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# 第一章

Why CMake?

为什么使用CMake？

If you have ever maintained the build and installation process for a software package, you will be interested in CMake. CMake is an open source build manager for software projects that allows developers to specify build parameters in a simple portable text ﬁle format. This ﬁle is then used by CMake to generate project ﬁles for native build tools including Integrated Development Environments such as Microsoft Visual Studio or Apple’s Xcode, as well as UNIX, Linux, NMake, and Borland style Makeﬁles. CMake handles the difﬁcult aspects of building software such as cross platform builds, system introspection, and user customized builds, in a simple manner that allows users to easily tailor builds for complex hardware and software systems.

如果你曾经维护过软件包的构建和安装过程，你就会对CMake感兴趣。CMake是一个开源的软件工程的构建管理工具，它允许开发者在一个可移植的文本格式的文件中指定构建参数。CMake使用这个文件生成使用开发环境中集成的本地构建工具的工程文件，比如微软的Visual Studio或者苹果的Xcode，在UNIX，Linux系统中，生成NMake，Borland风格的Makefile文件。CMake处理构建软件中复杂的部分比如（跨平台构建 （交叉编译）），系统内省，和定制构建，只用简单的操作就可以方便用户剪裁对应复杂硬件和软件系统的构建。

For any project, and especially cross platform projects, there is a need for a uniﬁed build system. Many projects today ship with both a UNIX Makeﬁle (or Makeﬁle.in) and a Microsoﬁ Visual Studio workspace. This requires that developers constantly try to keep both build systems up to date and consistent with each other. To target additional build systems such as Borland or Xcode requires even more custom copies of these ﬁles, creating an even bigger problem. This problem is compounded if you try to support optional components, such as including JPEG support if libjpeg is available on the system. CMake solves this by consolidating these different operations into one simple easy to understand ﬁle format.

对于任意工程，特别是跨平台工程，需要一个统一的构建系统。现在，许多工程都提供UNIX Makefile和微软Visual Studio构建环境。这就需要开发人员持续维护更新两套构建系统并使它们保持一致。如果要添加对应Borland或者Xcode的构建系统，就需要修改更多的文件，这将会产生更多的问题。如果要支持可选的组件，比如如果系统有libjpeg库，就包含JPEG，这将会使得问题变得更加复杂。CMake通过将这些不同的操作编写到一个易于理解的文件中解决这个问题。

If you have multiple developers working on a project, or multiple target platforms, then the software will have to be built on more than one computer. Given the wide range of installed software and custom options that are involved with setting up a modern computer, the chances are that two computers running the same OS will be slightly different. CMake provides many beneﬁts for single platform multi-machine development environments including:

如果你的工程有多个开发人员，或者多个目标平台，那么你的软件会在不止一台电脑上构建。因为不同的电脑安装的软件不同，配置不同，那么不同的电脑运行相同的操作系统也会有些许不同，CMake对于这种单一平台多个电脑的运行环境提供一些帮助。这包括：

* The ability to automatically search for programs, libraries, and header files that may be required by the software being built. This includes the ability to consider environment variables and Window’s registry settings when searching.
* 自动查找软件构件所需程序，程序库，头文件。这包含查找系统环境变量和视窗系统注册表的能力。
* The ability to build in a directory tree outside of the source tree, This is a useful feature found on many UNIX platforms; CMake provides this feature on Windows as well. This allows a developer to remove an entire build directory without fear of removing source ﬁles.
* 在源代码树之外的文件夹中构建的能力，这在UNIX平台下是很有用的特性；CMake也为视窗系统提供这种特性。也就允许开发者删除整个构建文件夹而不用担心误删源文件。
* The ability to create complex custom commands for automatically generated ﬁles such as Qt's moc (qt.nokia.com), The Insight Toolkit’s CABLE wrappers(publickitware.com/Cable/HTML/Index.html) and SWIG (www.swig.org) wrapper generators. These commands are used to generate new source ﬁles during the build process that are in turn compiled into the software.
* \*\*\*\*todo\*\*\*\*
* The ability to select optional components at conﬁguration time. For example, several of VTK’s libraries are optional, and CMake provides an easy way for users to select which libraries are built.
* 在配置时选择可选组建的能力。比如一些VTK库是可选的，CMake提供一种简单的方式让用户选择构建哪个程序库。
* The ability to automatically generate workspaces and projects from a simple text ﬁle. This can be very handy for systems that have many programs or test cases, each of which requires a separate project ﬁle, typically a tedious manual process to create using an IDE.
* 通过简单的文本文件自动生成工作区和工程的能力。这对于那些有很多程序和测试用例，每个程序和测试用例需要单独的工程文件的工程是非常方便的，一般情况下，需要IDE手动生成这些工程。
* The ability to easily switch between static and shared builds. CMake knows how to create shared libraries and modules on all platforms supported. Complicated platform-speciﬁc linker ﬂags are handled, and advanced features like built in run time search paths for shared libraries are supported on many UNIX systems.
* 方便切换创建静态库或共享库的能力。CMake知道如何在所支持的系统上创建共享库和模块。能够处理复杂的平台相关的链接标志位，和一些高级特性，比如许多UNIX系统都支持的内嵌的对于共享库路径的运行时查找。
* Automatic generation of ﬁle dependencies and support for parallel builds on most platforms.

When developing cross platform software, CMake provides a number of additional features:

* 在大多数平台支持文件依赖及并行构建。

当开发跨平台软件时，CMake提供了一系列额外的特性：

* The ability to test for machine byte order and other hardware speciﬁc characteristics.
* 检测机器字节顺序和其他硬件特性的能力。
* A single set of build conﬁguration ﬁles that work on all platforms. This avoids the problem of developers having to maintain the same information in several different formats inside a project.
* 适用于全平台的一套构建配置文件。这可以避免开发者维护记录相同信息的不同格式的文件。
* Support for building shared libraries on all platforms that support it.
* 在支持的平台上构建共享库的能力。
* The ability to conﬁgure ﬁles with system dependent information such as the location of data ﬁles and other information. CMake can create header ﬁles that contain information such as paths to data ﬁles and other information in the form of #deﬁne macros. System speciﬁc ﬂags can also be placed in conﬁgured header ﬁles. This has advantages over command line -D options to the compiler because it allows other build systems to use the CMake built library without having to specify the exact same command line options used during the build.
* 使用系统相关信息如数据文件的位置或其他信息来配置文件的能力。CMake能够生成包含数据文件路径或其他信息的头文件（以#define宏的形式）比命令行中传递给编译器-D可选项要好，因为他允许其他的构建系统使用CMake的构建库而不必在构建中指明该命令行可选项。

1.1 The History of CMake

1.1 CMake的历史

CMake development began in 1999 as part of the Insight Toolkit (ITK, www.itk.org) funded by the US National Library of Medicine. ITK is a large software project that works on many platforms and can interact with many other software packages. To support this, a powerful, yet easy to use, build tool was required. Having worked with build systems for large projects in the past, the developers designed CMake to address these needs. Since then CMake has continuously grown in popularity, with many projects and developers adopting it for its ease of use and ﬂexibility. Since 1999 CMake has been under active development and has matured to the point where it is a proven solution for a wide range of build issues. The most telling example of this is the successful adoption of CMake as the build system of the K Desktop Environment (KDE), arguably the largest open source software project in existence.

CMake项目开始于1999年，它是作为由美国国家医学图书馆赞助的项目（Insight Toolkit ITK，www.itk.com）的一部分出现的。ITK是一个大型的软件工程，能够在许多不同的平台上运行，可以和许多其他软件配合使用。为了支持这一特性，就需要一个强大的易于使用的构建工具。基于使用过往的大型工程的构建工具的经验，开发者们按上述需求设计CMake。之后，CMake逐渐流行，许多工程和开发者因其易用性和灵活性接受了它。之后CMake不断发展，在解决广泛的构建方面的问题上日渐成熟。一个非常有说服力的例子是CMake作为构建系统在K Desktop Environment（KDE）这个庞大的开源软件项目中被使用至今。

1.2 Why Not Use Autoconf?

1.2 为什么不使用Autoconf？

Before developing CMake its authors had experience with the existing set of available tools. Autoconf combined with automake provides some of the same functionality as CMake, but to use these tools on a Windows platform requires the installation of many additional tools not found natively on a Windows box. In addition to requiring a host of tools, autoconf can be difﬁcult to use or extend and impossible for some tasks that are easy in CMake. Even if you do get autoconf and its required environment running on your system, it generates Makeﬁles that will force users to the command line. CMake on the other hand provides a choice, allowing developers to generate project ﬁles that can be used directly from the IDE to which Windows and Xcode developers are accustomed.

在开发CMake之前，它的作者使用过一系列其他的构建工具。Autoconf连同automake部分提供了和CMake相同的功能，但是要是在Windows平台使用这些工具，就需要安装额外的工具。除了依赖其他工具，autoconf难于使用和扩展，一些在CMake中易于使用的tasks（任务），在autoconf中无法使用。即使你你安装了autoconf依赖的环境，并在你的系统中运行了autoconf，它所生成的Makefiles强迫用户使用命令行执行。CMake提供了另外一种选择，它允许开发者生成能够直接被IDE导入的工程文件，这些IDE是开发者所熟悉的。

While autoconf supports user speciﬁed options, it does not support dependent options where one option depends on some other property or selection. For example, in CMake you could have a user option to enable multithreading be dependent on ﬁrst determining if the user’s system has multithreading support. CMake provides an interactive user interface, making it easy for the user to see what options are available and how to set them.

虽然autoconf支持用户指定选项，但它不支持依赖于其他属性或选择的选项。比如，在CMake中你可以指定一个用户选项去开启多线程，这个选项依赖于检测用户系统是否支持多线程的结果。CMake提供了一个交互界面，方便使用者确认哪些选项是开启的，以及如何设置这些选项。

For UNIX users, CMake also provides automated dependency generation that is not done directly by autoconf. CMake’s simple input format is also easier to read and maintain than a combination of Makeﬁle.in and conﬁgure in ﬁles. The ability of CMake to remember and chain library dependency information has no equivalent in autoconf/automake.

对于UNIX的用户，CMake也支持自动依赖生成，而autoconf并不直接支持。CMake的配置文件也比Makefile.in和configure文件易于理解和维护。CMake记录和链接程序库依赖信息的能力也不是autoconf/automake可比的。

1.3 Why Not Use JAM, qmake, SCons, or ANT?

1.3 为什么不使用JAM，qmake，SCons或ANT

Other tools such as ANT, qmake, SCons, and JAM have taken different approaches to solving these problems and they have helped us to shape CMake. Of the four, qmake, is the most similar to CMake although it lacks much of the system interrogation that CMake provides. Qmake‘s input format more is closely related to a traditional Makeﬁle. ANT, JAM and SCons are also cross-platform although they do not support generating native project ﬁles. They do break away from the traditional Makeﬁle oriented input with ANT using XML, JAM using its own language, and SCons using Python. A number of these tools run the compiler directly, as opposed to letting the system’s build process perform that task. Many of these tools require other tools such as Python or Java to be installed before they will work.

其他工具比如ANT，qmake，SCons，和JAM通过不同的方式解决了这些问题，这帮助我们更加了解CMake。这四个工具中，qmake和CMake最像，虽然它不支持CMake提供的那种系统查询功能。Qmake的输入格式类似于传统的Makefile。ANT，JAM和SCons也是跨平台的，虽然它们不支持生成工程文件。它们和传统的输入向Makefile完全不同，ANT使用XML，JAM使用自己的语音，SCons使用Python。其中很多工具直接运行编译器，这和构建过程执行任务（task）截然不同。这些工具需要安装其他软件，如Python或者Java。

1.4 Why Not Script It Yourself?

1.4 为什么不自己写脚本

Some projects use existing scripting languages such as Perl or Python to conﬁgure build processes. Although similar functionality can be achieved with systems like this, over-use of tools can make the build process more of an Easter egg hunt than a simple—to-use build system. When building your software package users are forced to ﬁnd and install version 4.3.2 of this, and 3.2.4 of that, before they can even start the build process. To avoid that problem, it was decided that CMake would require no more tools than the software it was being used to build would require. At a minimum using CMake requires a C compiler, that compiler's native build tools, and a CMake executable. CMake was written in C++, requires only a C++ compiler to build and precompiled binaries are available for most systems. Scripting it yourself also typically means you will not be generating native Xcode or Visual Studio workspaces, making Mac and Windows builds limited.

有些工程使用脚本语言如Perl或者Python来配置构建过程。尽管也能实现CMake类似的功能，但是过度使用工具会造成构建过程更加复杂。当构建软件包时，用户必须查找并安装对应版本的工具，然后才能开始构建过程。为了避免这一问题，CMake被设计成只依赖软件构建所必需的工具。最小情况下CMake只依赖C编译器，和CMake可执行文件。CMake是由C++编写的，对于大多数系统，只需要C++编译器和预编译二进制文件。自己编写脚本文件意味着无法生成Xcode或Visual Studio工程文件，这在Mac和Windows系统下是受限制的。

1.5 On What Platforms Does CMake Run?

1.5 CMake能运行在哪些平台上？

CMake runs on a wide variety of platforms including Microsoft Windows, Apple Mac OS X, and most UNIX or UNIX-like platforms. At the time of the writing of this book CMake was tested nightly on the following platforms: Windows 98/2000/XP/Vista/7, AIX, HPUX, IRIX, Linux, Mac OS X, Solaris, OSF, QNX, CYGWIN, MinGW, and FreeBSD. You can check www.cmake.org for a current list of tested platforms.

CMake可以运行在广泛的平台上，包括微软视窗系统，苹果Mac OS X，和大多数UNIX或类UNIX系统。在写本书的时候，CMake每日测试版可以运行在下列平台：Windows 98/2000/XP/Vista/7, AIX, HPUX, IRIX, Linux, Mac OS X, Solaris, OSF, QNX, CYGWIN, MinGW, and FreeBSD。你可以访问www.cmake.org查看当前适配的平台。

Likewise, CMake supports most common compilers. It supports the GNU compiler on all CMake supported platforms. Other tested compilers include Visual Studio 6 through 10, Intel C, SGI CC, Mips Pro, Borland, Sun CC and HP aCC. CMake should work for most UNIX-style compilers out of the box. If the compiler takes arguments in a strange way, then see the section Porting CMake to New Platform on page 241 for information on how to customize CMake for a new compiler.

同样的，CMake支持大多数编译器。在所有适配的平台上CMake都支持GNU编译器。其他测试过的编译器包括Visual Studio 6-10，Intel C, SGI CC, Mips Pro, Borland, Sun CC and HP aCC。CMake还应该支持大多数UNIX风格的编译器。如果编译器以古怪的方式接受参数，请参考第241页的Porting CMake to New Platform章节获得如何为新编译器定制CMake的信息。

Chapter 2

第二章

Getting Started

新手入门

2.1 Getting and Installing CMake on Your Computer

2.1 在你的计算机中获取并安装CMake

Before using CMake you will need to install or build the CMake binaries on your system. On many systems you may ﬁnd that CMake is already installed, or is available for install with the standard package manager tool for the system. Cygwin, Debian, FreeBSD, Mac OS X Fink, and many others all have CMake distributions. If your system does not have a CMake package, you can ﬁnd CMake precompiled for most common architectures at www.cmake.org. If you do not ﬁnd binaries for your system precompiled, then you can build CMake from source. To build CMake you will need a modern C++ compiler.

在使用CMake之前你需要在你的系统中安装或构建CMake二进制文件。你会发现在许多系统中已经安装了CMake，或者可以通过系统的标准包管理器安装。Cygwin, Debian, FreeBSD, Mac OS X Fink，和许多其他的系统都有对应的CMake版本。如果你的系统没有CMake软件包，你能在www.cmake.org找到对应大多数架构的预编译好的CMake。如果没有找到对应你的系统的CMake版本，你也可以通过源代码构建CMake。如果这样你需要一个现代的编译器。

If your system provides CMake as one of its standard packages, follow your system’s package installation instructions. If your system does not have CMake, or has an out of date version of CMake, you can download precompiled binaries from www.cmake.org. The binaries from www.cmake.org come in the form of a compressed tar ﬁle. The tar ﬁle contains a README ﬁle and an enclosed tar ﬁle. The README ﬁle contains a manifest of the ﬁles contained in the enclosed tar ﬁle, and some instructions. To install, simply extract the enclosed tar ﬁle into a destination directory (typically /usr/local). However, it can be any directory, and does not require root privileges for installation.

如果你的系统提供CMake作为标准包，按照你的系统的包安装指令操作。如果你的系统没有CMake，或者CMake的版本太老，你可以从www.cmake.org下载预编译好的二进制文件。这些二进制文件被达成了一个tar格式的压缩包。其中包括一个README文件。和tar文件。README文件描述了在tar文件中的文件的清单文件，和一些指令。要安装CMake，解压缩tar文件到目标目录（一般是/usr/local）。也可以是任意目录，这并不需要root权限来安装。

For Windows CMake has a NullSoﬁ install ﬁle available for download from www.cmake.org. To install this ﬁle, simply run the executable on the windows machine on which you want to install CMake. You will be able to run CMake from the Start Menu after it is installed.

对于视窗系统，CMake在www.cmake.org提供一个NullSofi安装文件，只需在想要安装的视窗系统中执行这个可执行文件，即可安装。装好后，你可以从开始菜单中执行CMake。

2.2 Building CMake Yourself

2.2 自己构建CMake

If binaries are not available for your system, or if binaries are not available for the version of CMake you wish to use, you can build CMake from the source code. You can obtain the CMake source code by following the instructions at www.cmake.org. Once you have the source code it can be built in two different ways. If you have a version of CMake on your system you can use it to build other versions of CMake. Generally the current development version of CMake can always be built from the previous release of CMake. This is how new versions of CMake are built on most Windows systems.

如果没有对应你的系统的二进制文件，或者二进制文件的版本号和你希望使用的CMake版本号不一致，你可以通过源码构建CMake。你可以在www.cmake.org按指令下载源码。一旦拥有的源码，你可以通过两种方式构建CMake。如果你的系统中安装了CMake，你可以使用它构建其他版本的CMake。一般来说，当前开发版的CMake都是由之前发布的CMake构建的。这也是大多数视窗系统CMake的构建方式。

The second way to build CMake is by running its bootstrap build script. To do this you change directory into your CMake source directory and type

第二种构建方式是执行CMake的引导构建脚本。要这样做，你需要切换到CMake源码目录，并执行

./bootstrap

make

make install

The make install step is optional since CMake can run directly from the build directory if desired. On UNIX, if you are not using the GNU C++ compiler, you need to tell the bootstrap script which compiler you want to use. This is done by setting the environment variable CXX before running bootstrap. If you need to use any special ﬂags with your compiler, set the CXXFLAGS environment variable. For example, on the SGI with the 7.3X compiler, you would build CMake like this:

第三步是可选的，因为CMake能够直接在构建目录中执行。在UNIX系统中，如果你没有使用CNUC++编译器，你需要告诉引导脚本你想要使用的编译器。这通过在执行引导脚本前设置环境变量CXX来实现。如果你需要使用特殊的编译器标志位，设置CXXFLAGS环境变量。比如说，在SGI中使用7.3x版本编译器。你需要这样构建CMake：

cd CMake

(setenv CXX CC; setenv CXXFLAGS "—LANsttd"; ./bootstrap)

make

make install

2.3 Basic CMake Usage and Syntax

2.3 CMake的基本用法及语法

Using CMake is simple. The build process is controlled by creating one or more CMakeLists ﬁles (actually CMakeLists.txt but this guide will leave off the extension in most cases) in each of the directories that make up a project. The CMakeLists ﬁles should contain the project description in CMake's simple language. The language is expressed as a series of commands. Each command is evaluated in the order that it appears in the CMakeLists ﬁle. The commands have the form

command (args...)

使用CMake很简单。构建过程由工程每个文件夹中的一个或多个CMakeLists（事实上是CMakeLists.txt文件，不过大多数情况下省略扩展名）文件控制。CMakeLists文件应该包含由CMake的简单语言写的工程描述。这个语言由一系列的命令组成。每条命令以它在CMakeLists文件中的顺序执行。命令以

command(args...)的格式书写。

where command is the name of the command, and args is a white-space separated list of arguments. (Arguments with embedded white-space should be double quoted.) CMake is case insensitive to command names as of version 2.2. So where you see command you could use COMMAND or Command instead. Older versions of CMake only accepted uppercase commands.

在这里command指命令的名称，args是由空格分开的参数列表。（参数中包含空格需要用双引号括起来。）CMake从2.2版开始对于命令大小写不敏感。所以你可以看到它的命令可能写成COMMAD或者Command。老版本的CMake只接受大写命令。

CMake supports simple variables that can be either strings or lists of strings. Variables are referenced using a ${VAR} syntax. Multiple arguments can be grouped together into a list using the set command. All other commands expand the lists as if they had been passed into the command with white-space separation. For example, set (Foo a b c) will result in setting the variable Foo to a b c, and if Foo is passed into another command command ($ {Foo} ) it would be equivalent to command (a b c) . If you want to pass a list of arguments to a command as if it were a single argument simply double quote it. For example command ( "$ {Foo} ") would be invoked passing only one argument equivalent to command(

"a b c" ).

CMake支持以字符串或字符串数组列表的形式的简单变量。变量使用${VAR}这样的语法来引用。多个参数可以通过使用set命令聚集成一个列表。当它被以空格分隔传入其他命令时将展开这个列表。比如，set(Foo a b c)会设置变量Foo的值为 a b c，如果Foo被传入其他命令command command(${Foo})就等同于command(a b c)。如果你想要传入参数列表并把它当做一个参数，可以使用双引号括起来。比如command("${Foo}")，这将等同于传入一个参数的command("a b c")。

System environment variables and Windows registry values can be accessed directly in CMake. To access system environment variables the syntax $ENV{VAR} is used. CMake can also reference registry entries in many commands using a syntax of the form [HKEYiCURRENTiUSER\\Software\\pathl\\path2;key], where the paths are built from the registry tree and key.

系统环境变量和Windows注册表的值可以被CMake直接访问。在CMake中以$ENV{VAR}的形式获得环境变量的值。在许多命令中，CMake也可以以[HKEYiCURRENTiUSER\\Software\\pathl\\path2;key]的形式引用注册表中的表项，这里paths是指注册表中的路径和键。

2.4 Hello World for CMake

2.4 Hello World

For starters let us consider the simplest possible CMakeLists ﬁle. To compile an executable from one source ﬁle the CMakeLists ﬁle would contain two lines:

作为初学者，我们从一个最简单的CMakeLists文件开始。想要从一个源文件编译成一个可执行文件只需要两行代码：

project (Hello)

add\_executable (Hello Hello.c)

To build the Hello executable you follow the process described in Running CMake (See section 2.5) to generate the Makeﬁles or Microsoft project ﬁles. The project command indicates what the name of the resulting workspace should be and the add\_executable command adds executable an target to the build process. That’s all there is to it for this simple example. If your project requires a few ﬁles it is also quite easy, just modify the add\_executable line as shown below.

要编译可执行文件Hello，你需要按第2.5小节的步骤生成Makefiles或Microsoft工程文件。project命令指明工程（工作区）的名字，add\_executable命令将生成一个可执行文件的目标添加到构建过程。这就是这个简单例子的全部了。如果你的工程有几个源文件也很简单，只需按下面的方式修改add\_executable命令。

add\_executable (Hello Hello.c File2.c File3.c File4.c)

add\_executable is just one of many commands available in CMake. Consider the more

complicated example below.

add\_executable是CMake众多命令中的一条。下面是更复杂的例子。

cmake\_minimum\_required (2.6)

project (HELLO)

set (HELLO\_SRCS Hello.c File2.c File3.c)

if (WIN32)

Set(HELLO\_SRCS ${HELLO\_SRCS} WinSupport.c)

else()

set(HELLO\_SRCS ${HELLO\_SRCS} UnixSupport.c)

endif()

add\_executable (Hello ${HELLO\_SRCS})

# look for the Tcl library

find\_library (TCL\_LIBRARY

NAMES tcl tc184 tcl83 tcl82 tcl80

PATHS /usr/lib /usr/local/lib

)

if (TCL\_LIBRARY)

target\_link\_library (Hello ${TCL\_LIBRARY})

endif()

In this example the set command is used to group together source ﬁles into a list. The if command is used to add either WinSupport.c or UnixSupport.c to this list based on whether or not CMake is running on Windows. Finally, the add\_executable command is used to build the executable with the ﬁles listed in the variable HELLO\_SRCS. The find\_library command looks for the Tcl library under a few different names and in a few different paths. An if command checks if the TCL\_LIBRARY was found and if so adds it to the link line for the Hello executable target. Note the use of the # character to denote a comment line. All characters from the # to the end of the line are considered to be part of the comment.

在这个例子中，set命令将若干源文件组成一个列表，if命令通过判断CMake是否运行在Windows中，选择加入源文件WinSupport.c或UnixSupport.c到列表中。最后add\_executable命令使用变量HELLO\_SRCS列表中的源文件构建可执行文件。find\_library命令在指定名字和路径下查找Tcl程序库。如果if命令判断找到TCL\_LIBRARY，就将它同Hello可执行目标链接。请注意，字符#表示一个注释行。它后面的字符都被认为是注释。

2.5 How to Run CMake?

2.5 如何运行CMake？

Once CMake has been installed on your system, using it to build a project is easy. There are two main directories CMake uses when building a project: the source directory and the binary directory. The source directory is where the source code for your project is located. This is also where the CMakeLists ﬁles will be found. The binary directory is where you want CMake to put the resulting object ﬁles, libraries, and executables. Typically CMake will not write any ﬁles to the source directory, only the binary directory. If you want to you can set the source and binary directories to be the same. This is known as an in-source build, in contrast to an out-of-source build where they are different.

如果已经安装好CMake，使用它构建工程就简单了。当构建工程时，CMake主要使用两个文件目录：源文件目录和二进制文件目录。源文件目录是工程源码所在目录。CMakeLists文件也放在此目录。二进制文件目录是CMake存放结构目标文件，程序库，和可执行文件的目录。一般来说CMake不在源文件目录，而只在二进制目录创建文件。如果你需要，可以将源文件目录和二进制目录设置成一样的。这就是所谓的源码内构建，与之相对的是源码外构建。

CMake supports both in-source and out-of-source builds on all operating systems. This means that you can conﬁgure your build to be completely outside of the source code tree which makes it very easy to remove all of the ﬁles generated by a build. Having the build tree differ from the source tree also makes it easy to support having multiple builds of a single source tree. This is useful when you want to have multiple builds with different options but just one copy of the source code. Now let us consider the specifics of running CMake using its Qt based GUI and command line interfaces.

CMake在所有系统中支持源码内构建和源码外构建。这就意味着你可以配置使它完全在源代码外部构建，从而是删除构建结构变得非常容易。在源代码外部构建也使得支持使用一套源码生成多个构建得到支持。这对于通过选项使用一套源码生成多个构建是很有用的。下面我们来看如何通过基于Qt的交互界面和命令行运行CMake。

Running CMake’s Qt Interface

运行CMake Qt交互界面

CMake includes a Qt based user interface developed by Clinton Stimpson that can be used on most platforms, including UNIX, Mac OS X, and Windows. This interface is included in the CMake source code, but you will need an installation of Qt on your system in order to build it.

CMake包含一个由Clinton Stimpson开发的可以再大多数系统（包括UNIX，Mac和Windows）上运行的基于Qt的交互界面。这个交互界面包含在CMake的源码中，但是要运行这个交互界面，你需要在系统中安装Qt库来构建它。

On Windows the executable is named cmake-gui.exe and should be in your Start menu under Program Files. There may also be a shortcut on your desktop, or if you built CMake from source, it will be in the build directory. For UNIX and Mac users the executable is named cmake-gui and it can be found where you installed the CMake executables.A GUI will appear similar to what is shown in Figure l. The top two entries are the source code and binary directories. They allow you to specify where the source code is for What you want to compile and where the resulting binaries should be placed. You should set these two values ﬁrst. If the binary directory you specify does not exist, it will be created for you. If the binary directory has been conﬁgured by CMake before then it will automatically set the source tree.

在Windows中这个可执行文件是cmake-gui.exe，它应该在你的开始菜单的Program Files项中。在你的桌面上也应该有它的快捷方式，如果你从源代码构建CMake，它也应该在你的构建目录中。对于UNIX和苹果系统的用户，这个可执行文件是cmake-gui，它可以在你的安装目录中被找到。这个图形交互界面和图一类似。顶部是源文件目录和构建目录。你可以指定源文件目录和构建的二进制目录。你应该先设置这两个目录。如果你指定的构建目录不存在，它会为你生成一个。如果你之前配置过CMake的构建目录，它会自动找到对应的源文件目录。

The middle area is where you can specify different options for the build process. More obscure variables may be hidden, but can be seen if you select ”Advanced View" from the View pulldown. You can search for values in the middle area by typing all or part of the name into the Search box. This can be handy for ﬁnding speciﬁc settings or options in a large project. The bottom area of the window includes the Conﬁgure and Generate buttons as well as a progress bar and scrollable output window.

在中间部分你可以为构建过程指定不同的可选项。一些隐藏变量不会显示，你可以勾选“Advanced View”选项显示它们。你可以在搜索框中输入关键字搜索选项。这对于在一个庞大的工程中查找指定设置是很有用的。底部区域包含配置和生成按钮，进度条，可一个可滚动的输出窗口。

Once you have speciﬁed the source code and binary directories you should click the Conﬁgure button. This will cause CMake to read in the CMakeLists ﬁles from the source code directory and then update the cache area to display any new options for the project. If you are running cmake-gui for the ﬁrst time on this binary directory it will prompt you to determine what generator you wish to use, as shown in Figure 2. This dialog also presents options for customizing and tweaking the compilers you wish to use for this build.

一旦你指定了源文件目录和构建目录，你需要点击Configure按钮，使CMake读取源文件目录中的CMakeLists文件，更新缓存区域，显示工程的新选项。对应指定的构建目录，如果你是第一次在运行cmake-gui，它会提示你选择使用哪种生成器（如图2所示）。这个对话框也会显示你希望构建时使用的定制和调整编译器的可选项。

After the ﬁrst conﬁgure you can adjust your cache settings if desired and click the Conﬁgure button again. New values that were created by the conﬁgure process will be colored red. To be sure you have seen all possible values you should click Conﬁgure until no values are red and you are happy with all the settings. Once you are done conﬁguring, click the Generate button, this will produce the appropriate ﬁles.

第一次配置完后，如果需要你可以调整缓存设置，并再次点击Configure按钮。配置过程中新的值会被标记成红色。你需要确认所有的选项，直到它们不再显示成红色。一旦配置完成，点击Generate按钮，生成恰当的文件。

It is important that you make sure that your environment is suitable for running cmake-gui. If you are using an IDE such as Visual Studio then your environment will be setup correctly for you. If you are using NMake or MinGW then you need to make sure that the compiler can run from your environment. You can either directly set the required environment variables for your compiler or use a shell in which they are already set. For example, Microsoft Visual Studio has an option on the start menu for creating a Visual Studio Command Prompt. This opens up a command prompt window that has its environment already setup for Visual Studio. You should run cmake-gui from this command prompt if you want to use NMake Makeﬁles. The same approach applies to MinGW, you should run cmake-gui from a MinGW shell that has a working compiler in its path.

确认你的环境适合运行cmake-gui是非常重要的。如果你使用集成开发环境，如VIsual Studio，那么你的环境将被正确设置。如果你使用NMake或者MinGW，那么你需要确认在你的环境中编译器可以运行。你既可以为你的编译器设置所需的环境变量，也可以使用已经设置好环境变量的shell。比如说Microsoft Visual Studio在开始菜单有一个选项生成命令提示符。这会打开一个命令提示符窗口，并为Visual Studio设置好相应的环境变量。如果你想使用NMake Makefiles，你可以在这个命令提示符下运行cmake-gui。同样的，你也可以在MinGW shell中运行cmake-gui，它已经在path中配置好了一个可用的编译器。

When cmake-gui ﬁnishes it will have generated the build ﬁles in the binary directory you speciﬁed. If Visual Studio was selected as the generator, a MSVC workspace (or solution) ﬁle is created. This ﬁle's name is based on the name of the project you speciﬁed in the PROJECT command at the beginning of your CMakeLists ﬁle. For many other generator types, Makeﬁles are generated. The next step in this process is to open the workspace with MSVC. Once open, the project can be built in the normal manner of Microsoft Visual C++. The ALL\_BUILD target can be used to build all of the libraries and executables in the package. If you are using a Makeﬁle build type, then you would build by running make or nmake on the resulting Makeﬁles.

当使用cmake-gui后它会在你指定的构建目录中生成构建文件。如果指定Visual Studio生成器，则生成MSVC工作区文件。这个文件的名字基于你在CMakeLists文件开头使用PROJECT命令指定的工程名。大多数生成器生成Makefiles文件。下一步，使用MSVC打开工作区，然后就可以使用Microsoft Visual C++构建。ALL\_BUILD目标可以被用来构建所有的程序库和可执行文件。如果你使用Makefile构建，需要使用生成的Makefiles文件执行make或者nmake。

Running the ccmake Curses Interface

运行ccmake Curses界面

On most UNIX platforms, if the curses library is supported, CMake provides an executable called ccmake. This interface is a terminal-based text application that is very similar to the Qt based GUT. To run ccmake, change directory (Cd) to the directory where you want the binaries to be placed. This can be the same directory as the source code for what we call in-source builds or it can be a new directory you create. Then run ccmake with the path to the source directory on the command line. For in-source builds use "." for the source directory. This will start the text interface as shown in Figure 3 (in this case the cache variables are from VTK and most are set automatically).

在大多数UNIX平台上，如果支持curses 程序库，CMake提供了一个可执行文件ccmake。这个交互界面是基于终端的文本程序这类似于基于Qt的GUT。要运行ccmake，使用cd命令切换到构建目录。要是使用源码内构建，构建目录可以和源码目录一致。然后运行ccmake，使用源码目录作为参数。对于源码内构建，使用”.”指定源码目录。然后会显示如图3所示文本交互界面（这里缓存变量来自于VTK，大部分是自动设置的）。

Brief instructions are displayed in the bottom of the window. If you hit the "c" key, it will conﬁgure the project. You should always conﬁgure after changing values in the cache. To change values, use the arrow keys to select cache entries, and then the enter key to edit them. Boolean values will toggle with the enter key. Once you have set all the values as you like, you can hit the ”g" key to generate the Makeﬁles and exit. You can also hit "h" for help, "q" to quit, and "t" to toggle the Viewing of advanced cache entries. Two examples of CMake usage on the UNIX platform follow for a hello world project called Hello. In the ﬁrst example, an in-source build is performed.

在窗口的底部是指令的简要介绍。如果按“c”键，将配置工程。你应该在缓存中修改了值后，重新配置。要修改值，使用方向键选择缓存项，然后点击回车键编辑它们。布尔型的值可以通过回车键切换。一旦你设置好所有的值，按”g”键生成Makefiles并退出。你也可以按”h”键，显示帮助，”q”键退出，”t”键切换高级显示模式。下面是UNIX平台上，两个使用CMake的例子，它们是hello world工程，叫Hello。第一个例子是源码内构建的。

cd Hello

ccmake

make

In the second example, an out-of-source build is performed.

第二个例子是源码外构建。

mkdir Hello-Linux

cd Hello-Linux

ccmake ../Hello

make

Running CMake from the Command Line

使用命令行运行CMake

From the command line, CMake can be run as an interactive question and answer session or as a non-interactive program. To run in interactive mode, just pass the "-i” option to CMake. This will cause CMake to ask you for a value for each entry in the cache file for the project. CMake will provide reasonable defaults, just like it does in the GUI and curses based interfaces. The process stops when there are no longer any more questions to ask. An example of using the interactive mode of CMake is provided below.

在命令行下，CMake可以以问答的交互方式运行，也可以以非交互方式运行。使用”-i”可选项，CMake将以交互方式运行。CMake将会询问工程中缓存文件每项的值。CMake会提供一个合理的默认值，就像基于GUI和curses的交互中那样。当问完所有问题这个过程就结束了。下面是一个使用CMake交互方式的例子。

$ cmake -i eG "NMake Makefiles" ../CMake

Would you like to see advanced options? [No]:

Please wait while cmake processes CMakeLists.txt files....

Variable Name: BUILD\_TESTING

Description: Build the testing tree.

Current Value: ON

New Value (Enter to keep current value):

Variable Name: CMAKE\_INSTALL PREFIX

Description: Install path prefix, prepended onto install

directories.

Current Value: C:/Program Files/CMake

New Value (Enter to keep current value):

Please wait while cmake processes CMakeLists.txt files....

CMake complete, run make to build project.

Using CMake to build a project in non—interactive mode is a simple process if the project has few or no options. For larger projects like VTK, using ccmake, cmake -i, or cmake-gui is recommended. To build a project with a non—interactive CMake, first change directory to where you want the binaries to be placed. For an in-source build you then run cmake . and pass in any options using the -D ﬂag. For out-of-source builds the process is the same except you run cmake and also provide the path to the source code as its argument. Then type make and your project should compile. Some projects will have install targets as well, you can type make install to install them.

如果工程只有若干选择项或者没有，使用CMake非交互方式构建会很简单。对于庞大的工程，比如VTK，推荐使用ccmake，cmake -i，或者cmake-gui。使用非交互方式构建工程，首先切换到构建目录，如果是源码内构建，运行cmake .后面使用-D标示传入可选项。对于源码外构建，运行cmake后面传入源码路径作为参数。然后输入make编译工程。有些工程有install目标，你可以输入make install安装。

Specifying the Compiler to CMake

指定CMake编译器

On some systems you may have more than one compiler to choose from or your compiler may be in a non-standard place. In these cases you will need to specify to CMake where your desired compiler is located. There are three ways to specify this; the generator can specify the compiler, an environment variable can be set, or a cache entry can be set. Some generators are tied to a speciﬁc compiler, for example the Visual Studio 6 generator always uses the Microsoft Visual Studio 6 compiler. For Makeﬁle based generators CMake will try a list of usual compilers until it ﬁnds a working compiler. The list can be found in the ﬁles:

在某些系统中，可能存在多个编译器或者编译器装在非标准位置。在这种情况下你需要指定编译器所在位置。有三种方法指定；可以使用生成器指定编译器，可以设置环境变量，或者设置缓存项。有些生成器同特定的编译器绑定在一起。比如Visual Studio 6生成器总是使用Microsoft Visual Studio 6 编译器。对于基于Makefile的生成器，CMake会尝试在一些列常用编译器中找到一个可用的。这些常用编译器能够在下列文件中找到：

Modules/CMakeDeterminCCompiler.cmake 和

Modules/CMakeDeterminCXXCompiler.cmake

The lists can be preempted with environment variables that can be set before CMake is run. The CC environment variable speciﬁes the C compiler while CXX speciﬁes the C++ compiler. You can specify the compilers directly on the command line by using -DCMAKE\_CXX\_COMPILER=cl for example. If those are not set, CMake will try the following list of compilers:

这个列表可以由在CMake运行之前设置的环境变量取代。环境变量CC指定C编译器，CXX指定C++编译器。你可以在命令行中通过-DCMAKE\_CXX\_COMPILER=cl可选项直接指定编译器。如果没有指定，CMake会测试下列编译器列表：

c++ g++ CC aCC cl bcc xlC.

Once CMake has been run and picked a compiler, you can change the selection by changing the cache entries CMAKE\_CXX\_COMPILER and CMAKE\_C\_COMPILER, although this is not recommended. The problem with doing this is that the project you are conﬁguring may have already run some tests on the compiler to determine what it supports. Changing the compiler does not normally cause these tests to be rerun which can lead to incorrect results. If you must change the compiler, start over with an empty binary directory. The ﬂags for the compiler and the linker can also be changed by setting environment variables. Setting LDFLAGS will initialize the cache values for link ﬂags, while CXXFLAGS and CFLAGS will initialize CMAKE\_CXX\_FLAGS and CMAKE\_C\_FLAGS respectively.

一旦CMake开始运行并选择了一个编译器，你可以通过改变缓存项CMAKE\_CXX\_COMPILER和CMAKE\_C\_COMPILER改变指定的编译器，虽然这么做并不推荐。这样做的问题是配置中的工程可能正在执行编译器支持功能的测试。更换编译器并不会重新执行这些测试，这可能导致不正确的结果。如果你必须要更换编译器，从一个空的构建目录开始。通过设置环境变量也可以改变编译器和连接器的标志位。设置LDFLAGS将初始化连接标志位的缓存项，CXXFLAGS和CFLAGS将分别初始化CMAKE\_CXX\_FLAGS和CMAKE\_C\_FLAGS变量。

Dependency Analysis

依赖分析

CMake has powerful built-in dependency analysis capabilities for C and C++ source code ﬁles. CMake also has limited support for Fortran and Java dependencies. Since Integrated Development Environments (IDES) support and maintain dependency information, CMake skips this step for those build systems. However, Makeﬁles with a make program do not know how to automatically compute and keep dependency information up-to-date. For these builds, CMake automatically computes dependency information for C, C++ and Fortran ﬁles. Both the generation and maintenance of these dependencies are automatically done by CMake. Once a project is initially configured by CMake, users only need to run make, and CMake does the rest of the work. CMake’s dependencies fully support parallel builds for multiprocessor systems.

对于C和C++源文件，CMake具有强大的依赖分析能力。而且对于Fortran和Java语言CMake也有一定的支持。因为集成开发环境支持并维护依赖信息，所以CMake跳过了这一步，而Makefiles和make程序并不能自动的计算和维护更新依赖信息。对于使用这些方式的构建，CMake为C，C++和Fortran自动计算依赖信息，这些依赖信息的生成和维护都是自动的。一个工程由CMake配置后，用户只需运行make，而CMake做了其他的工作。对于多处理器系统，CMake的依赖支持并行构建。

Although users do not need to know how CMake does this work, it may be useful to look at the dependency information ﬁles for a project. This information for each target is stored in four ﬁles called depend.make, flags.make, build.make, and Dependlnfo.cmake. depend.make stores the depend information for all the object ﬁles in the directory. flags . make contains the compile ﬂags used for the source ﬁles of this target. If they change then the ﬁles will be recompiled. Dependlnfo.cmake is used to keep the dependency information up-to-date and contains information about what ﬁles are part of the project and what languages they are in. Finally, the rules for building the dependencies are stored in build.make. If a dependency is out of date then all of the dependencies for that target will be recomputed, keeping the dependency information current.

尽管用户并不知道CMake是如何做的，不过能看到工程的文件依赖信息可能是有用的。每个目标的信息存储在depend.make，flags.make，build.make，和DependInfo.make等四个文件中。depend.make存储目中所有目标文件的依赖信息。flags.make包含这个目标的编译标志位。如果这些标志位改变了那么这些文件会被重新编译。DependInfo.cmake用来更新依赖信息，它包含了工程所包含的文件，和它们所使用的语言。最后，构建这些依赖的规则保存在build.make。如果一个依赖过时了，那么这个目标的所有依赖将被重新计算，保持依赖信息最新。

2.6 Editing CMakeLists Files

2.6 编辑CMakeLists文件

CMakeLists ﬁles can be edited in almost any text editor. Some editors, such as Notepad++, come with CMake syntax highlighting and indentation support built in. For editors such as Emacs or Vim CMake includes indentation and syntax highlighting modes. These can be found in the Docs directory of the source distribution, or downloaded from the CMake web site. The ﬁle Cmake-mode.el is the Emacs mode, and cmake-indent.vim and cmake-syntax.vim are used by Vim. Within Visual Studio the CMakeLists ﬁles are listed as part of the project and you can edit them simply by double clicking on them. Within any of the supported generators (Makeﬁles, Visual Studio, etc) if you edit a CMakeLists ﬁle and rebuild, there are rules that will automatically invoke CMake to update the generated ﬁles (eg. Makeﬁles or project ﬁles) as required. This helps to assure that your generated ﬁles are always in sync with your CMakeLists ﬁles.

CMakeLists文件几乎可以用任意文本编辑器编辑。有些编辑器，如Notepad++，支持内置的CMake语法高亮和缩进。对于Emacs或者Vim编辑器，CMake包含缩进和语法高亮模式。这些可以再源文件家的Docs目录找到，或者在CMake网站下载。Cmake-mode.el是Emacs使用的，cmake-indent.vim和cmake-syntax.vim是Vim使用的。对于Visula Studio工程，CMakeLists文件是工程文件，你可以通过双击编辑它。对于所支持的生成器（Makefiles，Visual Studio，等等）如果你编辑了CMakeLists文件，规则会自动调用CMake更新所需生成的文件（如Makefiles或者工程文件）。这确保生成的文件和你的CMakeLists文件保持同步。

Since CMake computes and maintains dependency information, the CMake executables must always be available (though they don’t have to be in your PATH) when make or an IDE is being run on CMake generated ﬁles. This means that if a CMake input ﬁle changes on disk, your build system will automatically re-run CMake and produce up-to-date build ﬁles. For this reason you generally should not generate Makeﬁles or projects with CMake and move them to another machine that does not have CMake installed.

因为CMake计算并维护依赖信息，当make或者IDE运行时，CMake可执行文件应该总是可以执行的（尽管它们不必须在PATH路径下）。也就是说如果CMake输入文件改变了，你的构建系统会自动重新执行CMake并生成更新的构建文件。因此你不应该使用CMake生成Makefiles或者工程文件，并把它们移动到没有安装CMake的机器中。

2.7 Setting Initial Values for CMake

2.7 设置CMake的初始值

While CMake works well in an interactive mode, sometimes you will need to setup cache entries without running a GUI. This is common when setting up nightly dashboards or if you will be creating many build trees with the same cache values. In these cases the CMake cache can be initialized in two different ways. The ﬁrst way is to pass the cache values on the CMake command line using -DCACHE\_VAR: TYPE=VALUE arguments. For example, consider the following nightly dashboard script for a UNIX machine:

由于CMake在互动模式下工作的很好，有时你不需要在GUI模式下设置缓存项。这在设置每日构建或使用一套缓存项创建多个构建树时是很正常的。在这种情况下，CMake缓存可以以两种方式初始化。第一种是执行CMake命令式通过-DCACHE\_VAR: TYPE=VALUE参数传入。例如，下面是一个UNIX系统上的每日构建脚本：

#!/bin/tcsh

cd ${HOME}

# wipe out the old binary tree and then create it again

rm -rf Foo-Linux

mkdir Foo-Linux

cd Foo-Linux

# run cmake to setup the cache

cmake -DBUILD\_TESTING:BOOL=ON <etc...> ../Foo

# generate the dashboard

ctest -D Nightly

The same idea can be used with a batch ﬁle on Windows. The second way is to create a ﬁle to be loaded using CMake's -c option. In this case instead of setting up the cache with -D options it is done though a ﬁle that is parsed by CMake. The syntax for this ﬁle is standard CMakeLists syntax and it is typically just a series of set commands such as:

同样的方式也可以应用到Windows的批处理文件。第二种方式是创建一个文件使用-c可选项传入到CMake。这种方式可以代替第一种使用-D可选项的方式。这个文件的语法是标准的CMakeLists语法，其实就是一系列的set命令：

#Build the vtkHybrid kit.

set (VTK\_USE\_HYBRID ON CACHE BOOL "doc string")

In some cases there might be an existing cache and you want to force the cache values to be set a certain way. For example say you want to turn Hybrid on even if the user has previously run CMake and turned it off. Then you can do:

某种情况下，可能缓存已经存在，而你想要强制设置缓存项。比如你想设置Hybrid项为启用，即使用户之前已经运行了CMake并设置该项为关闭。那么你可以这样做：

#Build the vtkHybrid kit always.

set (VTK\_USE\_HYBRID ON CACHE BOOL "doc" FORCE)

Another option is that you want to set and then hide options so the user will not be tempted to adjust them later on. This can be done using the following commands:

另一种可选项是你想要设置并隐藏它，让用户以后无法改变它。你可以这样做：#Build the vtkHybrid kit always and don’t distract

#the user by showing the option.

set (VTK\_USE\_HYBRID ON CACHE INTERNAL "doc" FORCE)

mark\_as\_advanced (VTK\_USE\_HYBRID)

You might be tempted to edit the cache ﬁle directly, or to "initialize" a project by giving it an initial cache ﬁle. This may not work and could cause additional problems in the future. First, the syntax of the CMake cache is subject to change. Second, cache ﬁles have full paths in them that make them unsuitable for moving between binary trees. So if you want to initialize a cache ﬁle use one of the two standard methods described above.

你可能想要直接编辑缓存文件，或者给定缓存文件初始化工程。这可能行不通，或者产生额外的问题。第一，CMake缓存的语法有可能变化。第二，缓存文件中存在绝对路径，在构建树之间移动它们是不合适的。所以如果你想要初始化缓存文件，使用上述两种方法。

2.8 Building Your Project

2.8 构建你的工程

After you have run CMake your project will be ready to be built. If your target generator is based on Makeﬁles then you can build your project by changing directory to your binary tree and typing make (or gmake or nmake as appropriate). If you generated ﬁles for an IDE such as Visual Studio, you can start your lDE, load the project ﬁles into it, and build as you normally would.

当执行完CMake你的工程就可以开始构建了。如果你的目标生成器是基于Makefiles的，那么你可切换目录到构建目录，输入make（或者gmake或者nmake）来构建你的工程。如果你生成的文件是IDE工程文件，如Visual Studio，你可以启动IDE，载入工程文件，构建工程。

Another option is to use CMake’s -build option from the command line. This option is simply a convenience that allows you to build your project from the command line, even if that requires launching an IDE. The command line options for -build include:

另外也可以通过命令行使用CMake的 -build可选项。这个可选项只是为了方便你使用命令行构建你的工程，这可能需要启动IDE。命令行可选项-build包括：

Usage: cmake --build <dir> [options] [-- [native-options]]

Options:

<dir> = Project binary directory to be built.

--target <tgt> = Build <tgt> instead of default targets.

--config <cfg> = For multi-configuration tools, choose <cfg>.

--clean-first = Build target 'clean' first, then build.

(To clean only, use --target 'clean'.)

-- = Pass remaining options to the native tool.

So even if you are using Visual Studio as your generator you can type the following to build your project from the command line if you wish.

所以即使你使用Visual Studio作为生成器，你也可以输入下列命令从命令行构建你的工程。

cmake --build <your binary dir>

That is all there is to installing and running CMake for simple projects. In the following chapters we will consider CMake in more detail and how to use it on more complex software projects.

这就是安装运行CMake的全部内容。之后的章节会讨论CMake的更多使用细节及如何将它使用在复杂工程中。

Chapter 3

第三章

Key Concepts

核心概念

3.1 Main Structures

3.1 主结构

This chapter provides an introduction to CMake's key concepts. As you start working with CMake you will run into a variety of concepts such as targets, generators, and commands. In CMake these concepts are implemented as C++ classes and are referenced in many of CMake's commands. Understanding these concepts will provide you with the working knowledge you need to create effective CMakeLists ﬁles.

本章介绍了CMake的核心概念。当你开始使用CMake时，你会接触到很多新概念例如目标，生成器，命令。在CMake里，这些概念由C++的类实现，并在很多命令中用到。理解这些概念可以帮助你编写高效的CMakeLists文件。

Before going into detail about CMake’s classes it is worth understanding their basic relationships. At the lowest level there are source files. These correspond to typical C or C++ source code files. Source files are combined into targets. A target is typically an executable or library. A directory represents a directory in the source tree and typically has a CMakeLists file and one or more targets associated with it. Every directory has a local generator that is responsible for generating the Makeﬁles or project ﬁles for that directory. All of the local generators share a common global generator that oversees the build process. Finally, the global generator is created and driven by the cmake class itself.

在深入了解这些类的实现细节之前，理解它们之间的关系是很有帮助的。最底层是源文件，对应C或者C++的源码文件。源文件组成目标。目标一般指代一个可执行文件或者程序库。目录表示源代码树所在文件夹，一般包含一个CMakeLists文件。里面定义了一个或多个目标。每个目录有个一个本地生成器来生成Makefiles或对应本目录的工程文件。所有的本地生成器共享一个全局生成器，监控构建过程。最后，全局生成器有cmake创建并驱动。

Figure 4 shows the basic class structure of CMake. We will now consider CMake's concepts in a bit more detail. CMake's execution begins by creating an instance of the cmake class and passing the command line arguments to it. This class manages the overall conﬁguration process and holds information that is global to the build process such as the cache values. One of the ﬁrst things the cmake class does is to create the correct global generator based on the user's selection of what generator to use (such as Visual Studio 10, Borland Makeﬁles, or UNIX Makefiles). At this point the cmake class passes control to the global generator it created by invoking the conﬁgure and generate methods.

图4显示了CMake类的基本结构。我们现在可以深入了解CMake的概念的更多细节。CMake执行时，先创建一个cmake类的对象，把命令行参数传递给它。这个类管理全部的配置过程并在构建过程中保存全局数据，如缓存项。首先cmake类根基用户选择的生成器（如Visual Studio 10，Borland Makefiles，或者UNIX Makefiles）创建全局生成器。然后cmake类将控制权传给它调用配置和生成方法生成的全局生成器。

The global generator is responsible for managing the conﬁguration and generation of all of the Makeﬁles (or project ﬁles) for a project. In practice most of the work is actually done by local generators which are created by the global generator. One local generator is created for each directory of the project that is processed. So while a project will have only one global generator it may have many local generators. For example, under Visual Studio 7 the global generator creates a solution ﬁle for the entire project while the local generators create a project ﬁle for each target in their directory.

全局生成器负责管理对应所有工程的Makefiles（或者工程文件）的配置和生成。实际上，由全局生成器创建的本地生成器完成了大部分的工作。每个本地生成器对应工程中的一个目录。所以一个工程有一个全局生成器和多个本地生成器。例如，在Visual Studio 7中全局生成器创建一个对应整个工程的解决方案文件，而本地生成器创建对应每个目标所在目录的工程文件。

In the case of the "Unix Makeﬁles" generator, the local generators create most of the Makeﬁles and the global generator simply orchestrates the process and creates the main top-level Makeﬁle. Implementation details vary widely among generators. The Visual Studio 6 generators make use of .dsp and .dsw ﬁle templates and perform variable replacements on them. The generators for Visual Studio 7 and later directly generate the XML output without using any ﬁle templates. The Makeﬁle generators including UNIX, NMake, Borland, etc use a set of rule templates and replacements to generate their Makeﬁles.

例如"Unix Makefiles"生成器，本地生成器生成大部分的Makefiles而全局生成器只管理整个过程并创建最顶部的Makefile。生成器的实现多种多样。VIsual Studio 6生成器使用.dsp和。dsw文件作为模板，替换它们中间的变量。Visual Studio 7及更高版本不使用模板直接生成XML文件。而Makefile生成器（包括UNIX，NMAKE，Borland，等等）使用一套规则模板，替换生成它们自己的Makefiles。

Each local generator has an instance of the class cmMakeﬁle, cmMakeﬁle is where the results of parsing the CMakeLists ﬁles are stored. Speciﬁcally, for each directory in a project there will be a single cmMakeﬁle instance which is why the cmMakeﬁle class is often referred to as the directory. This is clearer for build systems that do not use Makeﬁles. That instance will hold all of the information from parsing that directory's CMakeLists ﬁle (see Figure 5). One way to think of the cmMakeﬁle class is as a structure that starts out initialized with a few variables from its parent directory, and is then ﬁlled in as the CMakeLists ﬁle is processed. Reading in the CMakeLists ﬁle is simply a matter of CMake executing the commands it ﬁnds in the order it encounters them.

每个本地生成器有一个cmMakefile实例，它分析CMakeLists文件并保存结果。特别的，工程中的每个目录都会有一个cmMakefile实例，所以通常cmMakefile指代一个目录。这对于不使用Makefiles的构建系统是明确的。这个实例保存通过分析对应目录中的CMakeLists文件（参考图5）获得的信息。可以这样理解，cmMakefile类是一个结构体，它通过父目录的一些变量初始化，通过分析CMakeLIst文件保存信息。CMake按CMakeList文件中的命令顺序执行。

Each command in CMake is implemented as a separate C++ class, and has two main parts. The ﬁrst part of a command is the InitialPass method. The lnitialPass method receives the arguments and the cmMakefile instance for the directory currently being processed, and then performs its operations. In the case of the set command, it processes its arguments and if the arguments are correct it calls a method on the cmMakefile to set the variable. The results of the command are always stored in the cmMakefile instance. Information is never stored in a command. The last part of a command is the FinalPass. The FinalPass of a command is executed after all commands (for the entire CMake project) have had their InitialPass invoked. Most commands do not have a FinalPass, but in some rare cases a command must do something with global information that may not be available during the initial pass.

CMake中的每个命令由不同的C++类实现，主要分为两部分。命令的第一部分是InitialPass (初始化传递)方法。该方法接收参数，当前目录的cmMakefile实例开始执行操作。例如set命令，它处理传递进来的参数，如果参数正确，就调用cmMakefile去设置变量的值。命令执行的结果总是保存在cmMakefile实例中。信息不会保存在命令中。命令的第二部分是FinalPass(最终传递)，它执行在所有命令（整个CMake工程中的）执行完InitalPass之后。大多数命令没有FinalPass部分，但是有些特殊情况命令必须做某些设计全局信息的事情，而它在InitialPass阶段无法完成。

Once all of the CMakeLists ﬁles have been processed the generators use the information collected into the cmMakefile instances to produce the appropriate ﬁles for the target build system (such as Makeﬁles).

一旦所有的CMakeLists文件被处理完，生成器将收集到的信息传入cmMakefile实例，产生适用于目标构建系统的文件（如Makefiles）。

3.2 Targets

3.2 目标

Now that we have discussed the overall process of CMake, let us consider some of the key items stored in the cmMakefile instance. Probably the most important item is targets. Targets represent executables, libraries, and utilities built by CMake. Every add\_l ibrary, add\_executable, and add\_custom\_target command creates a target. For example, the following command will create a target named foo that is a static library, with foo1.c and foo2.c as source ﬁles.

现在我们开始全面讨论CMake的工作过程，cmMakefile实例保存了一些重要的条目。这里最重要的部分就是目标。目标指代由CMake构建的可执行文件，程序库，或者工具。每个add\_library，add\_executable和add\_custom\_targe命令创建一个目标。例如下面的命令创建一个叫做foo的目标，它使用源文件foo1.c和foo2.c构建静态程序库。

add\_library (foo STATIC foo1.c foo2.c)

The name foo is now available for use as a library name everywhere else in the project, and CMake will know how to expand the name into the library when needed. Libraries can be declared to be of a particular type such as STATIC, SHARED, MODULE, or left undeclared. STATIC indicates that the library must be built as a static library. Likewise SHARED indicates it must be built as a shared library. MODULE indicates that the library must be created so that it can be dynamically loaded into an executable. On many operating systems this is the same as SHARED, but on other systems such as Mac OS X it is different. If none of these options are speciﬁed this indicates that the library could be built as either shared or static. In that case CMake uses the setting of the variable BUILD\_SHARED\_LIBS to determine if the library should be SHARED or STATIC. If it is not set, then CMake defaults to building static libraries.

在整个工程中foo被用作程序库的名字，CMake知道怎样展开程序库的名字。程序库能够被声明成不同的类型，如静态库，共享库，模块，或者未声明。静态库指明程序库被构建为静态程序库。共享库是指构建成共享程序库。模块是指构建成程序库可以被可执行文件动态调用。在许多操作系统中，它和共享程序库是一样的，但是在Max OS X这类操作系统中是不同的。如果这个选项没有被指明，则表示它可以被构建成动态或者共享的。也就是说CMake通过变量BUILD\_SHARED\_LIBS判断程序库应该被构建成共享的还是静态的。如果该变量没有设置，CMake默认构建静态程序库。

Likewise executables have some options. By default an executable will be a traditional console application that has a main (int argc, const char\*argv[] ). If WIN32 is speciﬁed after the executable name then the executable will be compiled as a MS Windows executable and the operating system will call WinMain instead of main at startup. WIN32 has no effect on non-Windows systems.

另外，可执行文件文件也有一些可选项。默认情况下，可执行文件会被构建成传统的控制台程序，它有一个main(int argc, const char\* argv[])函数作为入口。如果可执行文件的把名字后面跟着WIN32，那么它将被编译成MS Windows可执行程序，入口函数就变成了WinMain。这在非Windows系统中无效。

In addition to storing their type, targets also keep track of general properties. These properties can be set and retrieved using the set\_target\_properties and get\_target\_property commands, or the more general set\_property and get\_property commands. The most commonly used property is LINK\_FLAGS, which is used to specify link ﬂags for a speciﬁc target. Targets store a list of libraries that they link against which are set using the target\_link\_libraries command. Names passed into this command can be libraries, full paths to libraries, or the name of a library from an add\_library command. They also store the link directories to use when linking, the install location for the target, and custom commands to execute after linking.

除了保存类型，目标也保存通用属性项。这些属性项可以通过命令被set\_target\_properties和get\_target\_property命令设置或取得，也可以使用set\_property和get\_property命令。最常用的属性项是LINK\_FLAGS，它被用来指明特定目标的连接标志位。目标保存由target\_link\_libraries命令设置的连接时使用的程序库列表。传入这个命令的名字可以是程序库的名字，可以是程序库的绝对地址，或者是使用add\_library命令指定的名字。它们也保存连接时使用的目录，目标安装路径，以及连接后执行的用户命令。

For each library CMake creates, it keeps track of all the libraries on which that library depends. Since static libraries do not link to the libraries on which they depend, it is important for CMake to keep track of the libraries so they can be speciﬁed on the link line of the executable being created. For example,

对于CMake创建的每个程序库，它都跟踪它们所依赖的程序库。因为静态程序库并不连接它们的依赖，所以当使用这些程序库连接可执行文件时保持跟踪它们所依赖的程序库就非常重要了。例如，

add‘library (foo foo.cxx)

target‘linkﬁlibraries (foo bar)

addiexecutable (foobar foobar.cxx)

target\_link\_libraries (foobar foo)

This will link the libraries foo and bar into the executable foobar even, although only foo was explicitly linked into foobar. With shared or DLL builds this linking is not always needed, but the extra linkage is harmless. For static builds this is required. Since the foo library uses symbols from the bar library, foobar will most likely also need bar since it uses foo.

这将会连接程序库foo和bar到可执行文件foobar，尽管只写明程序库foo连接到foobar。要是使用动态共享库或者动态链接库就不需要了，不过加上也没有坏处。对于静态程序库这是必须的。因为程序库foo使用程序库bar定义的标志，foobar很可能也需要bar。

3.3 Source Files

3.3 源文件

The source ﬁle structure is in many ways similar to a target. It stores the ﬁlename, extension, and a number of general properties related to a source ﬁle. Like targets you can set and get properties using set\_source\_files\_properties and get\_source\_file\_property, or the more generic versions. The most common properties include:

源文件的结构和目标的类似。它保存文件名，扩展名，和一系列的源文件相关通用属性项。和目标类似，你可以通过set\_source\_files\_properties和get\_source\_file\_property来设置和获得这些属性项。常用的属性项包括：

COMPILE\_FLAGS

编译标志位

Compile ﬂags speciﬁc to this source ﬁle. These can include source speciﬁc -D and -I ﬂags.

编译标志位是源码文件的属性项。可以通过-D和-I加入这些标志位。

GENERATED

生成的

The GENERATED property indicates that the source ﬁle is generated as part of the build process. In this case CMake will treat it differently for computation of dependencies because the source ﬁle may not exist when CMake is ﬁrst run.

“生成的”属性表示源码文件是在构建过程中生成的。CMake不会计算它的依赖，因为源码文件在CMake第一次运行时可能不存在。

OBJECT\_DEPENDS

对象依赖

Adds additional ﬁles on which this source ﬁle should depend. CMake automatically performs dependency analysis to determine the usual C, C++ and Fortran dependencies, This parameter is used rarely in cases where there is an unconventional dependency or the source ﬁles do not exist at dependency analysis time.

加入该源码文件的依赖。CMake自动进行依赖分析，决定是C，C++还是Fortran的依赖，这个参数并不常用如果源码文件在依赖分析时不存在，或者存在非常规依赖。

ABSTRACT

WRAP\_EXCLUDE

抽象包装排除

CMake doesn't directly use these properties. Some loaded commands and extensions to CMake look at these properties to determine how and when to wrap a C++ class into languages such as Tcl, Python, etc.

CMake并不直接使用这些属性项。有些CMake加载的命令和扩展查找这些属性项决定合适及如何包装一个C++类到其他语言，如Tcl，Python等等。

3.4 Directories, Generators, Tests, and Properties

3.4 目录，生成器，测试和属性项

in addition to targets and source ﬁles you may ﬁnd yourself occasionally working with other classes such as directories, generators, and tests. Normally such interactions take the shape of setting or getting properties from these objects. All of these Classes have properties associated with them, as do source ﬁles and targets. A property is a key—value pair attached to a speciﬁc object such as a target. The most generic way to access properties is through the set\_property and get\_property commands. These commands allow you to set or get a property from any class in CMake that has properties. Some of the properties for targets and source ﬁles have already been covered. Some useful properties for a directory include:

除了目标和源码文件，你可能还会遇到其他的概念如目录，生成器，和测试。一般的使用设置和获取方法属性项。所有这些类都有与之相关的属性项，这和源码文件及目标一样。属性项就是某些指定对象的一个键值对，如目标。访问属性项最通用的方式是使用set\_property和get\_property命令。这些命令允许你设置或获取CMake中的任何类的属性项。目标和源码文件的属性项有些已经介绍过了。下面是目录的一些比较有用的属性项：

ADDITIONAL\_MAKE\_CLEAN\_FILES：

额外需要清理的文件：

This property speciﬁes a list of additional ﬁles that will be cleaned as a part of the "make clean" stage. By default CMake will clean up any generated ﬁles that it knows about, but your build process may use other tools that leave ﬁles behind. This property can be set to a list of those ﬁles so that they also will be properly cleaned up.

这个属性项指定了一个在“清理”阶段额外需要清理的文件列表。默认情况下，CMake将清除它所知的生成的所有文件，但是构建过程可能使用其他工具生成文件，这些文件不被删除。该属性项设置一个额外需要删除的文件列表。

EXCLUDE\_FROM\_ALL

排除属性

This property indicates if all the targets in this directory and all sub directories should be excluded from the default build target. If it is not, then with a Makeﬁle for example typing make will cause these targets to be built as well. The same concept applies to the default build of other generators.

这个属性项表示该目录及其子目录中的所有目标将被排除在默认构建目标之外。如果没有设置该属性项，则对于是Makefile生成器，输入make项构建这些目标。对于其他生成器，该概念同样适用。

LISTFILE\_STACK

文件列表栈

This property is mainly useful when trying to debug errors in your CMake scripts. It returns a list of what list ﬁles are currently being processed, in order. So if one CMakeLists ﬁle does an include command then that is effectively pushing the included CMakeLists ﬁle onto the stack.

该属性项在检查CMake脚本错误时非常有用。它返回一个已经处理完的有序的文件列表。所以如果一个CMakeLists文件使用了include命令，它会有效的将包含的CMakeLists文件加入这个栈。

A full list of properties supported in CMake can be obtained by running cmake with the --help-property-list option. The generators and directories are automatically created for you as CMake processes your source tree.

运行cmake时使用--help-property-list选项将显示CMake所支持的完整的属性项列表。生成器和目录将在CMake处理你的源代码树时自动创建。

3.5 Variables and Cache Entries

3.5 变量和缓存项

CMakeLists files use variables much like any programming language. Variables are used to store values for later use, and can be a single value such as "ON" or "OFF", or they can represent a list such as(/usr/include /home/foo/include /usr/local/include). A number of useful variables are automatically deﬁned by CMake and are discussed in Appendix A - Variables.

CMakeLists文件像编程语言一样使用变量。变量用来存储之后要用到的值，它可以是简单的“ON”或“OFF”，或者可以是一个列表如(/usr/include /home/foo/include /usr/local/include)。一些有用的变量已经由CMake自动定义好了，我们在附件A-变量章节会继续讨论。

Variables in CMake are referenced using a ${VARIABLE} notation, and they are deﬁned in the order of execution of the set commands. Consider the following example:

变量在CMake中可以使用￥{VARIABLE}重新定义，它们按set命令执行的顺序定义。请参考下面的例子：

# FOO is undefined

set (FOO 1)

# FOO is now set to 1

set (FOO 0)

# FOO is now set to 0

This may seem straightforward, but consider the following example:

这可能有点简单，请看下面的例子：

set (FOO 1)

if (${FOO} LESS 2)

set (FOO 2)

else (${FOO} LESS 2)

set (FOO 3)

endif (${FOO} LESS 2)

Clearly the if statement is true, which means that the body of the if statement will be executed. That will set the variable FOO to 2, and so when the else statement is encountered FOO will have a value of 2. Normally in CMake the new value of FOO would be used, but the else statement is a rare exception to the rule and always refers back to the value of the variable when the if statement was executed. So in this case the body of the else clause will not be executed. To further understand the scope of variables consider this example:

首先，如果if判断为真，那么条件语句体将被执行。变量FOO的值会被设成2，else语句判断时FOO的值就会是2。正常情况下，在CMake中会使用FOO变量的新值，但是else语句使用特殊规则，它使用if语句时变量的值判断。所以这种情况下else后面的语句体将不被执行。下面的例子有助于理解变量的作用域：

set (foo 1)

# process the dir1 subdirectory

add\_subdirectory (dir1)

# include and process the commands in file1.cmake

include (file1.cmake)

set (bar 2)

# process the dir2 subdirectory

add\_subdirectory (dir2)

# include and process the commands in file2.cmake

include (file2.cmake)

In this example because the variable foo is deﬁned at the beginning, it will be deﬁned while processing both dir1 and dir2. In contrast bar will only be deﬁned when processing dir2. Likewise foo will be deﬁned when processing both ﬁle1.cmake and ﬁle2.cmake, whereas bar will only be deﬁned while processing ﬁle2.cmake.

在这个例子中变量foo在一开始就定义了，在处理dir1和dir2的过程中，它一直有效。相反的，变量bar只在处理dir2的过程中有效。同样的foo在处理file1.cmake和file2.cmake时有效，而bar只在处理file2.cmake时有效。

Variables in CMake have a scope that is a little different from most languages. When you set a variable it is visible to the current CMakeLists ﬁle or function, as well as any subdirectory’s CMakeLists ﬁles, any functions or macros that are invoked, and any ﬁles that are included using the INCLUDE command. When a new subdirectory is processed (or a function called) a new variable scope is created and initialized with the current value of all variables in the calling scope. Any new variables created in the child scope, or changes made to existing variables, will not impact the parent scope. Consider the following example:

CMake中变量的作用域同大多数语言有一些区别。当你设置了一个变量，它对于当前CMakeList文件或函数是可见的，而且对于子目录CMakeLists文件，函数，宏，以及使用include命令包含的文件也可见。当处理一个新的子目录时（或者函数调用时），生成一个新的变量的作用域，使用调用时的变量的值对它进行初始化。新的变量在子作用域中被创建，或者转存到已经存在的变量中，它不会影响父作用域。请参考下面的例子：

function (foo)

message (${test}) # test is 1 here

set (test 2)

message (${test}) # test is 2 here, but only in this scope

endfunction()

set (test 1)

foo()

message (${test}) # test will still be 1 here

In some cases you might want a function or subdirectory to set a variable in its parent’s scope. This is one way for CMake to return a value from a function, and it can be done by using the PARENT\_SCOPE option with the set command. We can modify the prior example so that the function foo changes the value of test in its parent’s scope as follows:

某些时候你可能想要一个函数或者子目录设置父作用域中的变量。这是CMake使用函数返回值的方式，可以通过set命令使用PARENT\_SCOPE选项来实现。我们可以修改之前的例子使得函数foo改变父作用域变量test的值，例子如下：

function (foo)

message (${test}) # test is 1 here

set (test 2 PARENT\_SCOPE)

message (${test}) # test still 1 in this scope

endfunction()

set (test 1)

foo()

message (${test}) # test will now be 2 here

Variables can also represent a list of values. In these cases when the variable is expanded it will be expanded into multiple values. Consider the following example:

变量也可以表示为值的列表。在这种情况下当变量将展开成多个值的形式。请看下面的例子：

# set a list of items

set (items\_to\_buy apple orange pear beer)

# loop over the items

foreach (item ${items\_to\_buy})

message ( "Don’t forget to buy one ${item}" )

endforeach ()

In some cases you might want to allow the user building your project to set a variable from the CMake user interface. In that case the variable must be a cache entry. Whenever CMake is run it produces a cache file in the directory where the binary ﬁles are to be written. The values of this cache file are displayed by the CMake user interface. There are a few purposes of this cache. The first is to store the user's selections and choices, so that if they should run CMake again they will not need to reenter that information. For example, the option command creates a Boolean variable and stores it in the cache.

某种情况下你可能允许用户使用CMake用户界面去设置一些变量，来构建你的工程。这种情况下，变量必须是缓存项。每次CMake运行，它都在构建目录下产生一个缓存文件。这个缓存文件的内容显示在CMake用户界面中。这样做有几个目的。 首先是保存用户选项，再执行CMake时不必重新选一次。例如，option命令生成一个布尔型变量，并保存在缓存中。

option (USE\_JPEG "Do you want to use the jpeg library")

The above line would create a variable called USE\_JPEG and put it into the cache. That way the user can set that variable from the user interface and its value will remain in case the user should run CMake again in the future. To create a variable in the cache you can use commands like option, findifile, or you can use the standard set command with the CACHE option.

上面这一行生成一个变量USE\_JPEG并把它放入缓存中。这样用户可以通过用户交互界面设置变量的值，