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Automated Software Testing and Release with Nix Build Farms

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The Goal: Building and Testing Software

- It is good development practice to build and test a software system every time a developer commits a change to the project's version management repository.
- A **build farm** supports this:it's a set of machines that continuously builds and tests software components from a version management system, producing status reports and/or releases.
- It is called a build farm because the software typically must be tested in many hardware / operating system configurations (Windows, Linux, Mac OS X, 32 bits, 64 bits, etc.) - so **a large number of (virtual) machines** is required.
- A build farm allows many quality aspects of a project to be monitored:

Does it build correctly?

```
Making all in nix-store
building help.txt.hh
Making all in nix-hash
building help.txt.hh
Making all in libexpr
building nixexpr-ast.hh
make[3]: Entering directory `/tmp/nix-13939-3/nix-0.10pre6460/src/libexpr'
building all
make all-am
building nixexpr.lo
make[4]: Entering directory `/tmp/nix-13939-3/nix-0.10pre6460/src/libexpr'
if /bin/sh ../../libtool --tag=CXX --mode=compile g++ -DHAVE_CONFIG_H -I. -I. -I../.. -I../.. -I/...-db4-4.4.20/include
-I/...-aterm-2.4.2/include -I./../libutil -I./../libstore -g -O2 -MT nixexpr.lo -MD -MP -MF ".deps/nixexpr.Tpo" -c -o
nixexpr.lo nixexpr.cc; \" then mv -f ".deps/nixexpr.Tpo" ".deps/nixexpr.Plo"; else rm -f ".deps/nixexpr.Tpo"; exit 1; fi
mkdir .libs
g++ -DHAVE_CONFIG_H -I. -I. -I../.. -I./.. -I/...-db4-4.4.20/include -I/...-aterm-2.4.2/include -I./../libutil
-I./../libstore -g -O2 -MT nixexpr.lo -MD -MP -MF .deps/nixexpr.Tpo -c nixexpr.cc -fPIC -DPIC -o .libs/nixexpr.o
nixexpr-ast.hh:6: error: 'AFun' does not name a type
nixexpr-ast.hh: In function '_ATerm* nix::makePos(_ATerm*, int, int)':
nixexpr-ast.hh:10: error: 'symPos' was not declared in this scope
nixexpr-ast.hh:10: error: 'ATmakeInt' was not declared in this scope
nixexpr-ast.hh:10: error: 'ATmakeApl3' was not declared in this scope
nixexpr-ast.hh: In function 'bool nix::matchPos(_ATerm*, _ATerm*&, int&, int&)':
nixexpr-ast.hh:15: error: 'ATgetType' was not declared in this scope
nixexpr-ast.hh:15: error: 'AT_APPL' was not declared in this scope
nixexpr-ast.hh:15: error: 'AFun' was not declared in this scope
```

Does it pass the test suite?

```
List with some elements
strategy failed
List with element of illegal type
List with element of illegal type
Empty list
[ lt-dfta-accept-tests | critical ] No productive start symbols
left in rtg
RTG(Start([]),ProdRules([]))
FAIL: dfta-accept-tests
========================================
1 of 2 tests failed
Please report to stratego-bugs@cs.uu.nl
========================================
make[4]: *** [check-TESTS] Error 1
make[4]: Leaving directory
`/tmp/nix-24398-5/svn-export/stratego-libraries/rtg/tests'
make[3]: *** [check-am] Error 2
```

Is it portable?

```
Making all in nix-setuid-helper
if g++ -DHAVE_CONFIG_H -I. -I. -I../.. -I./.. -I/...-aterm-2.4.2-fixes/include -I./../libutil
-D_FILE_OFFSET_BITS=64 -g -O2 -MT main.o -MD -MP -MF ".deps/main.Tpo" -c -o main.o main.cc; \
then mv -f ".deps/main.Tpo" ".deps/main.Po"; else rm -f ".deps/main.Tpo"; exit 1; fi
main.cc: In function `void secureChown(unsigned int, unsigned int, unsigned
int, unsigned int, const nix::Path&)':
main.cc:49: error: `lchown' undeclared (first use this function)
main.cc:49: error: (Each undeclared identifier is reported only once for each
function it appears in.)
main.cc: In function `void runBuilder(unsigned int, unsigned int, const
nix::StringSet&, const std::string&, std::basic_string<char,
std::char_traits<char>, std::allocator<char> >, int, char**, char**)':
main.cc:101: warning: passing negative value `-1' for argument passing 2 of `
void secureChown(unsigned int, unsigned int, unsigned int, unsigned int,
const nix::Path&)'
main.cc:101: warning: argument of negative value `-1' to `unsigned int'
main.cc: In function `void run(int, char**)':
main.cc:228: warning: passing negative value `-1' for argument passing 1 of `
void secureChown(unsigned int, unsigned int, unsigned int, unsigned int,
const nix::Path&)'
main.cc:228: warning: argument of negative value `-1' to `unsigned int'
make[3]: *** [main.o] Error 1
```

Build Farm Results for Package strategoxt

Note: there is also a overview of the latest build results per package.

Package	Release	Rev	All	Source tarball	i686-linux	i686-darwin	powerpc-darwin	i686-cygwin	Red Hat 9.0	Fedora Core 2	Fedora Core 3	SuSE 9.0	Check	Coverage
strategoxt	0.17M2pre15838	15838	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓✓✓	
strategoxt	0.17M2pre15837	15837	✗	✓	✓	✓	✓		✓	✓	✓	✓	✓✓✗	
strategoxt	0.17M2pre15836	15836	✗	✗	✗	✗	✗		✗	✗	✗	✗	✓✓✗	
strategoxt	0.17M2pre15835	15835	✗	✗	✗	✗	✗		✗	✗	✗	✗	✓✓✗	
strategoxt	0.17M2pre15831	15831	✗	✗	✗	✗	✗		✗	✗	✗	✗	✓✓✗	
strategoxt	0.17M2pre15819	15819	✗	✗	✗	✗	✗		✗	✗	✗	✗	✓✓✗	
strategoxt	0.17M2pre15809	15809	✗	✓	✗	✗	✗		✓	✓	✓	✓	✓✓✗	
strategoxt	0.17M2pre15799	15799	✗	✓	✗	✗	✗		✗	✗	✗	✗	✓✓✗	
strategoxt	15784-bad	15784	✗	✗	✗	✗	✗		✗	✗	✗	✗	✗✗✗	
strategoxt	0.17M2pre15779	15779	✗	✓	✗	✗	✗		✗	✗	✗	✗	✓✓✗	
strategoxt	0.17M2pre15767	15767	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓✓✓	
strategoxt	0.17M2pre15761	15761	✗	✗	✗	✗	✗		✗	✗	✗	✗	✓✓✗	
strategoxt	0.17M2pre15760	15760	✗	✗	✗	✗	✗		✗	✗	✗	✗	✓✓✗	
strategoxt	15757-bad	15757	✗	✗	✗	✗	✗		✗	✗	✗	✗	✓✗✗	
strategoxt	15755-bad	15755	✗	✗	✗	✗	✗		✗	✗	✗	✗	✓✗✗	
strategoxt	15754-bad	15754	✗	✗	✗	✗	✗		✗	✗	✗	✗	✓✗✗	

Run static/dynamic analyses

LTP GCOV extension - code coverage report

Current view: directory - src/libexpr
Test: app.info
Date: 2006-11-14 — Instrumented lines: 1842
Code covered: 86.2 % — Executed lines: 1588

Filename	Coverage	
attr-path.cc	85.3 %	29 / 34 lines
eval.cc	90.8 %	356 / 392 lines
expr-to-xml.cc	92.9 %	52 / 56 lines
get-drvs.cc	79.4 %	77 / 97 lines
get-drvs.hh	50.0 %	2 / 4 lines
lexer.l	96.0 %	72 / 75 lines
nixexpr-ast.cc	100.0 %	121 / 121 lines
nixexpr-ast.hh	95.4 %	293 / 307 lines
nixexpr.cc	78.1 %	168 / 215 lines
nixexpr.hh	100.0 %	13 / 13 lines
parser.y	96.6 %	171 / 177 lines
primops.cc	66.7 %	234 / 351 lines

Produce downloadable releases

PHP-SAT, the PHP static analysis tool release php-sat-0.1pre286

This page provides release **php-sat-0.1pre286** of PHP-SAT, the PHP static analysis tool. It was generated automatically on 2006-11-14 22:13:35 UTC from revision 286 of the path /php-sat/trunk of its Subversion repository (the XML record of the build job is available).

Distribution

Binary archive for Microsoft Windows

- php-sat.zip (10642950 bytes; MD5 hash: 9ce5bb9f87a613803547cece51c1d451)

RPM for Red Hat 9.0

- php-sat-0.1pre286-1.i386.rpm (145051 bytes; MD5 hash: fcfdcd512e3c9e6e548d0bbbb0647bba)
- php-sat-0.1pre286-1.src.rpm (551573 bytes; MD5 hash: f06c9bfc1ac95041ce52ab61e7df64a9)

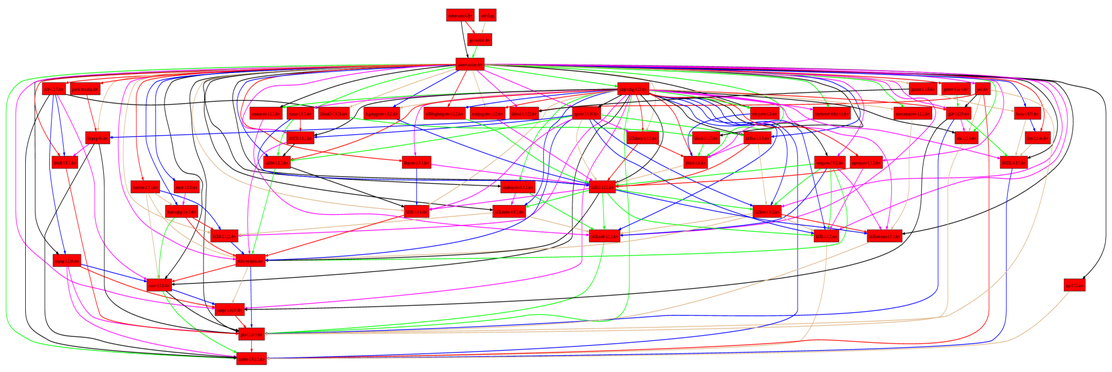
This RPM requires that the following packages are also installed:

- aterm-2.4.2-1.i386.rpm
- php-front-0.1pre287-1.i386.rpm
- sdf2-bundle-2.3.4pre15345-1.i386.rpm
- strategoxt-0.17M3pre15898-1.i386.rpm

SuSE RPM for SuSE 9.0

The Problem: Managing the Complexity of the Build Environment

- Non-trivial software packages typically have a **large number of dependencies**.



Example: build-time dependency graph of **Mozilla Firefox** (on Linux).

- So if we need to build a package with N dependencies on M configurations, then to install and manage those dependencies takes **N x M effort**!
- And what if there are **conflicting dependencies**? E.g., package A builds with GCC 3.3 but not GCC 4.1, while package B needs at least GCC 4.1.
- Finally, the (virtual) machines themselves need to be set up and maintained.

The Solution: The Nix Deployment System

- **Nix** (http://nix.cs.uu.nl/) is a **purely functional package management system**.
- Packages are built from pure functions (Nix expressions), i.e., the build result only depends on the declared inputs and never changes after it has been built.
- Packages are stored in a **Nix store** under a name that contains a **cryptographic hash of all package inputs**:

```
/
└ usr
  ├ bin
  │ ├ gcc
  │ ├ firefox
  │ └ acroread
  ├ lib
  │ ├ libgtk-x11.so.0
  │ ├ libstdc++.so.6
  │ └ libxml2.so.2
  ├ include
  │ ├ stdlib.h
  │ └ zlib.h
  └ man
    └ ...

/nix/store
├ 66qra1164b1s...-gtk+-2.10.9
│ └ lib
│   └ libgtk-x11-2.0.so.0
├ i33jmpd2p14r...-firefox-2.0.0.2
│ └ bin
│   └ firefox
├ kpqz9a4clx96...-gcc-4.1.1
│ ├ bin
│ │ └ gcc
│ └ lib
│   └ libstdc++.so.6
└ s749sha8pf73...-gcc-3.3.6
  ├ bin
  │ └ gcc
  └ lib
    └ libstdc++.so.5
```

Unique paths for different versions

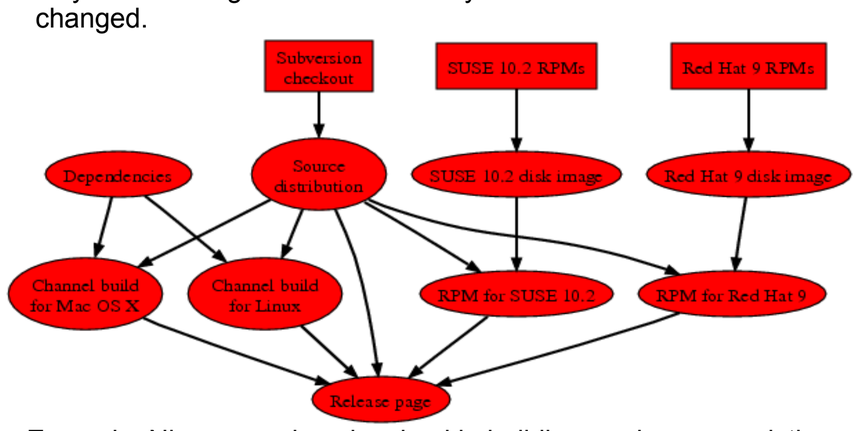
Why is this useful for a build farm?

- As a component build language, the Nix expression language is ideal for **describing the build tasks** to be performed.
- As a functional language, the Nix expression language makes it easy to **describe variants**.
- **Virtual machines** can be built and used on the fly in a Nix expression from a declarative specification.
- Nix **manages the storage** of the dependencies.
- Nix supports **distributed multi-platform builds** transparently.
- The hashing scheme + complete dependencies allow builds to be **reproduced** reliably.
- **Efficiency**: due to the hashing scheme, we only rebuild things that have actually changed.

```
{stdenv, fetchurl, perl}:

stdenv.mkDerivation {
  name = "hello-2.1.1";
  src = fetchurl {
    url = .../hello-2.1.1.tar.gz;
    md5 = "70c9ccf9fac0...";
  };
  buildInputs = [perl];
}
```

Example: Nix expression for Hello World



Example: Nix expressions involved in building a release consisting of Nix channel builds and RPMs for various platforms

Status and Research Directions

- Nix-based build farm in use at UU, TUD.
- Used by various open source projects: Stratego/XT, MetaEnvironment, Nix, NixOS...
- Future work: **automatic exploration of the configuration space** – try to select configurations that are more likely to exhibit problems.
- Future work: use static analyses to find potentially troublesome configurations, e.g., interference between `#ifdefs` in a C program

More information

- Nix web site: http://nix.cs.uu.nl/
- Example Nix build farms: http://nix.cs.uu.nl/dist/, http://buildfarm.st.ewi.tudelft.nl/