1)

```

sets the following variables in the current scope:

```

MyVar_ARG0="a;b"
MyVar_ARG1=""
MyVar_ARG2="c"
MyVar_OPT0="FALSE"
MyVar_OPT1="TRUE"

```


This allows you to define user-defined macros and functions that have a mixture of positional arguments and keyword-based arguments like you can do in other languages. The keyword-based arguments can be passed in any order and those that are missing are empty (or false) by default.

Any initial arguments that are not recognised as `<argNamesList>` or `<optionNamesList>` keyword arguments will be put into the local variable `<prefix>_DEFAULT_ARGS`. If no arguments in `${ARGN}` match any in `<argNamesList>`, then all non-option arguments are point into `<prefix>_DEFAULT_ARGS`. For example, if you pass in:

```
PARSE_SPECIAL_VARS (MyVar ARG5 a b c)
```

you will get:

```
MyVar_DEFAULT_ARGS="a;b;c"
MyVar_ARG0=""
MyVar_ARG1=""
MyVar_ARG2=""
MyVar_OPT0="FALSE"
MyVar_OPT1="FALSE"
```

Multiple occurrences of keyword arguments in `${ARGN}` is allowed but only the last one listed will be recored. For example, if you call:

```
PARSE_SPECIAL_VARS (MyVar ARG1 a b ARG1 c)
```

then this wil set:

```
MyVar_ARG0=""
MyVar_ARG1="c"
MyVar_ARG2=""
MyVar_OPT0="FALSE"
MyVar_OPT1="FALSE"
```

This is actually consistent with the way that most arugment list parsers behave with respect to multiple instances of the same argument so hopefully this will not be a surprise to anyone.

If you put an option keyword in the middle of a keyword argument list, the option keyword will get pulled out of the list. For exmaple, if you call:

```
PARSE_SPECIAL_VARS (MyVar ARG0 a OPT0 c)
```

then this wil set:

```
MyVar_ARG0="a;c"
MyVar_ARG1=""
MyVar_ARG2=""
MyVar_OPT0="TRUE"
MyVar_OPT1="FALSE"
```

If `PARSE_ARGUMENTS_DUMP_OUTPUT_ENABLED` ``is set to ``TRUE, then a bunch of detailed debug info will be printed. This should only lbe used in the most desparate of debug situations because it will print a *lot* of output!

PERFORMANCE: This function will scale as:

```
O( (len(<argNamesList>) * len(<optionNamesList>)) * len(<inputArgsList>) )
```

Therefore, this could scale very badly for large lests of argument and option names and input argument lists.

PREPEND_CMNDLINE_ARGS()

Utility function that prepends command-line arguments to a variable of command-line options.

Usage:

```
PREPEND_CMNDLINE_ARGS (<var> "<extraArgs>")
```

This function just prepends the command-line arguments in the string "<extraArgs>" but does not add an extra space if <var> is empty on input.

PREPEND_GLOBAL_SET()

Utility macro that prepends arguments to a global variable (reduces boiler-plate code and mistakes).

Usage:

```
PREPEND_GLOBAL_SET (<varName> <arg0> <arg1> ...)
```

NOTE: The variable <varName> must exist before calling this function. To set it empty initially use [GLOBAL_NULL_SET\(\)](#).

APPEND_SET()

Utility function to append elements to a variable (reduces boiler-plate code).

Usage:

```
APPEND_SET (<varName> <arg0> <arg1> ...)
```

Just calls:

```
LIST (APPEND <varName> <arg0> <arg1> ...)
```

PRINT_NONEMPTY_VAR()

Print a defined variable giving its name then value only if it is not empty.

Usage:

```
PRINT_NONEMPTY_VAR (<varName>)
```

Calls `PRINT_VAR (<varName>)` if `${<varName>}` is not empty.

PRINT_VAR()

Unconditionally print a variable giving its name then value.

Usage:

```
PRINT_VAR (<varName>)
```

This prints:

```
MESSAGE ("-- " "${VARIABLE_NAME}='${${VARIABLE_NAME}}' ")
```

The variable <varName> can be defined or undefined or empty. This uses an explicit "-- " line prefix so that it prints nice even on Windows CMake.

REMOVE_GLOBAL_DUPLICATES()

Remove duplicate elements from a global list variable.

Usage:

```
REMOVE_GLOBAL_DUPLICATES (<globalVarName>)
```

This function is necessary in order to preserve the “global” nature of the variable. If you just call `LIST(REMOVE_DUPLICATES ...)` it will actually create a local variable of the same name and shadow the global variable! That is a fun bug to track down!

SET_AND_INC_DIRS()

Set a variable to an include dir and call `INCLUDE_DIRECTORIES ()` (removes boiler plate).

Usage:

```
SET_AND_INC_DIRS(<dirVarName> <includeDir>)
```

On output, this justs `<dirVarName>` to `<includeDir>` in the local scope and calls `INCLUDE_DIRECTORIES (<includeDir>)`.

SET_CACHE_ON_OFF_EMPTY()

Usage:

```
SET_CACHE_ON_OFF_EMPTY(<varName> <initialVal> "<docString>" [FORCE])
```

Sets a special string cache variable with possible values “”, “ON”, or “OFF”. This results in a nice dropdown box in the CMake cache manipulation GUIs.

SET_DEFAULT()

Give a local variable a default if a non-empty value is not already set.

Usage:

```
SET_DEFAULT(<varName> <arg0> <arg1> ...)
```

If on input `"${<varName>}"` `=="`, then `<varName>` is set to the given default. Otherwise, the existing non-empty value is preserved.

SET_DEFAULT_AND_FROM_ENV()

Set a default value for a local variable and override from an env var of the same name if it is set.

Usage:

```
SET_DEFAULT_AND_FROM_ENV(<varName> <defaultVal>)
```

First calls `SET_DEFAULT(<varName> <defaultVal>)` and then looks for an environment variable named `<varName>` and if non-empty, then overrides the value of `<varName>`.

This macro is primarily used in CTest code to provide a way to pass in the value of CMake variables. Older versions of `ctest` did not support the option `-D <var>:<type>=<value>` to allow variables to be set through the commandline like `cmake` always allowed.

SPLIT()

Split a string variable into a string array/list variable.

Usage:

```
SPLIT ("<inputStr>" "<sepStr>" <outputStrListVar>)
```

The `<sepStr>` string is used with `STRING (REGEX . . .)` to replace all occurrences of `<sepStr>` in ```<inputStr>` with “;” and writing into `<outputStrListVar>`.

WARNING: `<sepStr>` is interpreted as a regular expression so keep that in mind when considering special regex chars like `'*'`, `'.'`, etc!

TIMER_GET_RAW_SECONDS()

Return the raw time in seconds since epoch, i.e., since 1970-01-01 00:00:00 UTC.

Usage:

```
TIMER_GET_RAW_SECONDS (<rawSecondsVar>)
```

This function is used along with [TIMER_GET_REL_SECONDS\(\)](#), and [TIMER_PRINT_REL_TIME\(\)](#) to time big chunks of CMake code for timing and profiling purposes. See [TIMER_PRINT_REL_TIME\(\)](#) for more details and an example.

NOTE: This function runs an external process to run the `date` command. Therefore, it only works on Unix/Linux type systems that have a standard `date` command. Since this runs an external process, this function should only be used to time very course grained operations (i.e. that take longer than a second).

TIMER_GET_REL_SECONDS()

Return the relative time between start and stop seconds.

Usage:

```
TIMER_GET_REL_SECONDS (<startSeconds> <endSeconds> <relSecondsOutVar>)
```

This simple function computes the relative number of seconds between `<startSeconds>` and `<endSeconds>` (i.e. from [TIMER_GET_RAW_SECONDS\(\)](#)) and sets the result in the local variable `<relSecondsOutVar>`.

TIMER_PRINT_REL_TIME()

Print the relative time between start and stop timers in `<min>m<sec>s` format.

Usage:

```
TIMER_PRINT_REL_TIME(<startSeconds> <endSeconds> "<messageStr>")
```

Differences the raw times `<startSeconds>` and `<endSeconds>` (i.e. gotten from [TIMER_GET_RAW_SECONDS\(\)](#)) and prints the time in `<min>m<sec>s` format. This can only resolve times a second or greater apart. If the start and end times are less than a second then `0m0s` will be printed.

This is meant to be used with [TIMER_GET_RAW_SECONDS\(\)](#) to time expensive blocks of CMake code like:

```
TIMER_GET_RAW_SECONDS (REAL_EXPENSIVE_START)

REAL_EXPENSIVE (...)

TIMER_GET_RAW_SECONDS (REAL_EXPENSIVE_END)

TIMER_PRINT_REL_TIME (${REAL_EXPENSIVE_START} ${REAL_EXPENSIVE_END}
    "REAL_EXPENSIVE() time")
```

This will print something like:

```
REAL_EXPENSIVE() time: 0m5s
```

Again, don't try to time something that takes less than 1 second as it will be recored as 0m0s.

UNITTEST_COMPARE_CONST()

Perform a single unit test equality check and update overall test statistics

Usage:

```
UNITTEST_COMPARE_CONST(<varName> <expectedValue>)
```

If `${<varName>} == <expectedValue>`, then the check passes, otherwise it fails. This prints the variable name and values and shows the test result.

This updates the global variables `UNITTEST_OVERALL_NUMRUN`, `UNITTEST_OVERALL_NUMPASSED`, and `UNITTEST_OVERALL_PASS` which are used by the unit test harness system to assess overall pass/fail.

UNITTEST_STRING_REGEX()

Perform a series regexes of given strings and update overall test statistics.

Usage:

```
UNITTEST_STRING_REGEX(
    <inputString>
    REGEX_STRINGS <str0> <str1> ...
)
```

If the `<inputString>` matches all of the of the regexs `<str0>`, "`<str1>`", ..., then the test passes. Otherwise it fails.

This updates the global variables `UNITTEST_OVERALL_NUMRUN`, `UNITTEST_OVERALL_NUMPASSED`, and `UNITTEST_OVERALL_PASS` which are used by the unit test harness system to assess overall pass/fail.

UNITTEST_FILE_REGEX()

Perform a series regexes of given strings and update overall test statistics.

Usage:

```
UNITTEST_FILE_REGEX(
    <inputFileName>
    REGEX_STRINGS <str1> <str2> ...
)
```

The contents of `<inputFileName>` are read into a string and then passed to [UNITTEST_STRING_REGEX\(\)](#) to assess pass/fail.

UNITTEST_FINAL_RESULT()

Print final statistics from all tests and assert final pass/fail

Usage:

```
UNITTEST_FINAL_RESULT(<expectedNumPassed>)
```

If `${UNITTEST_OVERALL_PASS}==TRUE` and `${UNITTEST_OVERALL_NUMPASSED} == <expectedNumPassed>`, then the overall test program is determined to have passed and string:

```
"Final UnitTests Result: PASSED"
```

is printed. Otherwise, the overall test program is determined to have failed, the string:

```
"Final UnitTests Result: FAILED"
```

is printed and `MESSAGE(SEND_ERROR "FAIL")` is called.

The reason that we require passing in the expected number of passed tests is an extra precaution to make sure that important unit tests are not left out. CMake is a loosely typed language and it pays to be a little paranoid.

13 Appendix

13.1 History of TriBITS

TriBITS started development in November 2007 as a set of helper macros to provide a CMake build system for a small subset of packages in Trilinos. The initial goal was to just to support a native Windows build (using Visual C++) to compile and install these few Trilinos packages on Windows for usage by another project (the Sandia Titan project which included VTK). At that time, Trilinos was using a highly customized autotools build system. Initially, this CMake system was just a set of macros to streamline creating executables and tests. Some of the conventions started in that early effort (e.g. naming conventions of variables and macros where functions use upper case like old FORTRAN and variables are mixed case) were continued in later efforts and are reflected in the current. Then, starting in early 2008, a more detailed evaluation was performed to see if Trilinos should stitch over to CMake as the default (and soon only) supported build and test system (see “Why CMake?” in [TriBITS Overview](#)). This led to the initial implementation of a scale-able package-based architecture (PackageArch) for the Trilinos CMake project in late 2008. This Trilinos CMake PackageArch system evolved over the next few years with development in the system slowing into 2010. This Trilinos CMake build system was then adopted as the build infrastructure for the CASL VERA effort in 2011 where CASL VERA packages were treated as add-on Trilinos packages (see Section [Multi-Repository Support](#)). Over the next year, there was significant development of the system to support larger multi-repo projects in support of CASL VERA. That led to the decision to formally generalize the Trilinos CMake PackageArch build system outside of Trilinos and the name TriBITS was formally adopted in November 2011. Work to refactor the Trilinos CMake system into a general reusable stand-alone CMake-based build system started in October 2011 and an initial implementation was complete in December 2011 when it was used for the CASL VERA build system. In early 2012, the ORNL CASL-related projects Denovo and SCALE (see [\[SCALE\]](#)) adopted TriBITS as their native development build systems. Shortly after TriBITS was adopted the native build system for the the CASL-related University of Michigan code MPACT. In addition to being used in CASL, all of these codes also had a significant life outside of CASL. Because they used the same TriBITS build system, it proved relatively easy to keep these various codes integrated together in the CASL VERA code meta-build. At the same time, TriBITS well served the independent development teams and non-CASL projects independent from CASL VERA. Since the initial extraction of TriBITS from Trilinos, the TriBITS system was further extended and refined, driven by CASL VERA development and expansion. Independently, an early version of TriBITS from 2012 was adopted by the LiveV project [footnote{https://github.com/lifev/cmake}](https://github.com/lifev/cmake) which was forked and extended independently.

Note that a TriBITS “Package” is not the same thing as a “Package” in raw CMake terminology. In raw CMake, a “Package” is some externally provided bit of software or other utility for which the current CMake project has an optional or required dependency. Therefore, a raw CMake “Package” actually maps to a [TriBITS TPL](#). A raw

CMake “Package” (e.g. Boost, CUDA, etc.) can be found using a standard CMake find module `Find<rawPackageName>.cmake` using the built-in command `FIND_PACKAGE(<rawPackageName>)`. It is unfortunate that the TriBITS and the raw CMake definitions of the term “Package” are not the same. However, the term “Package” was coined by the Trilinos project long ago before CMake was adopted as the Trilinos build system and Trilinos’ definition of “Package” (going back to 1998) pre-dates the development of CMake and therefore dictated the terminology of TriBITS

13.2 Design Considerations for TriBITS

ToDo: Discuss design requirements.

ToDo: Discuss why it is a good idea to explicitly list packages instead of just searching for them.

13.3 checkin-test.py --help

ToDo: Include output from `checkin-test --help`

13.4 egdist --help

ToDo: Include output from `egdist --help`