



# CMake: Improving Software Quality and Process

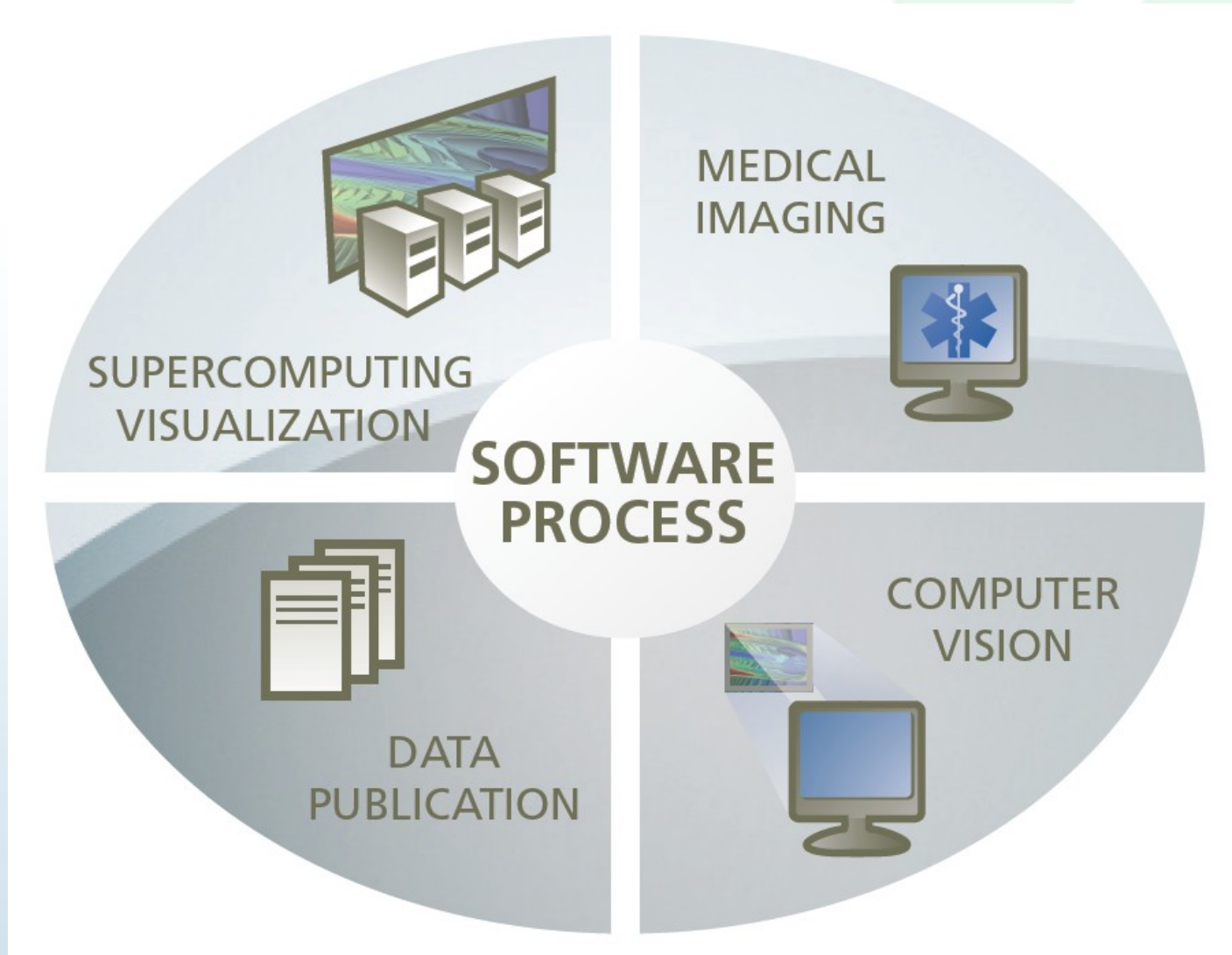
January 17, 2010  
Camp KDE

Dr. Marcus D. Hanwell  
R&D Engineer  
Kitware, Inc.  
[marcus.hanwell@kitware.com](mailto:marcus.hanwell@kitware.com)

# Kitware: The Company

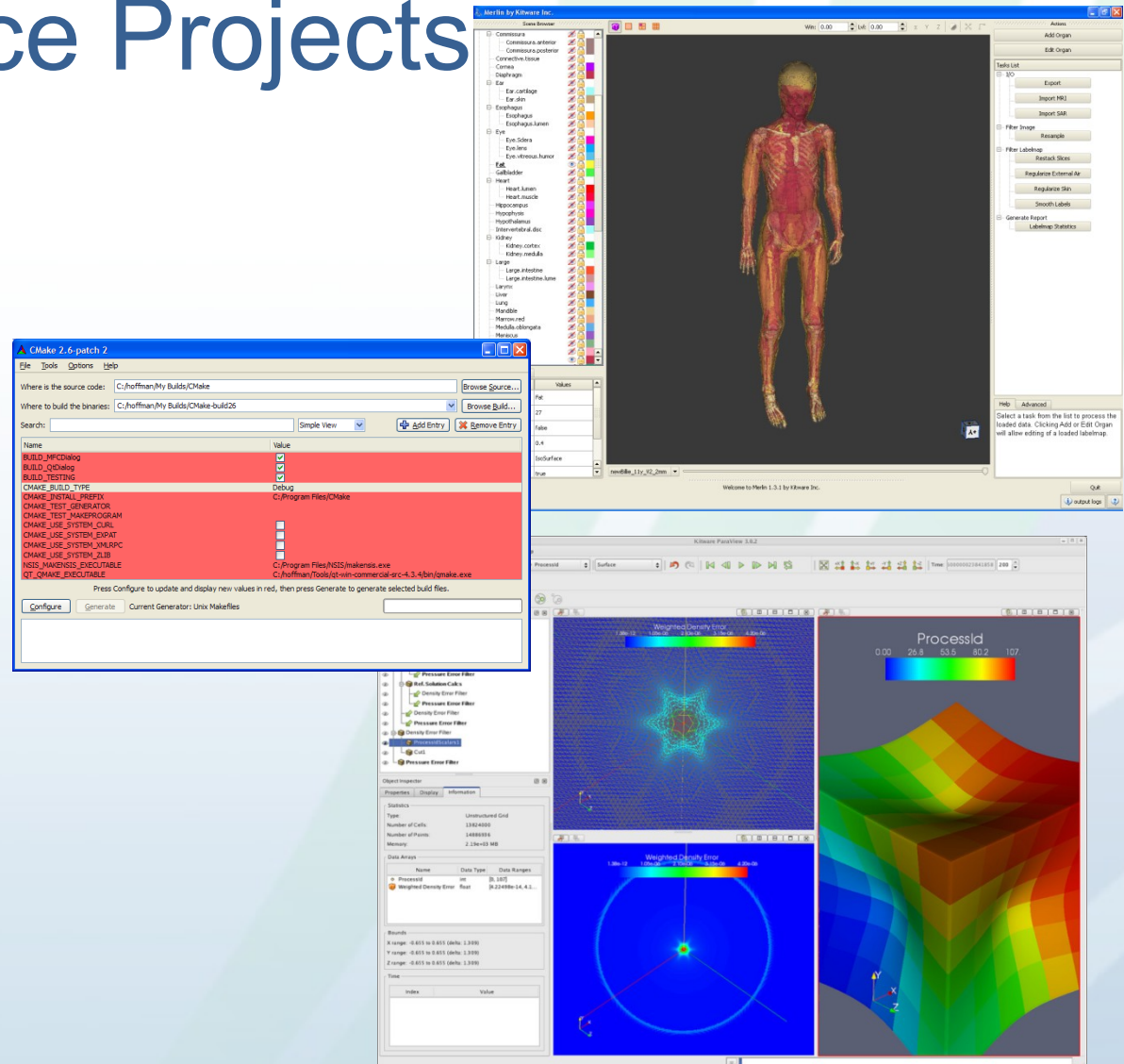
- Founded in 1998
- Founded by 5 previous employees of GE Corporate Research
- Privately held, profitable from creation
- Revenues projected at \$9 million in 2009
  - ~\$14 million if subcontractors are included
- Approximately 65 employees
  - ~30% growth in 2009
  - More than 30 PhDs

# Kitware: Core Technologies



# Open Source Projects

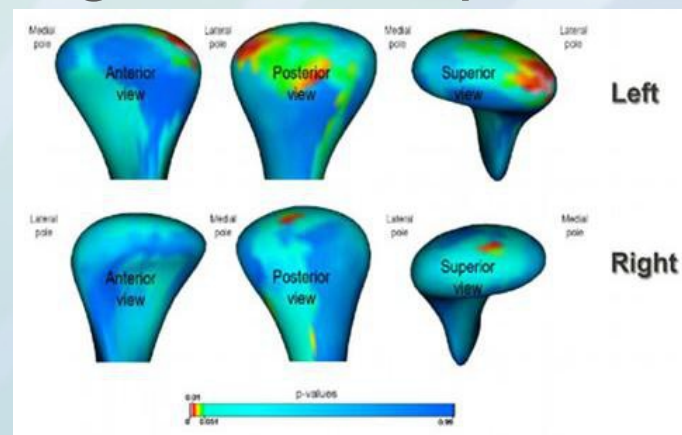
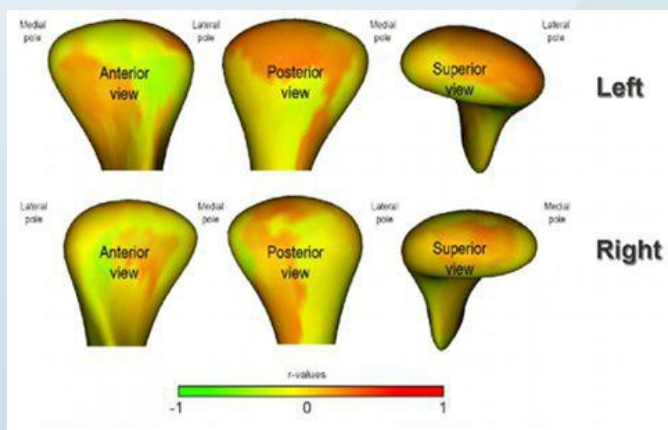
- CMake
- CDash
- VTK
- ITK
- ParaView
- IGSTK
- BatchMake



# NAMIC: National Alliance for Medical Computing

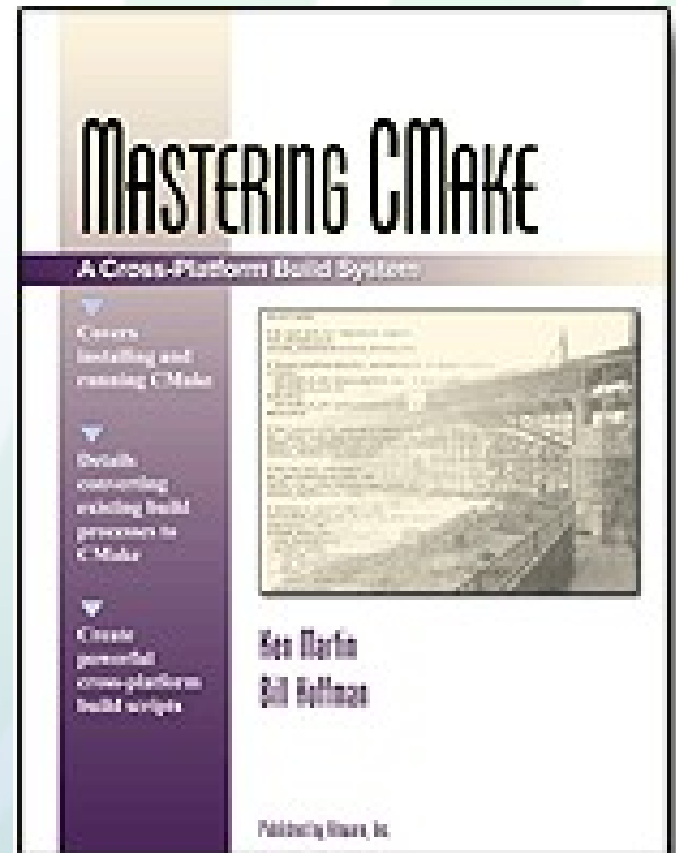


- An NIH national center for biomedical computing
- Kitware leads the NAMIC engineering core
- Committed to open science (source and data)
- New funding to port Slicer (open source) to Qt
- Aimed at leading edge clinical researchers
- More funding bodies are seeing value in open source

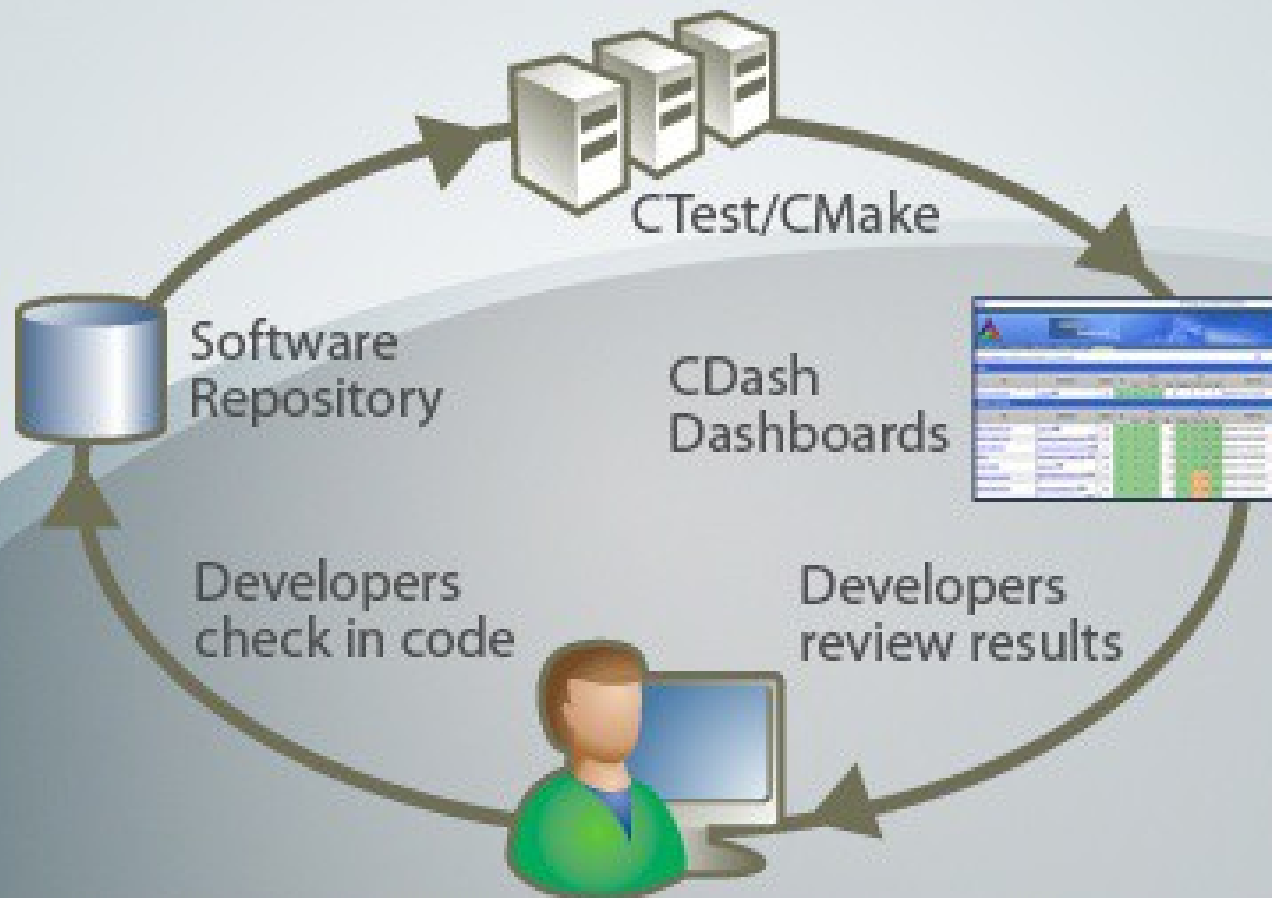


# CMake: Cross Platform Build System

- Why CMake?
- CMake features
- Using CMake
- Creating CMake input files
- Where to get help
  - Mastering CMake book
  - Web page: [www.cmake.org](http://www.cmake.org)
  - <http://www.cmake.org/Wiki/CMake>
  - mailing list: [cmake@cmake.org](mailto:cmake@cmake.org)



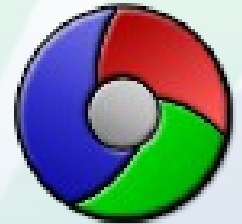
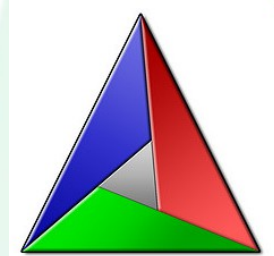
# Kitware Quality Software Process





# Key Components

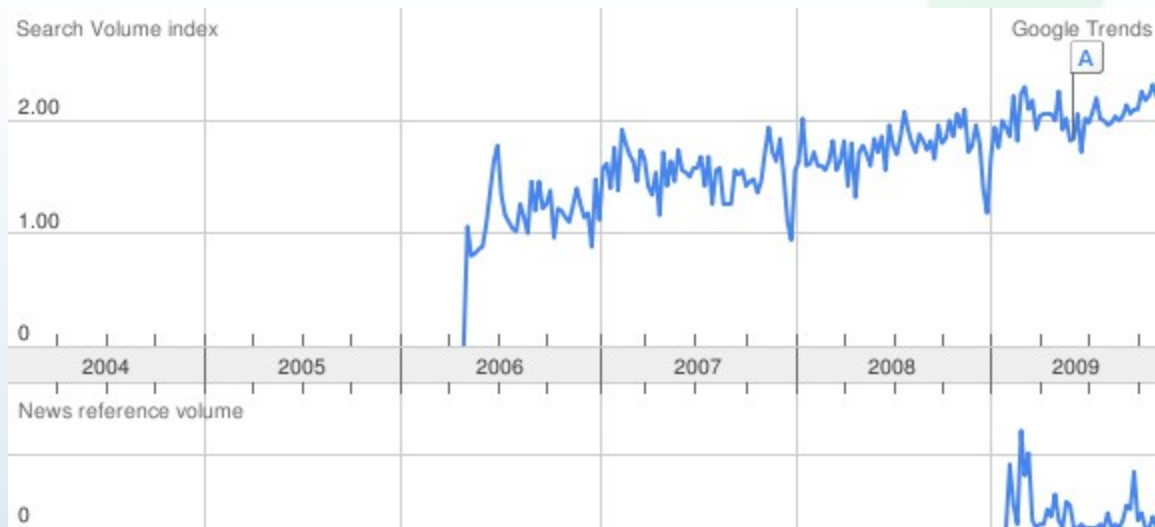
- CMake
  - Cross platform build
- CTest
  - Software testing and submission
- CDash
  - Aggregation of test results on a web server
- CPack
  - Cross platform software packaging





# Why CMake? Everyone is using it

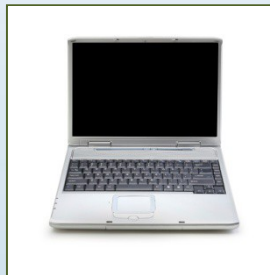
## KDE 2006 – Tipping Point!



- 1200+ downloads per day from [www.cmake.org](http://www.cmake.org)
- Major Linux distributions and Cygwin provide CMake packages
- KDE, Second Life, Boost (experimentally), many others

# How CMake Changes The Way We Build C++

- Boost aims to give C++ a set of useful libraries like Java, Python, and C#
- Give C++ compile portability, like the compile once and run everywhere of Java, and C#
  - Same build tool and files for all platforms
  - Easy to mix both large and small libraries



# Who Is Involved?

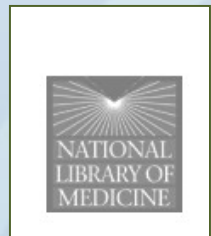
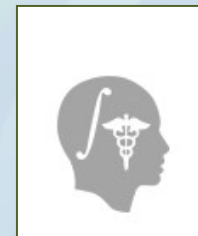
## Users

- KDE
- Second Life
- ITK
- VTK
- ParaView
- Trilinos
- Scribus
- Boost (experimentally)
- MySQL
- LLVM
- Many more



## Supporters

- Kitware
- ARL
- National Library of Medicine
- Sandia National Labs
- Los Alamos National Labs
- NAMIC



# Autonomous Systems Use CMake!



Argo is fully automated, with the onboard computers using code built using CMake. The helicopter is also semi-automated with similar code built using CMake!

# CMake Features

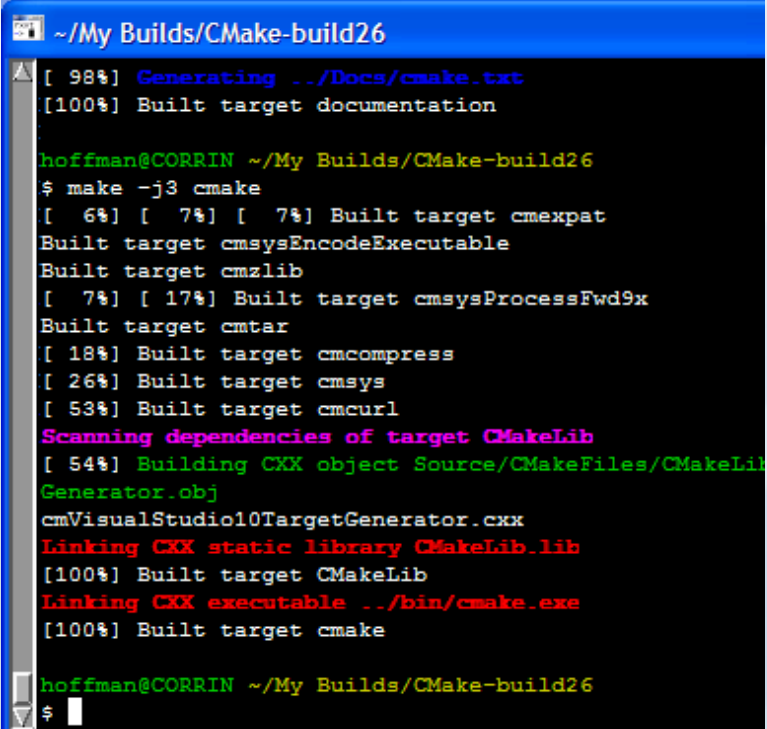
- One simple language for all platforms
  - Windows, Mac OS X, Linux, UNIX variants
  - HPC/embedded platforms via cross-compilation (ParaView/Python)
- Generates native build systems
  - Makefiles (GNU, NMake, Borland, etc.)
  - KDevelop, Eclipse
  - Visual Studio 6, 7, 8, 9 IDE
  - Xcode
- Out-of-source build trees leave source clean
- Interactive configuration via GUI
- Multiple configurations (debug, release, etc.)



# CMake Features - continued

- Automatic analysis
  - Implicit dependencies (C, C++, Fortran)
  - Transitive link dependencies
  - Ordering of linker search path and RPATH

- Advanced Makefile generation
  - Modular, Fast, Parallel
  - Color and progress display
  - Help targets – make help
  - Preprocessor targets – make foo.i
  - Assembly targets – make foo.s



```
~/My Builds/CMake-build26
[ 98%] Generating ../Docs/cmake.txt
[100%] Built target documentation

hoffman@CORRIN ~/My Builds/CMake-build26
$ make -j3 cmake
[ 6%] [ 7%] [ 7%] Built target cmexpat
Built target cmsysEncodeExecutable
Built target cmzlib
[ 7%] [ 17%] Built target cmsysProcessFwd9x
Built target cmtar
[ 18%] Built target cmcompress
[ 26%] Built target cmsys
[ 53%] Built target cmcurl
Scanning dependencies of target CMakeLib
[ 54%] Building CXX object Source/CMakeFiles/CMakeLib
Generator.obj
cmVisualStudio10TargetGenerator.cxx
Linking CXX static library CMakeLib.lib
[100%] Built target CMakeLib
Linking CXX executable ../bin/cmake.exe
[100%] Built target cmake

hoffman@CORRIN ~/My Builds/CMake-build26
$
```

# Input to CMake

- Simple scripting language in CMakeLists.txt file(s)
- Built-in commands for common rules

- `add_library(MyLib MyLib.cxx)`
  - `add_executable(MyExe MyMain.cxx)`

- **Example project using Qt 4 and new syntax:**

```
cmake_minimum_required(VERSION 2.8)
project(QtProject)
find_package(Qt4 4.5.2
    COMPONENTS QtCore QtGui QtOpenGL REQUIRED)
include(${QT_USE_FILE})
add_executable(mycoolapp main.cpp)
target_link_libraries(mycoolapp ${QT_LIBRARIES})
```



# Input to CMake: KDE Application

- Very little needs to change,

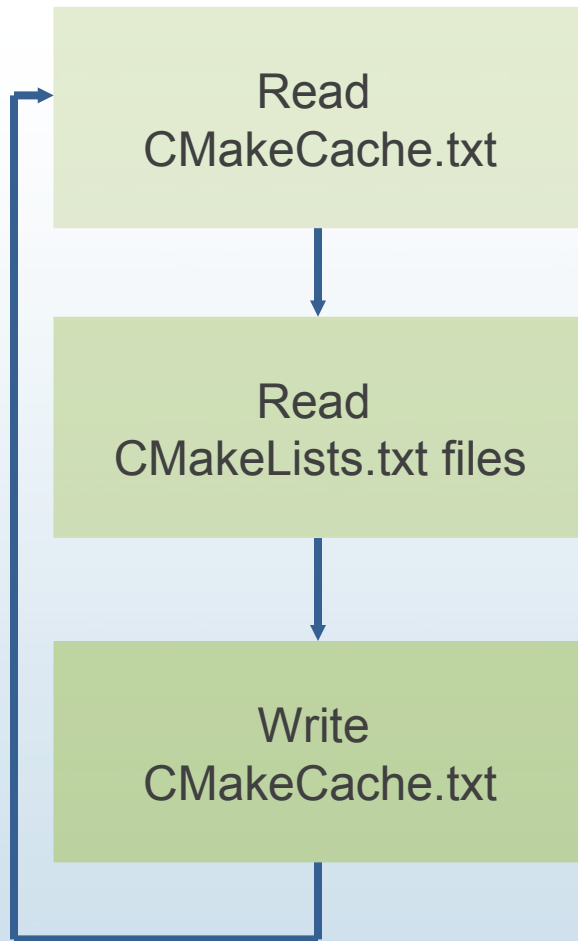
```
cmake_minimum_required(VERSION 2.8)
project(KDEProject)
find_package(KDE4 4.4 REQUIRED)
include(KDE4Defaults)
include_directories(${KDE4_INCLUDES})
kde4_add_executable(mykdeapp main.cpp)
target_link_libraries(mykdeapp
    ${KDE4_KDEUI_LIBS})
install(TARGETS mykdeapp
    ${INSTALL_TARGETS_DEFAULT_ARGS})
```

# CMake Scripts

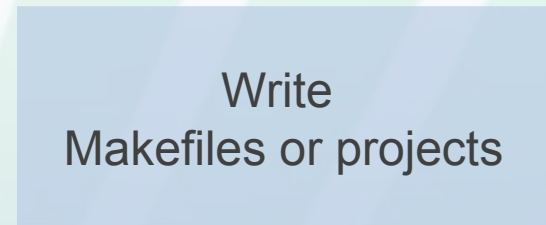
- `cmake -E` command
  - Cross platform command line utility
  - E.g. copy or remove files, conditionally copy...
- `cmake -P script.cmake`
  - Cross platform scripting utility
  - Does not generate a CmakeCache
  - Ignores all commands specific to build environment generation

# CMake Process

## Configure Step



## Generate Step



# Automatic Testing Benefits

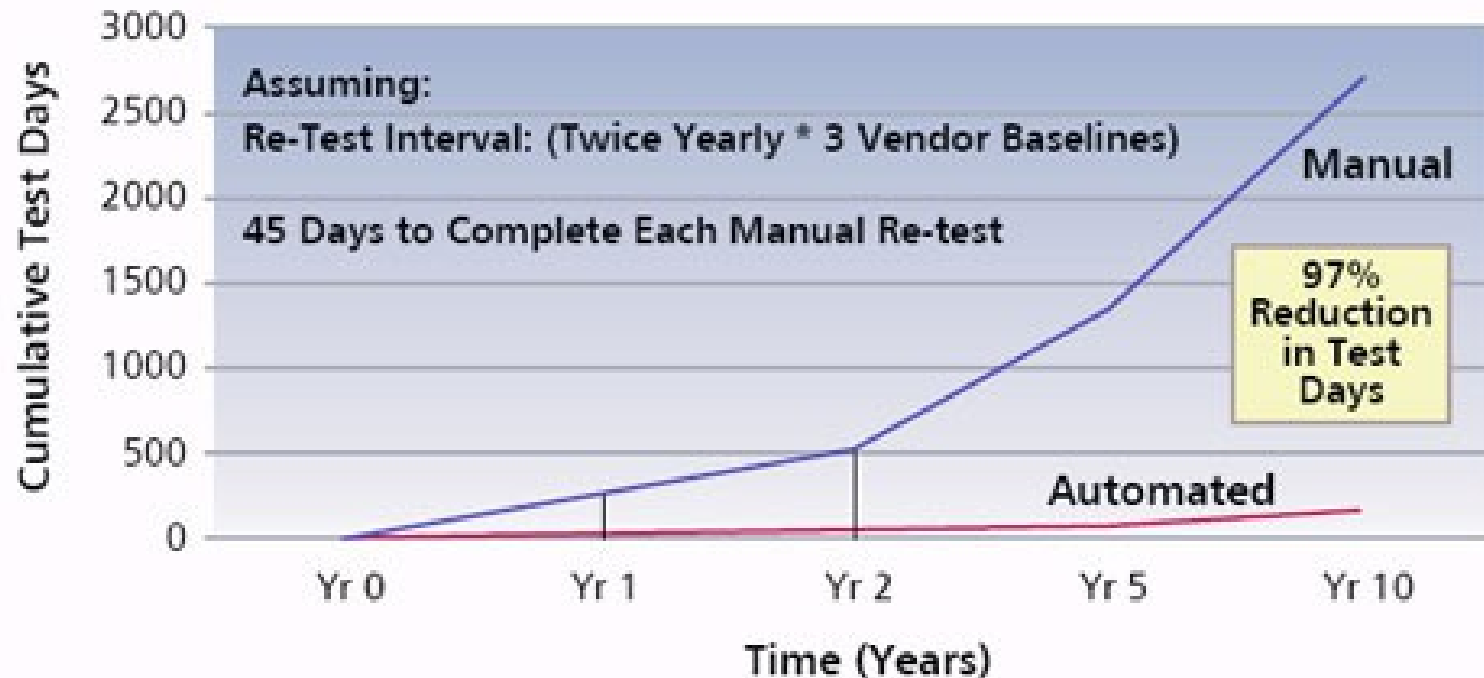
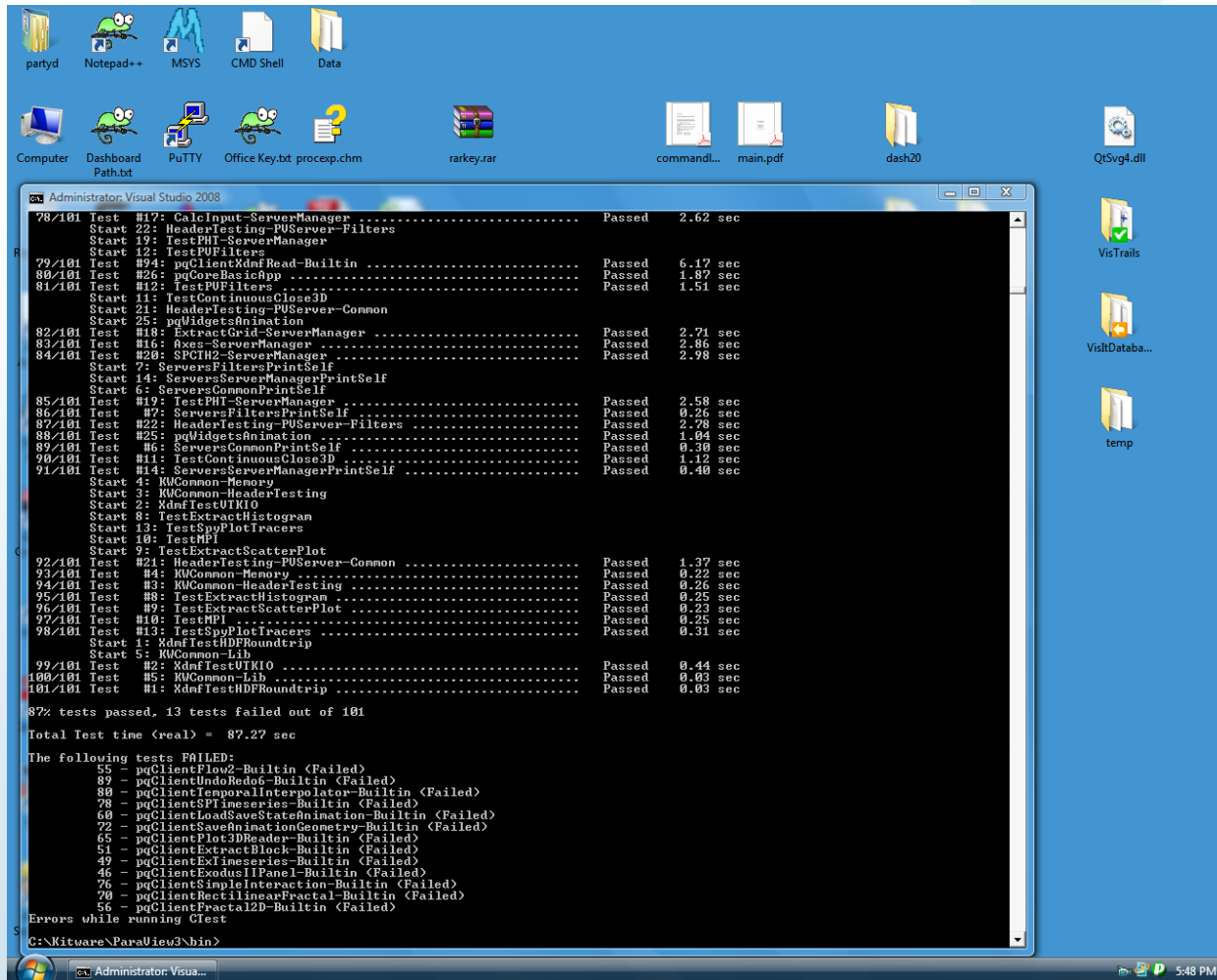


Figure 2. "Example Automated Software Testing Savings over Time"

“Automated Software Testing,”  
1999, Dustin, et al, Addison Wesley

# Video of ParaView Nightly Testing



The screenshot shows a Windows XP desktop with a blue background. The taskbar at the bottom displays the Start button, a search bar, and several open applications including 'Administrator: Visual Studio 2008'. The desktop contains various icons for folders like 'partyd', 'Data', and 'temp', as well as application shortcuts like 'Notepad++', 'MSYS', 'CMD Shell', 'DashBoard Path.txt', 'PuTTY', 'Office Key.txt', 'proexp.chm', 'rarkey.rar', 'command...', 'main.pdf', 'dash20', and 'QtSvg4.dll'. The 'Administrator: Visual Studio 2008' window is open, displaying a large text window with test results. The text shows a list of tests, their status (Passed or Failed), and the time taken for each. At the bottom of the text window, it states '87% tests passed, 13 tests failed out of 101' and 'Total Test time (real) = 87.27 sec'. The failed tests are listed below.

```
78/101 Test #17: CalcInput-ServerManager ..... Passed 2.62 sec
Start 22: HeaderTesting-PUServer-Filters
Start 19: TestPHI-ServerManager
Start 12: TestPUFilters
79/101 Test #94: pqClientXdmfRead-Builtin ..... Passed 6.17 sec
80/101 Test #26: pqConeBasicHpp ..... Passed 1.87 sec
81/101 Test #12: TestPUFilters ..... Passed 1.51 sec
Start 11: TestContinuousClose3D
Start 21: HeaderTesting-PUServer-Common
Start 25: pqWidgetsAnimation
82/101 Test #18: ExtractGrid-ServerManager ..... Passed 2.71 sec
83/101 Test #16: Axes-ServerManager ..... Passed 2.86 sec
84/101 Test #20: SPC1H2-ServerManager ..... Passed 2.98 sec
Start 7: ServersFiltersPrintSelf
Start 14: ServersServerManagerPrintSelf
Start 6: ServersCommonPrintSelf
85/101 Test #19: TestPHI-ServerManager ..... Passed 2.58 sec
86/101 Test #7: ServersFiltersPrintSelf ..... Passed 0.26 sec
87/101 Test #22: HeaderTesting-PUServer-Filters ..... Passed 2.78 sec
88/101 Test #25: pqWidgetsAnimation ..... Passed 1.04 sec
89/101 Test #6: ServersCommonPrintSelf ..... Passed 0.30 sec
90/101 Test #11: TestContinuousClose3D ..... Passed 1.12 sec
91/101 Test #14: ServersServerManagerPrintSelf ..... Passed 0.40 sec
Start 4: KWCommon-Memory
Start 3: KWCommon-HeaderTesting
Start 2: XdmfTestUTKIO
Start 8: TestExtractHistogram
Start 13: TestSpyPlotTracers
Start 10: TestPHI
Start 9: TestExtractScatterPlot
92/101 Test #21: HeaderTesting-PUServer-Common ..... Passed 1.37 sec
93/101 Test #4: KWCommon-Memory ..... Passed 0.22 sec
94/101 Test #3: KWCommon-HeaderTesting ..... Passed 0.26 sec
95/101 Test #8: TestExtractHistogram ..... Passed 0.25 sec
96/101 Test #9: TestExtractScatterPlot ..... Passed 0.23 sec
97/101 Test #10: TestPHI ..... Passed 0.25 sec
98/101 Test #13: TestSpyPlotTracers ..... Passed 0.31 sec
Start 1: XdmfTestHDFRoundtrip
Start 5: KWCommon-Lib
99/101 Test #2: XdmfTestUTKIO ..... Passed 0.44 sec
100/101 Test #5: KWCommon-Lib ..... Passed 0.03 sec
101/101 Test #1: XdmfTestHDFRoundtrip ..... Passed 0.03 sec

87% tests passed, 13 tests failed out of 101
Total Test time (real) = 87.27 sec

The following tests FAILED:
55 - pqClientFlow2-Builtin (Failed)
89 - pqClientUndoRedo6-Builtin (Failed)
80 - pqClientTemporalInterpolator-Builtin (Failed)
78 - pqClientSPTimeSeries-Builtin (Failed)
60 - pqClientLoadSaveStateAnimation-Builtin (Failed)
72 - pqClientSaveAnimationGeometry-Builtin (Failed)
65 - pqClientPlot3DHeader-Builtin (Failed)
51 - pqClientExtractBlock-Builtin (Failed)
49 - pqClientExTimeSeries-Builtin (Failed)
46 - pqClientExodusIIPanel-Builtin (Failed)
76 - pqClientSplineInterpolator-Builtin (Failed)
70 - pqClientRectilinearFractal-Builtin (Failed)
56 - pqClientFractal2D-Builtin (Failed)

Errors while running CTest
C:\Kitware\ParaView\bin>
```

# CDash Dashboard [www.cdash.org](http://www.cdash.org)

CDash - CMake - Mozilla Firefox

http://public.kitware.com/CDash/index.php?project=CMake

Kitware WIKI Dell CDash Dash1old CDash Public Road Runner Web Mail Kitware Calendar Kitware Inc. public.kitware.com: D... CNN.com - Breaking ... CMake Cross Platfor...

Google ugly duckling Search Bookmarks Check AutoLink AutoFill Send to ugly duckling Settings

Start Ora... TravelSer... CDash... can anyon... Communic... PackageM... Re: postfli... LOCAPHO... http:...dges Qt 4.3: Q... Hotel Nov... Google Maps

**CMAKE Dashboard**

DASHBOARD CALENDAR PREVIOUS CURRENT NEXT PROJECT

[Nightly Changes](#) as of 2008-02-20 21:00:00 EST

**Style** [Nightly Expected] [Nightly 2.4 Release] [Nightly] [Continuous] [Experimental] [Coverage] [Dynamic Analysis]

Site	Build Name	Update	Cfg	Build			Test					Build Date
				Error	Warn	Min	NotRun	Fail	Pass	NA	Min	
<a href="#">insight.journal.kitware</a>	<a href="#">KWStyle</a>	7	0	0	0	0	0					2008-02-21 02:28:33 EST

**Nightly Expected** [Style] [Nightly 2.4 Release] [Nightly] [Continuous] [Experimental] [Coverage] [Dynamic Analysis]

Site	Build Name	Update	Cfg	Build			Test					Build Date
				Error	Warn	Min	NotRun	Fail	Pass	NA	Min	
<a href="#">Titanium.IMTS.us</a>	<a href="#">Linux64-Rocks-ICC-Rel</a>	107	0	0	0	10.7	0	0	93	0	8.1	2008-02-21 10:23:00 EST
<a href="#">krondor.kitware</a>	<a href="#">Darwin-c++</a>	0	0	0	0	59.1	0	1	95	0	55.2	2008-02-21 09:56:00 EST
<a href="#">dash8.kitware</a>	<a href="#">Linux64-g++332</a>	0	0	0	0	6.3	0	0	95	0	18.3	2008-02-21 08:02:00 EST
<a href="#">RogueResearch3</a>	<a href="#">Mac10.5-CMake-Xcode-dbg-ppc64</a>	1	0	0	0	13.1	0	0	90	0	23.4	2008-02-21 05:15:00 EST
<a href="#">RogueResearch3</a>	<a href="#">Mac10.5-CMake-Xcode-dbg-ppc</a>	1	0	0	0	13	0	0	90	0	23.9	2008-02-21 04:28:00 EST

Find: qfilein Next Previous Highlight all Match case

Done

# CDash Subproject Support

CDash - Trilinos - Mozilla Firefox

File Edit View History Bookmarks Tools Help

http://trilinos-dev.sandia.gov/cdash/index.php?project=Trilinos&date=20090430

Most Visited Getting Started Latest Headlines Kitware Inc. CDash CDash - CMB Free Online Broken Lin... CMake Only Errors CMake Bugs Kitware Proposal Man... ARL CDash CNN.com - Breaking N... The New York Times - ...

Google Search

CDash - Trilinos

DASHBOARD CALENDAR PROJECT SUBPROJECTS

**Main Project**

Project

Project	Configure			Build			Test			Last submission
	Error	Warning	Pass	Error	Warning	Pass	Not Run	Fail	Pass	
<a href="#">Trilinos</a>	0	0	208	1	117	91	0	8	5227	2009-04-30 12:54:32

**SubProjects**

Project	Configure			Build			Test			Last submission
	Error	Warning	Pass	Error	Warning	Pass	Not Run	Fail	Pass	
<a href="#">Teuchos</a>	0	0	6	0	0	6	0	0	386	2009-04-30 16:59:38
<a href="#">RTOP</a>	0	0	5	0	0	5	0	0	95	2009-04-30 17:00:49
<a href="#">Kokkos</a>	0	0	5	0	0	5	0	0	10	2009-04-30 17:01:00
<a href="#">Epetra</a>	0	0	5	0	3	2	0	0	128	2009-04-30 17:01:14
<a href="#">Zoltan</a>	0	0	6	0	6	0	0	0	9	2009-04-30 18:08:12
<a href="#">Shards</a>	0	0	5	0	5	0	0	0	20	2009-04-30 17:02:09
<a href="#">Intrepid</a>	0	0	5	0	2	3	0	0	8	2009-04-30 17:10:38



# CDash: Query Filters

CDash - Trilinos - Mozilla Firefox

File Edit View History Bookmarks Tools Help

http://trilinos-dev.sandia.gov/cdash/index.php?project=Trilinos&display=project&filtercount=4&showfile

Most Visited Getting Started Latest Headlines Kitware Inc. CDash CDash - CMB Free Online Broken Lin... CMake Only Errors CMake Bugs

Google Search

CDash - Trilinos

## Trilinos Dashboard

DASHBOARD CALENDAR PREVIOUS CURRENT PROJECT

No file changed as of 2009-04-30T00:00:00 MDT [Help](#)

[\[Hide Filters\]](#)

Match  of the following rules:

Build Name	is	Linux-GCC-4.1.2-MPI_DEBUG	-	+
Site	is	godel.sandia.gov	-	+
Build Time	is after	2009-04-30T10:58:53 MDT	-	+
Build Time	is before	2009-04-30T12:02:16 MDT	-	+

### Nightly

Site	Build Name	Update		Configure			Build			Test				Build Time	Labels
		Files	Min	Error	Warn	Min	Error	Warn	Min	NotRun	Fail	Pass	Min		
<a href="#">godel.sandia.gov</a>	<a href="#">Linux-GCC-4.1.2-MPI_DEBUG</a>	0	0	0	0	0.1	0	0	1.2	0	0	40 +39	0.7	2009-04-30T11:40:16 MDT	Rythmos
<a href="#">godel.sandia.gov</a>	<a href="#">Linux-GCC-4.1.2-</a>	0	0	0	0	0	0	0	0.1	0	0	7	0.1	2009-04-30T11:09:49	AsterCC

Done

# CTest Command Wrappers

**Build Time:**2009-05-04T01:53:37 MDT

Found 1 Warnings

[Errors](#) are here.

**Warning while building C++ object file "CMakeFiles/Kokkos\_BaseSparseSolve.dir/cxx\_main.cpp.o" in target Kokkos\_BaseSparseSolve.**

Source File	packages/kokkos/test/BaseSparseSolve/cxx_main.cpp
Label	Kokkos
Command	<pre>"/Users/bmpersc/bin/gcc-4.3.3/bin/g++" "-mmacosx-version-min=10.5" "-ansi" "-pedantic" "-Wall" "-Wno-long-long" "-Wwrite-strings" "-g" "-O0" "-D_GLIBCXX_DEBUG" "-I/Users/bmpersc/nightly/Trilinos.base/SERIAL_DEBUG/BUILD/packages/kokkos/src" "-I/Users/bmpersc/nightly/Trilinos.base/SERIAL_DEBUG/Trilinos/packages/kokkos/src" "-I/Users/bmpersc/nightly/Trilinos.base/SERIAL_DEBUG/Trilinos/packages/kokkos/test/BaseSparseSolve/./BaseSparseMultiply" "-o" "CMakeFiles/Kokkos_BaseSparseSolve.dir/cxx_main.cpp.o" "-c" "/Users/bmpersc/nightly/Trilinos.base/SERIAL_DEBUG/Trilinos/packages/kokkos/test/BaseSparseSolve/cxx_main.cpp"</pre>
Directory	/Users/bmpersc/nightly/Trilinos.base/SERIAL_DEBUG/BUILD/packages/kokkos/test/BaseSparseSolve
Exit Condition	0
Standard Output	
Standard Error	<pre>/Users/bmpersc/nightly/Trilinos.base/SERIAL_DEBUG/Trilinos/packages/kokkos/src/Kokkos_BaseSparseSolve.hpp: In member functio /Users/bmpersc/nightly/Trilinos.base/SERIAL_DEBUG/Trilinos/packages/kokkos/test/BaseSparseSolve/cxx_main.cpp:262: instanti /Users/bmpersc/nightly/Trilinos.base/SERIAL_DEBUG/Trilinos/packages/kokkos/src/Kokkos_BaseSparseSolve.hpp:646: warning: sugg /Users/bmpersc/nightly/Trilinos.base/SERIAL_DEBUG/Trilinos/packages/kokkos/src/Kokkos_BaseSparseSolve.hpp:693: warning: sugg /Users/bmpersc/nightly/Trilinos.base/SERIAL_DEBUG/Trilinos/packages/kokkos/src/Kokkos_BaseSparseSolve.hpp: In member functio /Users/bmpersc/nightly/Trilinos.base/SERIAL_DEBUG/Trilinos/packages/kokkos/test/BaseSparseSolve/cxx_main.cpp:287: instanti /Users/bmpersc/nightly/Trilinos.base/SERIAL_DEBUG/Trilinos/packages/kokkos/src/Kokkos_BaseSparseSolve.hpp:541: warning: sugg /Users/bmpersc/nightly/Trilinos.base/SERIAL_DEBUG/Trilinos/packages/kokkos/src/Kokkos_BaseSparseSolve.hpp:583: warning: sugg</pre>



CDash 1.5.0 © 2009 [Kitware Inc.](#)  
[\[report problems\]](#)



# Coverage: GCov/Bullseye

<a href="#">./Source/CTest/cmCTestUpdateHandler.cxx</a>	68.21%	45	1
<a href="#">./Source/cmMakefileLibraryTargetGenerator.cxx</a>	68.48%	60	2
<a href="#">./Source/cmTargetLinkLibrariesCommand.cxx</a>	69.17%	17	1
<a href="#">./Source/cmGetPropertyCommand.cxx</a>	69.31%	36	2
<a href="#">./Source/cmExportInstallFileGenerator.cxx</a>	69.32%	16	2
<a href="#">./Source/kwsys/ProcessUNIX.c</a>	69.33%	371	11
<a href="#">./Source/cmVariableWatch.cxx</a>	69.44%	8	1
<a href="#">./Source/cmSystemTools.h</a>	69.64%	1	5
<a href="#">./Source/cmComputeLinkDepends.cxx</a>	69.89%	78	5
<a href="#">./Source/CTest/cmCTestStartCommand.cxx</a>	70.00%	12	0
<a href="#">./Source/cmMakefileExecutableTargetGenerator.cxx</a>	70.83%	16	1
<a href="#">./Source/cmLinkLibrariesCommand.cxx</a>	70.83%	7	0
<a href="#">./Source/cmMakeDepend.cxx</a>	71.01%	44	1
<a href="#">./Source/CTest/cmCTestBuildCommand.cxx</a>	71.74%	26	0
<a href="#">./Source/cmsys/auto_ptr.hxx</a>	71.88%	1	1
<a href="#">./Source/kwsys/testCommandLineArguments.cxx</a>	71.88%	7	1
<a href="#">./Source/CTest/cmCTestSVN.cxx</a>	72.07%	57	2
<a href="#">./Source/cmScriptGenerator.cxx</a>	72.34%	20	1

```

=====
Version: $Revision: 1.4 $

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This software is distributed WITHOUT ANY WARRANTY; without even
the implied warranty of MERCHANTABILITY or FITNESS FOR A PARTICULAR
PURPOSE. See the above copyright notices for more information.

-----/
#include "cmDefinePropertyCommand.h"
#include "cmake.h"

// cmDefinePropertiesCommand
bool cmDefinePropertyCommand
::InitialPass(std::vector<std::string> const& args, cmExecutionStatus &)
{
    00000013     if(args.size() < 1)
    00000013     {
    00000000         this->SetError("called with incorrect number of arguments");
    00000000         return false;
    00000000     }

    // Get the scope in which to define the property.
    00000013     cmProperty::ScopeType scope;
    00000013     if(args[0] == "GLOBAL")
    00000010     {
    00000003         scope = cmProperty::GLOBAL;
    00000003     }
    00000003     else if(args[0] == "DIRECTORY")
    00000000     {
    00000003         scope = cmProperty::DIRECTORY;
    00000003     }
    00000003     else if(args[0] == "TARGET")
    00000003     {
    00000003         scope = cmProperty::TARGET;
    00000003     }
    00000000     else if(args[0] == "SOURCE")

```

```

Coverage produced by bullseye covbr tool:
www.bullseye.com/help/ref_covbr.html
* An arrow --> indicates incomplete coverage.
* An X indicates a function that was invoked, a switch label that
  was exercised, a try-block that finished, or an exception handler
  that was invoked.
* A T or F indicates a boolean decision that evaluated true or false,
  respectively.
* A t or f indicates a boolean condition within a decision if the
  condition evaluated true or false, respectively.
* A k indicates a constant decision or condition.
* The slash / means this probe is excluded from summary results.

...
    20 #include "cmLocalGenerator.h"
    21 #include "cmGlobalGenerator.h"
    22
    X   23 bool cmCTestStartCommand
    24     ::InitialPass(std::vector<std::string> const& args, cmExecutionSta
    25     {
    -->F  26         if (args.size() < 1)
    27         {
    28             this->SetError("called with incorrect number of arguments");
    29             return false;
    ...
    37         cnt++;
    38
    39         this->CTest->SetSpecificTrack(0);
    -->F  40         if ( cnt < args.size() -1 )
    41         {
    -->   42             if ( args[cnt] == "TRACK" )
    43             {
    44                 cnt ++;
    45                 this->CTest->SetSpecificTrack(args[cnt].c_str());
    ...
    47         }

```

# Valgrind/Purify

Dynamic analysis started on 2009-05-03 03:36:06

Site Name: dash17.kitware

Build Name: Linux-g++4.0

Name	Status	Memory Leak	Uninitialized Memory Read	Potential Memory Leak	Uninitialized Memory Conditional	Mismatched Deallocate	Freeing Invalid Memory	Invalid Pointer Read	Invalid Pointer Write	Labels
<a href="#">QtChart-TestBarSeriesColors</a>	Passed		1	25						
<a href="#">QtChart-TestChartWidget</a>	Passed		1	26						
<a href="#">Mace</a>	Passed			2						
<a href="#">TestHyperOctreeContourFilter</a>	Passed			2	1					
<a href="#">TestUncertaintyTubeFilter</a>	Passed			2						
<a href="#">TestMultiBlock</a>	Passed			2						
<a href="#">TestTemporalStatistics</a>	Passed			3						
<a href="#">TestGenericCutter</a>	Passed			2						
<a href="#">TestActorLightingFlag</a>	Passed			2						
<a href="#">TestLabelPlacer</a>	Passed			2						
<a href="#">TestOpacity</a>	Passed			2						
<a href="#">TestTextActor3DAlphaBlending</a>	Passed			2						
<a href="#">TestAreaSelections</a>	Passed			2						
<a href="#">TestTranslucentImageActorDepthPeeling</a>	Passed		2	2						
<a href="#">TestGenericVertexAttributesGLSLDepthPeelingPass</a>	Passed			2						
<a href="#">TestFiniteColorMapWindowLevel</a>	Passed			2						

Dynamic analysis started on 2009-05-04 03:37:17

Site Name: dash17.kitware

Build Name: Linux-g++4.0

[TestMultiBlock](#) Passed

```

==3002== Memcheck, a memory error detector.
==3002== Copyright (C) 2002-2007, and GNU GPL'd, by Julian Seward et al.
==3002== Using LibVEX rev 1732, a library for dynamic binary translation.
==3002== Copyright (C) 2004-2007, and GNU GPL'd, by OpenWorks LLP.
==3002== Using valgrind-3.2.3, a dynamic binary instrumentation framework.
==3002== Copyright (C) 2000-2007, and GNU GPL'd, by Julian Seward et al.
==3002== For more details, rerun with: -v
==3002==
==3002==
==3002== ERROR SUMMARY: 0 errors from 0 contexts (suppressed: 119 from 2)
==3002== malloc/free: in use at exit: 30,294 bytes in 327 blocks.
==3002== malloc/free: 37,724 allocs, 37,397 frees, 5,207,986 bytes allocated.
==3002== For counts of detected errors, rerun with: -v
==3002== searching for pointers to 327 not-freed blocks.
==3002== checked 2,298,764 bytes.
==3002==
==3002== 64 bytes in 1 blocks are still reachable in loss record 15 of 34
==3002== at 0x401DC87: realloc (vg_replace_malloc.c:306)
==3002== by 0x62F83E5: (within /usr/lib/libX11.so.6.2.0)
==3002== by 0x62F908E: (within /usr/lib/libX11.so.6.2.0)
==3002== by 0x62F95F0: XrmGetStringDatabase (in /usr/lib/libX11.so.6.2.0)
==3002== by 0x659FB22: (within /usr/lib/libXt.so.6.0.0)
==3002== by 0x65A0ED4: _XtDisplayInitialize (in /usr/lib/libXt.so.6.0.0)
==3002== by 0x6596DC7: XtOpenDisplay (in /usr/lib/libXt.so.6.0.0)
==3002== by 0x437DD13: vtkXRenderWindowInteractor::Initialize() (vtkXRenderWindowInteractor.cxx:317)
==3002== by 0x42EFD0D: vtkRenderWindow::Render() (vtkRenderWindow.cxx:265)
==3002== by 0x441E401: vtkOpenGLRenderWindow::Render() (vtkOpenGLRenderWindow.cxx:1846)
==3002== by 0x8081AB6: TestMultiBlock(int, char**) (TestMultiBlock.cxx:142)
==3002== by 0x805B2E8: main (GraphicsCxxTests.cxx:306)
==3002==

```

# Email Notification

A submission to CDash for the project CMake has failing tests.  
You have been identified as one of the authors who have checked  
in changes that are part of this submission or you are listed in the default contact list.

Details on the submission can be found at <http://www.cdash.org/CDash/buildSummary.php?buildid=322849>

Project: CMake

Site: destiny.kitware

Build Name: HP-UX-aCC

Build Time: 2009-04-29T14:28:00 EDT

Type: Continuous

Tests failing: 85

## **\*Tests failing\*** (first 5)

SystemInformationNew (<http://www.cdash.org/CDash/testDetails.php?test=21959894&build=322849>)

CommandLineTest (<http://www.cdash.org/CDash/testDetails.php?test=21959897&build=322849>)

FindPackageTest (<http://www.cdash.org/CDash/testDetails.php?test=21959898&build=322849>)

FindModulesExecuteAll (<http://www.cdash.org/CDash/testDetails.php?test=21959899&build=322849>)

StringFileTest (<http://www.cdash.org/CDash/testDetails.php?test=21959900&build=322849>)

-CDash on [www.cdash.org](http://www.cdash.org)






# Kitware Hosted CDash <http://my.cdash.org/>

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**CDash** is a web-based software testing server. CDash **aggregates**, **analyzes** and **displays** the results of **software testing processes** submitted from clients located around the world. Developers depend on CDash to convey the state of a software system, and to continually improve its quality. To learn more about CDash visit the main [CDash website](#).

Starting a project is **easy** and **free**, in just a few clicks you can start monitoring the quality of your software development.

[Start My Project >](#)

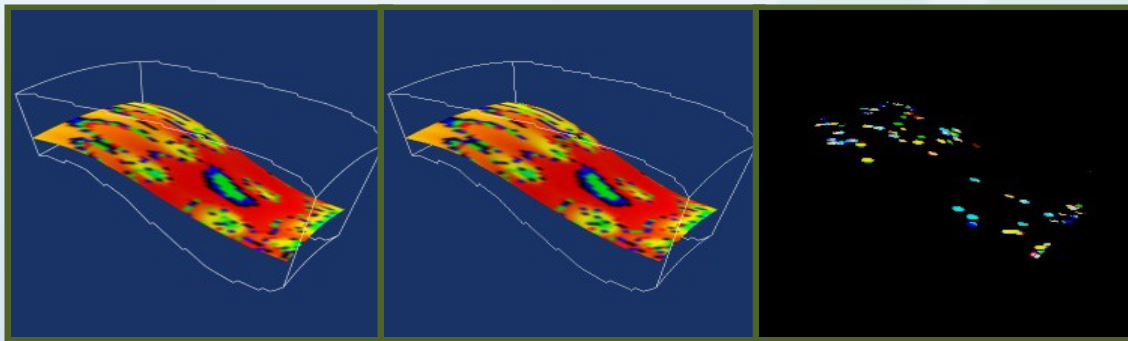


### Available Dashboards

Project	Description	Submissions	First build	Last activity
<a href="#">automoc4</a>	automoc4 is a tool which makes moc-processing with Qt4 easier.	264	2009-04-18T12:33:22 EDT	2010-01-13 17:03:42
<a href="#">Avogadro</a>	Avogadro is an advanced molecular editor designed for cross-platform use in computational chemistry, molecular modeling, bioinformatics, materials science, and related areas. It offers flexible rendering and a powerful plugin architecture.	546	2009-01-28T14:01:47 EST	2010-01-13 12:06:33
<a href="#">Boost</a>	Boost provides free peer-reviewed portable C++ source libraries.	505	2009-05-06T19:31:42 EDT	2010-01-13 00:19:39
<a href="#">cape</a>	a c++ version	6	2010-01-07T14:48:03 EST	2010-01-07 15:27:21
<a href="#">CERTI</a>	CERTI	495	2008-09-26T18:27:04 EDT	2010-01-12 22:32:00

# CDash Testing

- Purify / valgrind
- Coverage (gcov, bullseye)
- Configuration coverage
  - Make sure different OSes, libraries and options are covered
- Image difference testing









# Testing with CMake/CTest

- Testing command in CMake
  - `add_test (testName exeName arg1 arg2 ...)`
  - Executable is expected to return 0 for passed
  - Other passing criteria can be specified
- CTest – an executable that is distributed with CMake, can run tests in a project
  - Used for continuous integration testing
  - Client for CDash

# CTest/CDash: Current State

- Alexander Neundorf has already done a lot of work getting KDE dashboards up
- Currently testing full KDE modules
- If all developers start receiving email
  - Is a KStars dev interested in kalzium errors?
  - How long until they filter/unsubscribe?
  - Marble devs only receive Marble reports

Build Name	Update		Configure			Build			Test			
	Files	Min	Error	Warn	Min	Error	Warn	Min	NotRun	Fail	Pass	Min
<a href="#">FreeBSD-cmake-2.8.0</a> 	<a href="#">12</a>	0.1	<a href="#">0</a>	<a href="#">0</a>	0.8	<a href="#">0</a>	<a href="#">1</a>	20.6	<a href="#">147</a>	<a href="#">466</a>	<a href="#">0</a>	0.1
<a href="#">Linux-c++</a> 	<a href="#">12</a>	0.4	<a href="#">0</a>	<a href="#">0</a>	0.2	<a href="#">3</a> +3	<a href="#">22</a> -11	10.5	<a href="#">2</a> +2	<a href="#">14</a> -1	<a href="#">720</a> -1	66.1
<a href="#">Linux-gcc-4.3.2-cmake-2.6.2</a> 	<a href="#">12</a>	0.2	<a href="#">0</a>	<a href="#">0</a>	0.2	<a href="#">0</a>	<a href="#">8</a> -20	12.2	<a href="#">147</a>	<a href="#">466</a>	<a href="#">0</a>	0.1
<a href="#">SunOS-sunstudio-12.1-cmake-2.6.2</a> 	<a href="#">12</a>	0.2	<a href="#">0</a>	<a href="#">0</a>	0.6	<a href="#">0</a>	<a href="#">190</a> -10	12.7	<a href="#">147</a>	<a href="#">466</a>	<a href="#">0</a>	0.2

# KDE and Subprojects

- KDE modules are quite large
  - Typically more than 15 components
  - Developers don't normally work on all components in a module
  - Without subprojects testing is too noisy
- Divide KDE modules?
- Split modules into subprojects?
  - New feature in CMake 2.8

# Subproject Requirements

- Add LABELS property to build system
  - Source
  - Tests
- Create custom targets for subprojects
- CMake 2.8 CTest driver scripts
  - Only need CMake 2.8 on submission hosts
  - Continue using  $\geq$ CMake 2.6.2 to build

```
set_target_properties(avogadro PROPERTIES  
  VERSION ${Avogadro_VERSION_FULL} SOVERSION 1  
  LABELS "libavogadro")
```

# What Subprojects Get Us

- Build KDE modules in parts
- Test KDE modules in parts
- Developers receive emails about issues
  - Only for the subproject they committed to
  - CDash summaries for each part
    - Kalzium
    - Marble
  - Not everyone who committed to kdeedu!

# CTest Driver Script

- Update the source directory
  - CTest added Git support in 2.8
- Configure the module
- Loop over each subproject in the module
  - Build the custom subproject target
  - Run the tests for the subproject
- Submit the result of each part
- Uses new CTest script functionality

# Example CTest Driver Script

```
cmake_minimum_required(VERSION 2.8)
set(CTEST_SOURCE_DIRECTORY $ENV{HOME}/kdeedu)
set(CTEST_BINARY_DIRECTORY $ENV{HOME}/kdeedubuild)
set(CTEST_CMAKE_GENERATOR "Unix Makefiles")
set(CTEST_BUILD_COMMAND "make -j9")

# Empty the binary directory - clean build
ctest_empty_binary_directory("${CTEST_BINARY_DIRECTORY}")
```



# Example CTest Driver Script

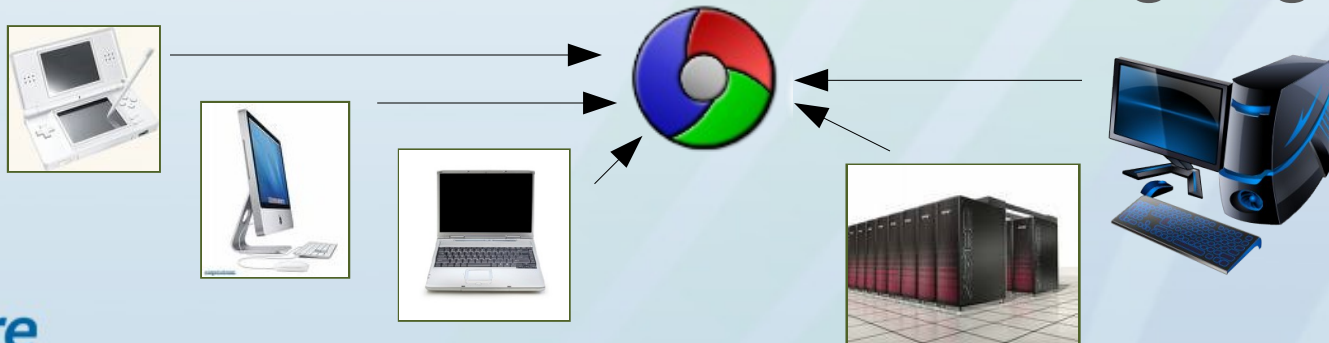
```
# Write initial cache
file(WRITE
  "${CTEST_BINARY_DIRECTORY}/CMakeCache.txt" "
  CMAKE_BUILD_TYPE:String=DebugFull
  CMAKE_CXX_COMPILER:FILEPATH=/usr/ccache/bin/c++
")
# Now start the update and configure steps
set(CTEST_UPDATE_COMMAND "svn")
ctest_start(Nightly)
ctest_update(SOURCE "${CTEST_SOURCE_DIRECTORY}")
ctest_submit(PARTS Update Notes)
ctest_configure(BUILD "${CTEST_BINARY_DIRECTORY}" APPEND)
ctest_submit(PARTS Configure)
```

# Example CTest Driver Script

```
include(  
    "${CTEST_SOURCE_DIRECTORY}/CTestConfig.cmake")  
foreach(sub ${CTEST_PROJECT_SUBPROJECTS})  
    set_property(GLOBAL PROPERTY SubProject ${sub})  
    set_property(GLOBAL PROPERTY Label ${sub})  
    set(CTEST_BUILD_TARGET ${sub})  
    ctest_build(BUILD "${CTEST_BINARY_DIRECTORY}" APPEND)  
    ctest_submit(PARTS Build)  
    ctest_test(BUILD "${CTEST_BINARY_DIRECTORY}"  
        INCLUDE_LABEL ${sub})  
    ctest_submit(PARTS Test)  
endforeach()
```

# Using CTest Driver Scripts

- Invoke the CTest binary in script mode
  - `ctest -S /path/to/driver_script.cmake`
- Can easily be run from a cron job, etc.
- Can submit parts of the submission
- Allows for much tighter control, scripting
- Access to most of the CMake language





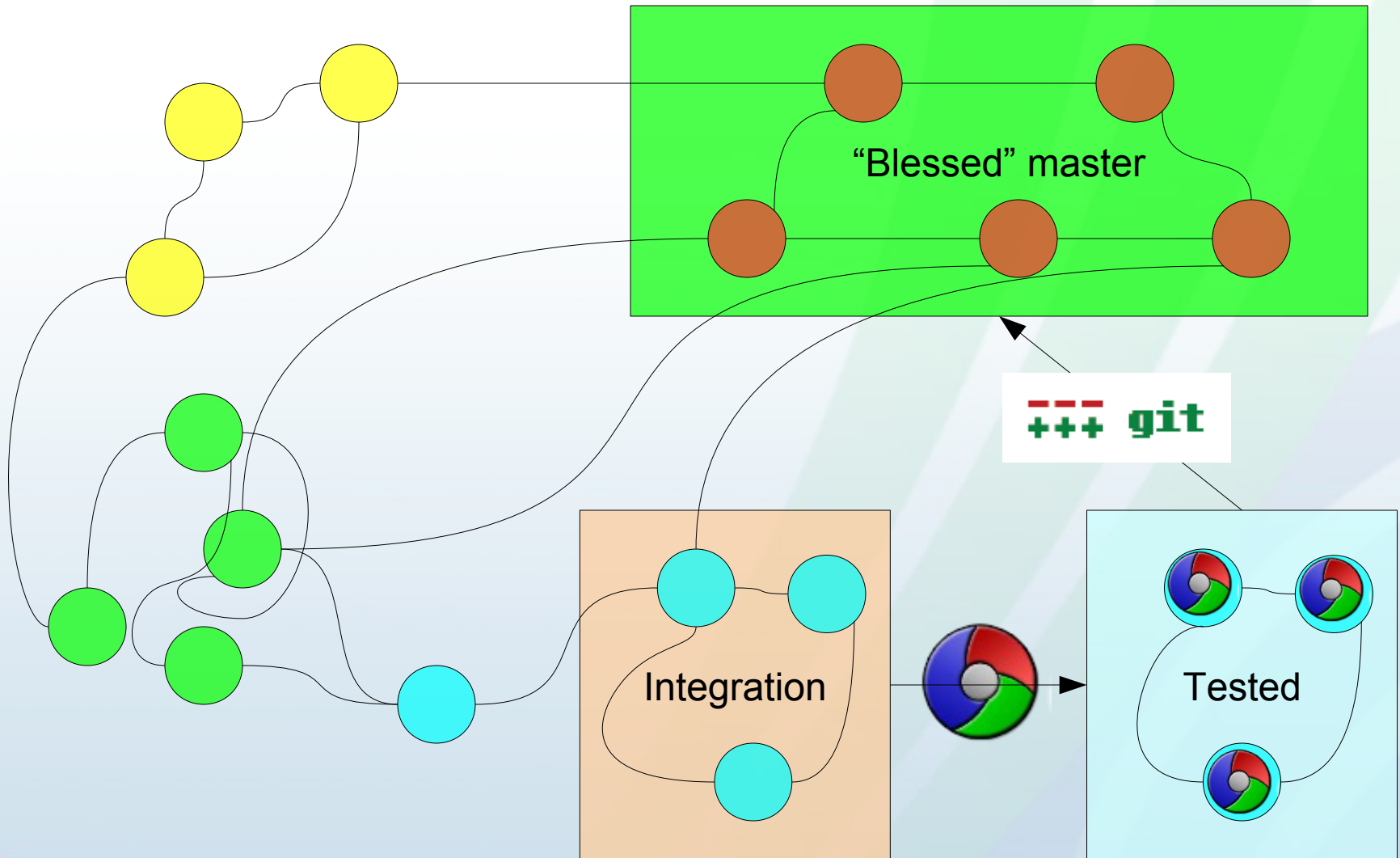
# CTest and Git

- CTest must understand version control
  - What files have changed?
  - Who changed those files?
  - What to checkout for a nightly dashboard?
- CMake 2.8 added support for Git, Mercurial and Bazaar (distributed VCS)
- Also abstracted support
  - Easier to add others in the future

# The Future: CTest and Git

- Is it possible to test changes before they are committed?
  - With distributed version control it is!
- Developer pushes experimental branch
- Requests CDash server tests this branch on all supported architectures
- If everything is green, proceed to merge
- Development tree is more stable!

# DVCS: New Workflows



Only merged after testing



# Cross Compiling

- New chapter in the new CMake book
- Far more important to the KDE community with embedded devices, e.g. N900+
- Significant work has already been done
- I need to read up on this!

# Kitware is Hiring

- Looking for talented developers
- Opportunities for internships this summer
- Work on interesting, challenging problems
  - Exceptional skill in C++
  - Other languages such as Python, Tcl, Java
  - Work on Linux, Unix, Mac OS X and/or Windows

<http://www.kitware.com/company/jobopps.html>

# Thank You

- Any questions?
- I will be available afterwards
- If you would like to learn more
  - Attend the tutorial session, Monday @ 2pm
- CMake is more than just a build system!

<http://www.cmake.org/>

[mhanwell@kde.org](mailto:mhanwell@kde.org)

# CMake Tutorial

- Summary of CMake
- CMake input files
- CMake GUIs
- CTest – testing your code
- CPack – packaging
- CDash – collating test results