Software Building
(Sestavování aplikací)

http://d3s.mff.cuni.cz

Pavel Parízek
parizek@d3s.mff.cuni.cz
Outline

- NuGet
- Gradle
- GNU build system
- CMake
NuGet

- Package manager for .NET
- Similar concepts to Maven
- Integration to Visual Studio

- Web: https://www.nuget.org/
- Docs: https://docs.microsoft.com/en-us/nuget/
.NET Core Templates

- Support for project templates
  - Implementing best & recommended practices

- Additional information
  - [https://docs.microsoft.com/en-us/dotnet/core/tools/custom-templates](https://docs.microsoft.com/en-us/dotnet/core/tools/custom-templates)

- Template engine
  - [https://github.com/dotnet/templating/](https://github.com/dotnet/templating/)

- Available templates
Gradle

- Another popular general-purpose build tool
  - Java, Scala, C, C++, Android
- Encourages best practices (like Maven)
- Script language (DSL) based on Groovy

- Web: https://gradle.org/
Gradle – examples

- **Scripts**
  - [https://docs.gradle.org/current/userguide/tutorial_using_tasks.html](https://docs.gradle.org/current/userguide/tutorial_using_tasks.html)
  - [https://docs.gradle.org/current/userguide/building_java_projects.html](https://docs.gradle.org/current/userguide/building_java_projects.html)

- **Running**
  - `gradle clean build`
  - `gradle run`

- **Project template for Java**
  - `gradle init --type java-application`
Motivation for GNU build system

- Portability of programs
  - over different UNIX-like systems
  - existing standards (C, POSIX) define only core aspects

- System-specific configuration
  - e.g., use of KDE instead of Gnome

- Complexity of Make files
  - unreadable, hard to maintain
  - writing all the rules is tedious

- Portability of Make files
  - Make is standardized by POSIX, but not all UNIX-like systems are 100% compliant
Selected portability and compatibility issues

- Programs in C
  - `exit()`: may return `void` or `int` (error code)
  - `free(NULL)`: sometimes does nothing
  - `malloc(0)`: returns `NULL` or valid pointer
  - (and many more)

- Functions in different headers and libraries

- Shell and utilities: Awk, Grep, Sed, ...
  - Multiple implementations (not all compatible)
Solutions for portability and compatibility

- Virtualized environment (Java, C#/.NET)

- GNU build system (Autotools)
  - De-facto standard in Unix/Linux world
  - Explicit support for different flavors
  - Database of known portability issues
  - Resolves issues during configuration
  - Uses only features available everywhere
GNU build system (Autotools)

- Autoconf
  - Configuration detector

- Automake
  - Makefile generator

- Libtool
  - Abstracts creation of libraries

- Gettext
  - Support for localization
1. Download the source code
2. “./configure”
   - Automatically tests the target system
     - e.g. for presence of required libraries
   - Detects system configuration (OS, HW)
   - Automatically generates Make files
3. “make”
4. “make install”
End user’s perspective – configuration

- Installation root directory
  - “configure --prefix=/opt”

- Cross-compilation
  - “configure --host”

- Optional features of the software
  - “configure --enable-FEATURE”
  - “configure --disable-FEATURE”

- Optional packages (libraries) to build with
  - “configure --with-PACKAGE”
  - “configure --without-PACKAGE”
What is behind the scenes

shell scripts with many system tests

configure

cache for test results between restarts

config.cache

autoheader

config.h.in

config.h

script which generates make files, taking test results from the cache

config.status

Makefile.in

Makefile

automake

Makefile.am

Makefile.am
Autoconf & the “configure” script

- Very portable shell script
  - Uses features in the lowest-common-denominator of known shells (no functions, ...)
  - Generated from a template (configure.ac)
  - Based on a library of tests of well-known portability and compatibility issues
AC_INIT(package, version, bug-report-address)

information about the package
checks for programs
checks for libraries
checks for header files
checks for types
checks for structures
checks for compiler characteristics
checks for library functions
checks for system services

AC_CONFIG_FILES([output file, ...])
AC_OUTPUT
AC_INIT([GNU cflow], [1.2], [bug-cflow@gnu.org])
AC_CONFIG_HEADER([config.h])

# Checks for programs.
AC_PROG_CC
AC_PROG_LEX

# Checks for header files.
AC_HEADER_STDC
AC_CHECK_HEADERS([stdlib.h string.h unistd.h locale.h])

AC_OUTPUT
“configure” – another example

- [Link](http://d3s.mff.cuni.cz/files/teaching/nswi154/sockets-auto.tgz)
  - configure.ac
  - src/config.h.in
  - src/client.cpp

- Achieving support for multiple platforms
Generating “configure.ac”

• Autoscan
  - Inspects source files (C/C++) to detect common portability issues
  - Generates skeleton of configure.ac

• Ifnames
  - Reports variables used in preprocessor conditionals
  - Often used to solve platform dependency issues
    • Example: #if HAVE_LOCALE_H
Automake – creating portable Makefiles

- `configure.ac`
- `Makefile.am`
- `autotake`
- `Makefile.in`
- `config.status`
- `Makefile`
Supported targets

- install, install-exec, install-data
- uninstall
- clean
- distclean
  - clean to what is distributed
  - removes also files generated by configure
- check
  - run test of compiled binaries
- installcheck
  - run test of installed program
- dist
  - creates source code distribution package (tarball)
“Makefile.am” template

Makefile.am

```
SUBDIRS = src
dist_doc_DATA = README
```

directories to be processed before this directory

install README into docdir and put it into distribution

src/Makefile.am

```
bin_PROGRAMS = hello
hello_SOURCES = main.c
```
“Makefile.am” template

Makefile.am

```
SUBDIRS = src
dist_doc_DATA = README
```

“hello” is a program to be installed into bindir

```
bin_PROGRAMS = hello
hello_SOURCES = main.c
```

program “hello” can be built from source “main.c”

since “main.c” is a source file, it will also be put into distribution (by “make dist”)
Automake – creating libraries

- **Static libraries (`.a`)**

  ```
  noinst_LIBRARIES = libgreeting.a
  libgreeting_a_SOURCES = greet.c ...
  ```

  ```
  bin_PROGRAMS = hello
  hello_SOURCES = main.c
  hello_LDADD = libgreeting.a
  ```

- **Shared libraries (`.so`)**

Autotools – the whole picture again

- configure
  - configure.ac
  - configure
  - Makefile.in
  - Makefile
  - config.h
  - config.status
  - config.cache
  - config.log

- autoconf
  - configure.ac
  - config.h.in
  - Makefile.in

- automake
  - Makefile.am
  - ifnames
  - autoscan
Further reading

- http://www.sourceforge.org/autobook/
- https://www.gnu.org/software/autoconf/
- https://www.gnu.org/software/automake/
CMake

- Cross-platform free and open-source build management application

- Compiler-independent tool
  - Supports various native build systems (make, Xcode, MS Visual Studio)


- Two phases of the build process
  - Generate native build scripts from platform-independent configuration (CMakeLists.txt)
  - Run target platform’s native tool for the actual build
Other build tools

- Ivy
  - https://ant.apache.org/ivy/

- Scons
  - http://www.scons.org/

- Bazel
  - http://bazel.io/
Homework

• Assignment
  ▪ http://d3s.mff.cuni.cz/files/teaching/nswi154/ukoly

• Deadline
  ▪ 3.11.2021 / 8.11.2021