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A CMake-Based Cross Platform Build System for Tcl/Tk

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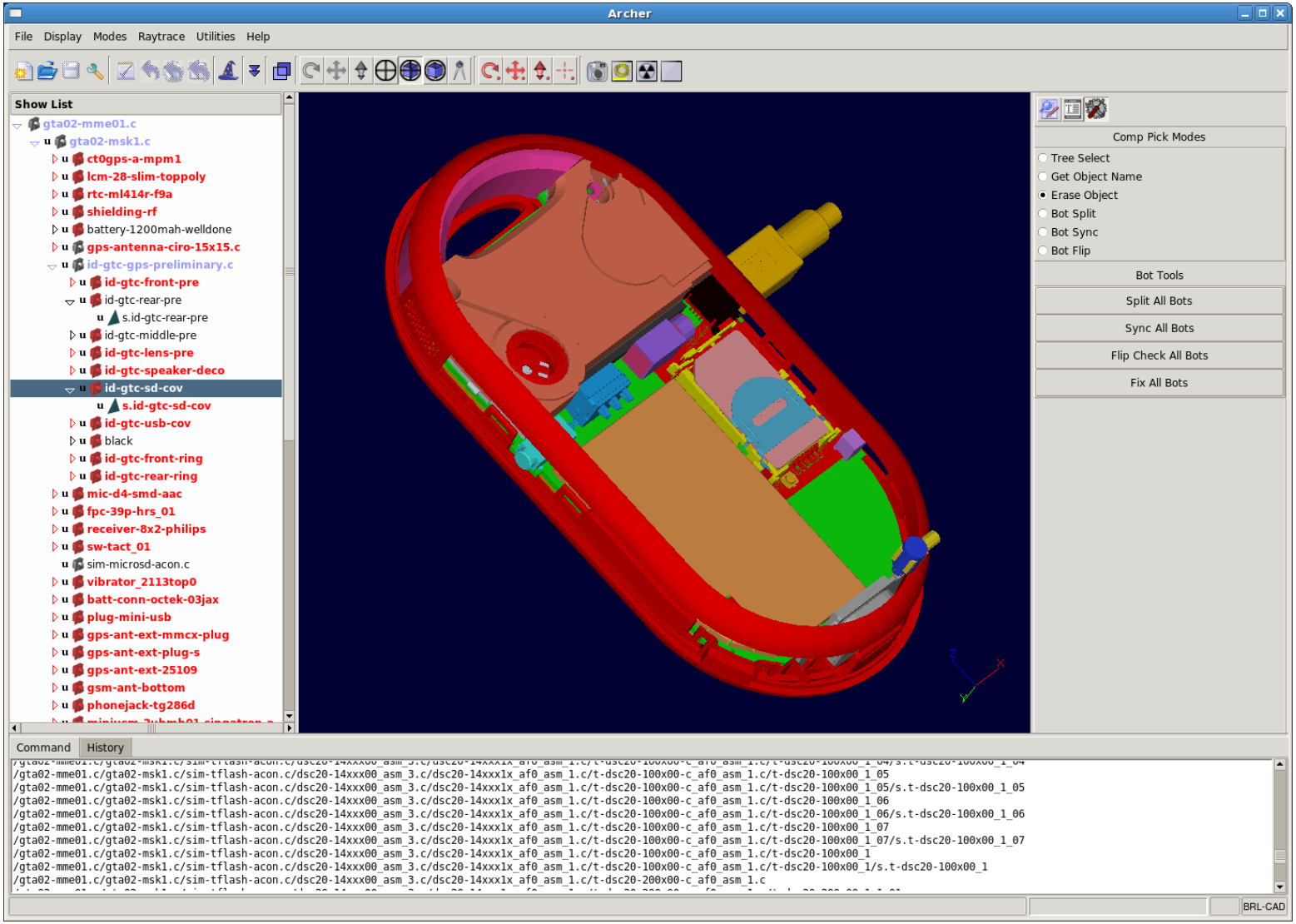
Background

- BRL-CAD - powerful open source solid modeling system developed originally by the Ballistic Research Laboratory (now the U.S. Army Research Laboratory)
  - More than 25 years of development, with ancestor codes dating to the early 1970s.
  - “the world's oldest source code repository” - August 2007, Robin Luckey, Ohloh Inc.
- Since the early days of its development, BRL-CAD has made use of Tcl/Tk
  - Graphical Editing Environments
  - Scripting
  - Interactive command prompt
- Current efforts to upgrade our GUI
  - Ttk widgets
  - HTML-based help system
  - Tktable-based editing tables
  - etc.

Mike Muuss working in the early 80's with BRL-CAD on a PDP-11/70 while Earl Weaver inspects a design printout

Background – Latest BRL-CAD GUI



Building Tcl/Tk - Why?

- Portability
  - Current “primary” platforms are Linux, Mac OS X, Windows, and FreeBSD
  - Historically, BRL-CAD has run on a vast number of operating systems and architectures – portability is key to code longevity
  - BRL-CAD is only as portable as Tcl/Tk
- Required Libraries
  - In order to isolate bugs, it is sometimes necessary to compile against known “good” versions of libraries.
  - Deployment of BRL-CAD often cannot wait on fixes to system libraries.
  - Deploying a version of a system library new enough to support BRL-CAD may break other applications.
  - BRL-CAD has occasionally needed to make changes and fixes to Tcl/Tk
- Bundling
  - To ensure a viable Tcl/Tk is available at all times on all target platforms, a version known to work is bundled with BRL-CAD's own sources.
  - Building the bundled Tcl/Tk requires integration of Tcl/Tk's build system with BRL-CAD's own build logic.

Existing Tcl/Tk Build Systems

- Tcl Extension Architecture (TEA)
  - Autoconf/M4 based
  - Two versions: SC_* for Tcl/Tk and TEA_* for extensions
  - Functionality tests and Tcl/Tk system configuration detection
  - Covers a *very* wide range of operating systems – some old enough that support for them is no longer needed by BRL-CAD.
- Windows
  - Visual Studio project files – listed version supported is Visual C++ 6.0
  - NMake build files.
  - MinGW/MSYS build files.
  - Cygwin is specifically listed as *not* supported.
- BRL-CAD Sub-builds
  - MSVC – Custom Visual Studio project files.
  - Autotools – Wrappers for Tcl/Tk's autoconf/SC_* logic.
  - Workable, but sometimes fragile – required tweaking each Tcl/Tk upgrade.

Tcl/Tk as a CMake Sub-build

- Summer 2010 - decision made to unify BRL-CAD's build logic into a single CMake build system
  - Primary goal - simplify building Windows releases.
  - Most BRL-CAD developers work on non-Windows platforms – Windows build files tended to be out of date
  - Windows is a popular deployment platform for BRL-CAD – important to improve the release building process.
- Building Tcl/Tk from CMake
  - 1st attempt - use Tcl/Tk's existing build files and ExternalProject_Add
  - Worked reasonably well on Linux (except for requiring the installation target be built before building the remainder of BRL-CAD.)
  - Visual Studio integration more difficult – initial efforts unsuccessful.
- Building Tcl/Tk *with* CMake
  - Implement enough of Tcl/Tk's build logic in CMake to support BRL-CAD's target platforms.
  - Avoids complexity of OS-dependent external build system triggers, integrates well with BRL-CAD.

Requirements

- To support BRL-CAD's requirements, a CMake build would need to:
  - Build successfully on target platforms:
    - Windows
    - Linux
    - FreeBSD
    - Mac OS X
    - Solaris
  - Ideally avoid significant alterations to the Tcl/Tk source code
  - Run tclsh and wish from the build directory without requiring installation – needed for BRL-CAD's compilation process
  - Support compilation of Tcl/Tk extensions
    - Support using either a system Tcl/Tk or BRL-CAD's local copy – both scenarios plausible.

Invoking CMake

- CMake vs. Autotools
  - Out of source directory builds *highly* recommended.
  - Slightly different invocation syntax (see paper for details):
    - ../tcl/unix/configure
    - cmake ../tcl
  - All operating systems use the same toplevel CmakeLists.txt
- CMake vs MSVC/nmake
  - Run CMake to generate a Visual Studio project
  - Launch Visual Studio to complete the build.

Demonstration...

"Internal" Headers

- Tcl and Tk are nominally separate projects, with distinct build systems
- Despite this separation, Tk requires *internal* Tcl headers when building
  - Tk requires the location of a Tcl source repository, as these headers are not guaranteed to be installed
  - Tk cannot be compiled against a system Tcl with any guarantee that the internal headers used match those used to build the system Tcl/Tk. Version numbers may match, but that does not preclude local modifications being present in the system Tcl.
- Several external Tcl/Tk packages also require the presence of the Tcl/Tk source code.
- To support existing code, CMake build logic also must support this source directory inclusion.
- Longer term, can internal header use be eliminated?

Index files

```
get_target_property(TK_LIBLOCATION tk LOCATION_${CMAKE_BUILD_TYPE})
get_filename_component(TK_LIBNAME ${TK_LIBLOCATION} NAME)
file(WRITE ${CMAKE_CURRENT_BINARY_DIR}/pkgIndex.tcl "package ifneeded Tk
    ${TK_PATCH_LEVEL} [list load [file join $dir .. .. ${LIB_DIR}
                        ${TK_LIBNAME}] Tk]")
install(FILES ${CMAKE_CURRENT_BINARY_DIR}/pkgIndex.tcl DESTINATION
            lib/tk${TK_PATCH_LEVEL})

file(WRITE ${CMAKE_LIBRARY_OUTPUT_DIRECTORY}/tk${TK_PATCH_LEVEL}/pkgIndex.tcl
     "package ifneeded Tk ${TK_PATCH_LEVEL} [list load [file join $dir
     ${CMAKE_LIBRARY_OUTPUT_DIRECTORY} ${TK_LIBNAME}] Tk]")
```

- To support both build directory and install directory pkgIndex.tcl files, CMake creates two and places them appropriately
- The “final” version intended for install is written to the current binary directory.
- The “in-build-directory version” is written to the appropriate location in CMake's library output directory.
- Tclsh and Wish binaries running from the binary output directory will find the pkgIndex.tcl file in the library output directory.

File Introspection


```
if(${line} MATCHES "package provide [^:]*::${ROOT_NAME}")
   STRING(REGEX REPLACE ".*package provide ([^:]*)::.*" "\\1" ITEM_SUBDIR ${line})
   STRING(REGEX REPLACE ".*package provide [^:]*::${ROOT_NAME} ([0-9\\.]*).*"
               "\\1" ITEM_VERSION ${line})
endif()
if(${line} MATCHES "package provide ${ROOT_NAME}")
   STRING REGEX REPLACE ".*package provide ${ROOT_NAME} ([0-9\\.]*).*" "\\1"
ITEM_VERSION ${line})
endif()
```

- CMake provides both the ability to read file contents into variables and apply regular expressions to strings.
- One or both of these abilities support a number of key features:
  - Intelligent placement of library files (code above is a subset of that macro)
  - Parsing tclConfig.sh and tkConfig.sh files (FindTCL.cmake)
  - Extracting root names from file names
  - Breaking up version numbers (major/minor/patch)

Dependent Options

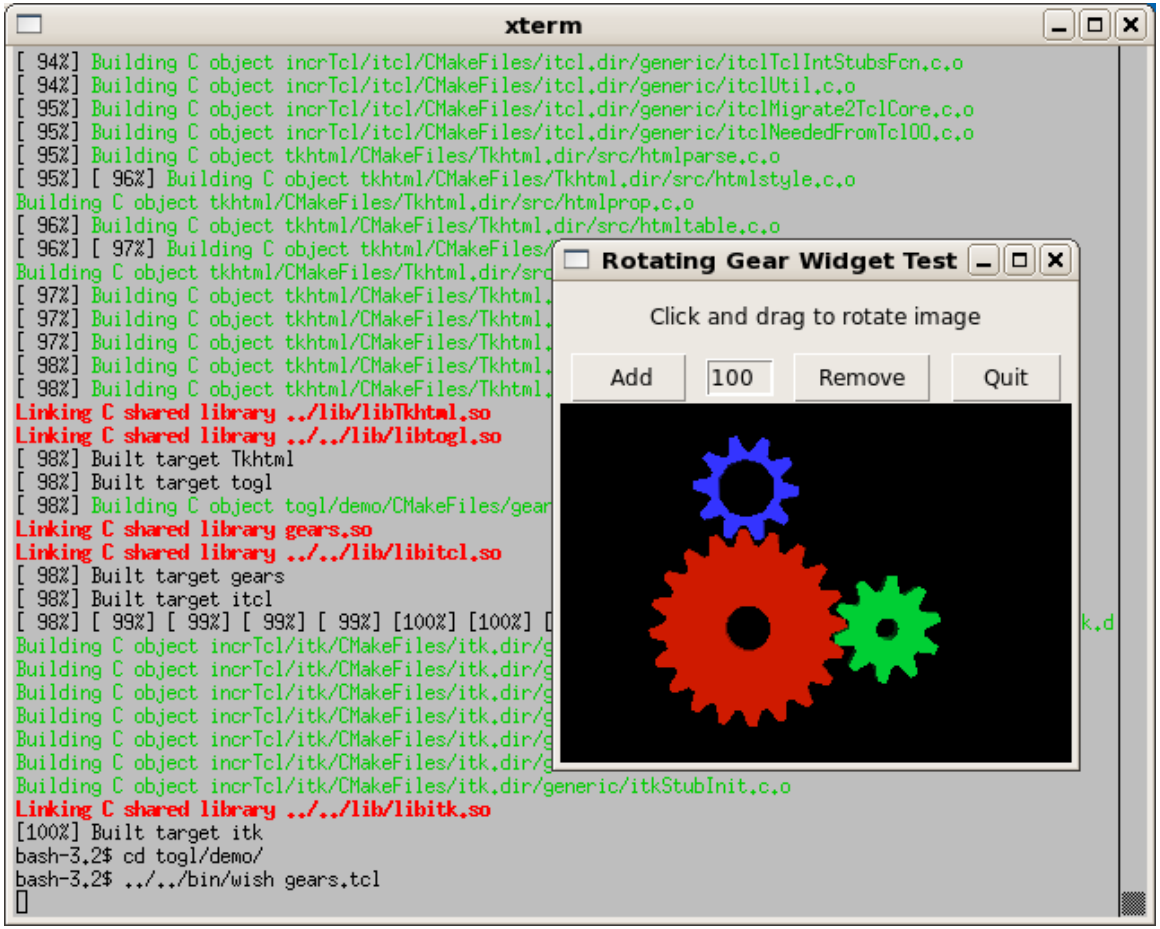

```
include(CMakeDependentOption)

CMAKE_DEPENDENT_OPTION(TK_ENABLE_XFT "Use freetype/fontconfig/xft" ON
   "TK_SYSTEM_GRAPHICS STREQUAL x11;FREETYPE_FOUND;${X11_Xft_FOUND}" OFF)
```

- Occasionally, options that are appropriate to show to the user rely on some particular system library (e.g. X11)
- Rather than show an option when the core system feature is not present, CMake provides a Dependent Option macro to conditionally provide options based on other search results.
- This feature is probably useful in more situations – only used right now for a couple of X11 related cases.

Extensions

- Can be built “stand-alone” but have the same constraints as TEA builds – need Tcl/Tk sources
- Extensions:
  - Tkhtml3
  - Tktable
  - Itcl
  - Itk
  - Togl



Results and Complexity

- Build times are comparable to Autoconf/SC builds on Linux.
  - Benchmark used a single processor build on a Gentoo Linux AMD Athlon II X2 245 CPU.
  - Observed build times within 10% of standard Tcl/Tk build, given the same compiler options.
- Build system complexity is comparable, given implemented logic
  - Hard to objectively measure “complexity” - Lines of Code are in the same ballpark (5-7k) but CMake does not implement all of Tcl/Tk's SC logic.
- As a sub-build within BRL-CAD Tcl/Tk CMake has been consistent and well behaved
  - Builds on all platforms currently supported by BRL-CAD
  - Runs successfully from within the build directory
  - Works with existing Tcl/Tk code – no significant source code modifications

Conclusions and Future Work

- CMake is an effective tool for providing Tcl/Tk with integrated cross-platform build system support.
- BRL-CAD will be maintaining and enhancing this method of Tcl/Tk compilation as part of ongoing development.
- Remaining items to address:
  - Ensure all necessary functionality tests have been ported
  - Implement CPack logic for tarball and binary generation.
  - Address “multi-config” development environments like Xcode
    - Current macros assume a single build directory target for libraries and executables
    - May need to support Debug/Release/etc. configs for proper Xcode integration.

Questions?

Thank you!