C++ bitand Nix

Etienne Laurin, 2018-12-03

Nix: a package manager

2003 “Initial version of nix”

2006 “Nix gives us important features that are lacking in most deployment systems, such as complete dependencies, complete deployment, side-by-side deployment, atomic upgrades and rollbacks, transparent source/binary deployment and reproducibility”

Nix: a package manager

2003 “Initial version of nix”

2006 “Nix gives us important features that are lacking in most deployment systems, such as complete dependencies, complete deployment, side-by-side deployment, atomic upgrades and rollbacks, transparent source/binary deployment and reproducibility”

2013 I install Nix on my computer

Nix: a package manager

2003 “Initial version of nix”

2006 “Nix gives us important features that are lacking in most deployment systems, such as complete dependencies, complete deployment, side-by-side deployment, atomic upgrades and rollbacks, transparent source/binary deployment and reproducibility”

2013 I install Nix on my computer

2014 I install NixOS on my computer

NixOS: A Linux distribution?

```
$ find /bin /usr
/bin
/bin/sh
/usr
/usr/bin
/usr/bin/env
```

NixOS: A Linux distribution?

```
$ find /bin /usr
/bin
/bin/sh
/usr
/usr/bin
/usr/bin/env
```

```
$ file /bin/sh
symbolic link to /nix/store/
    ↪ pd3xx55jjik53gvbyrs4h0him03l3wah-bash-
    ↪ interactive-4.4-p23/bin/sh
```

Installing Dependencies

```
$ cmake
bash: cmake: No such file or directory
```

```
$ nix-env -i cmake
installing 'cmake-3.11.2'
building '/nix/store/
    ↪ hgzmmpfg5kmm88rdwl4rixzvq4fz0nbh-user-
    ↪ environment.drv'...
created 2467 symlinks in user environment
```

```
$ cmake -Hsrc -Bbuild/release
CMake Error: CMake was unable to find a build program
    ↪  corresponding to "Unix Makefiles".
CMake Error: CMAKE_CXX_COMPILER not set, after
    ↪ EnableLanguage
```

Installing Dependencies

```
$ nix-env -i gnumake gcc
installing 'gnumake-4.2.1'
installing 'gcc-7.3.0'
these paths will be fetched (1.44 MiB download, 6.65
    ↪ MiB unpacked):
  /nix/store/5f6f618a5vlp3cgx39p6kzfykmmpf896-
      ↪ gnumake-4.2.1-info
  /nix/store/ba0p194b03201r0dphg4h4lnlp5rrz3w-gcc-
      ↪ 7.3.0-info
  /nix/store/kmhbrdyg6fsabp8kl8xs367xmf7lbv9c-
      ↪ gnumake-4.2.1-man
  /nix/store/wdi1a5zl3xnpln1warb7sskyvvkbnsm8-gcc-
      ↪ 7.3.0-man
created 2573 symlinks in user environment
```

Installing Dependencies

```
$ cmake -Hsrc -Bbuild/release
--The CXX compiler identification is GNU 7.3.0
--Check for working CXX compiler: /nix/store/
    ↪ iw94llkj05wgaz268mlzvgx8jkbi1ss0-gcc-wrapper-
    ↪ 7.3.0/bin/c++
...
CMake Error at cmake/Modules/
    ↪ FindPackageHandleStandardArgs.cmake:91 (
    ↪ MESSAGE):
  Could NOT find GMP (missing: GMP_INCLUDE_DIR
      ↪ GMP_LIBRARIES) (Required is at
    least version "5.0.5")
```

Build Environment

- shell.nix

```
with import <nixpkgs> {};

stdenv.mkDerivation rec {
  name = "lean-${version}";
  version = "3.4.2";

  nativeBuildInputs = [ cmake python ];
  buildInputs = [ gmp ];
}
```

Build Environment

```
$ nix-shell
[nix-shell]$ $ cmake -Hsrc -Bbuild/release
...
--Found GMP: /nix/store/
    ↪ ipba8r4418ls0j55p5y5gi4zmg2kna5n-gmp-6.1.2-
    ↪ dev/include (Required is at least version "5.0.5")
--Found PythonInterp: /nix/store/6
    ↪ b6lzbq74g95j8qlbrdjzkn2ghh81mgy-python-
    ↪ 2.7.15/bin/python (found version "2.7.15")
--Configuring done
--Generating done
--Build files have been written to: /home/atnnn/nix-and-
    ↪ c++/lean/build/release
```

Build Environment

```
[nix-shell]$ nethack
Shall I pick a character's race, role,
gender and alignment for you? [ynaq] y

You, a newly trained Aspirant, have been heralded
from birth as the instrument of Poseidon. You are
    ↪ destined
to recover the Amulet for your deity, or die in the
attempt. Your hour of destiny has come. For the sake
of us all: Go bravely with Poseidon!
```

Build Environment

```
[nix-shell]$ $ cmake -Hsrc -Bbuild/release
...
--Check for working CXX compiler: /home/atnnn/.nix-
    ↪ profile/bin/c++
```

Build Environment

```
$ nix-shell --pure

[nix-shell]$ nethack
nethack: command not found

[nix-shell]$ cmake -Hsrc -Bbuild/release
...
--Check for working CXX compiler: /nix/store/
    ↪ iw94llkj05wgaz268mlzvgx8jkbi1ss0-gcc-wrapper-
    ↪ 7.3.0/bin/g++
```

Package

- default.nix

```
with import <nixpkgs> {};

stdenv.mkDerivation rec {
  name = "lean-${version}";
  version = "3.4.2";

  nativeBuildInputs = [ cmake python ];
  buildInputs = [ gmp ];

  src = lib.cleanSource ./.;
  sourceRoot = "lean/src";
  postUnpack = "chmod -R a+w $sourceRoot/..";
}}
```

Package

```
$ nix build
[1/0/1 built] building lean-3.4.2 (configurePhase): --
    ↪ Detecting CXX compiler ABI info -done
```

```
[1/0/1 built] building lean-3.4.2 (buildPhase): [ 21%]
    ↪ Building CXX object util/CMakeFiles/util.dir/lbool.
    ↪ cpp.o
```

```
[1 built]


$
```

Package

```
$ result/bin/lean --version
Lean (version 3.4.2, Release)
```

```
ldd result/bin/lean
  libgmp.so.10 => /nix/store/
      ↪ rxaclc3vhxbzgfllv7601i85z854h48a-gmp-6.1.2/
      ↪ lib/libgmp.so.10 (0x00007f7d66270000)
  libstdc++.so.6 => /nix/store/
      ↪ zk5zj2307zxaq7dx585yia3dn5k4qlsl-gcc-7.3.0-
      ↪ lib/lib/libstdc++.so.6 (0x00007f7d65ce5000)
```

Package

```
$ file result
The program 'file' is currently not installed. You can
    ↪ install it by typing:
  nix-env -iA nixos.file
```

```
$ nix run nixpkgs.file -c file result
result: symbolic link to /nix/store/8
    ↪ n0f5i03k72j7wwkfaafnkn4hg7c8pdb-lean-3.4.1
```

Different Compiler

```
$ nix run nixpkgs.clang -c bash
[0/1 built, 1/28/30 copied (1279.7/1284.6 MiB),
    ↪ 108.8/230.7 MiB DL] fetching clang-5.0.2 from
    ↪ https://cache.nixos.org
```

```
[30 copied (1284.5 MiB), 0.0 MiB DL]

[run]$ clang --version
clang version 5.0.2 (tags/RELEASE_502/final)
```

Different Compiler

```
$ nix run nixpkgs.clang_7 -c clang --version
[16 copied (982.7 MiB), 0.0 MiB DL]
clang version 7.0.0 (tags/RELEASE_700/final)
```

```
$ nix run nixpkgs.gcc8 -c gcc --version
[4 copied (134.0 MiB), 0.0 MiB DL]
gcc (GCC) 8.2.0
```

Hydra

https://hydra.nixos.org/project/nixos

1457674	2018-05-18	nixpkgs → b12448c	38221 7282	+65
1457544	2018-05-17	nixpkgs → 456369f	38156 7347	+151
1457303	2018-05-17	nixpkgs → 2ecba01	38005 7498	+183
1457241	2018-05-16	nixpkgs → 283a61a	37822 7681	+2462
1456897	2018-05-15	nixpkgs → da5a692	35360 9974	+5253
1456381	2018-05-13	nixpkgs → 116cce8	30107 15230	+19
1456363	2018-05-13	nixpkgs → d93b315	30088 15249	+719
1456001	2018-05-12	nixpkgs → 1ac6445	29369 15968	+1314

Hydra

https://hydra.nixos.org/jobset/nixos/gcc-8

	Name	Description	Last evaluated	Success			
✗	gcc-8	GCC 8 test	2018-12-01 14:09:59	83%	38221	7282	
✗	nixup	Combined NixOS/Nixpkgs for https://github.com/NixOS/nixpkgs/pull/9250	2018-12-01 05:35:05	98%	19110	210	
✗	openssl-1.1	openssl 1.1 test	2018-12-01 13:06:33	65%	20964	11114	
✗	release-16.09	NixOS 16.09 release branch	2018-12-01 14:09:47	99%	26238	182	
✗	release-16.09-small	NixOS 16.09 small release branch	2018-12-01 14:09:37	83%	36	7	
✗	release-17.03	NixOS 17.03 release branch	2018-12-01 07:09:01	79%	21780	5490	
✓	release-17.03-small	NixOS 17.03 small release branch	2018-12-01 14:09:42	100%	42		
✗	release-17.09	NixOS 17.09 release branch	2018-12-01 07:09:07	99%	18886	159	
✓	release-17.09-small	NixOS 17.09 small release branch	2018-12-01 13:13:32	100%	43		
✗	release-18.03	NixOS 18.03 release branch	2018-12-01 09:30:28	99%	20374	93	
✗	release-18.03-aarch64	NixOS 18.03 release branch: aarch64	2018-12-01 04:13:39	94%	11284	686	
✓	release-18.03-small	NixOS 18.03 small release branch	2018-12-01 13:06:37	100%	48		
?	release-18.09	NixOS 18.09 release branch	2018-12-01 09:30:22	98%	26907	258	159
?	release-18.09-aarch64	NixOS 18.09 release branch: aarch64	2018-12-01 11:04:40	44%	6116	7692	11

Testing

- default.nix

```
doCheck = true;
checkPhase = "ctest -j$NIX_BUILD_CORES -V";
```

```
[1/0/1 built, 0.0 MiB DL] building lean-3.4.2 (
    ↪ checkPhase): 103/1313 Test #1218:
    ↪ leanfailtest_all ..................... Passed
```

Testing

```
$ nix build
builder for '/nix/store/
      ↪ ijpk5dbykpi8qnp30krqg5gwg8hbprnm-lean-3.4.2.
      ↪ drv' failed with exit code 8; last 10 log lines:
...
  1311 -c_univ_test (Failed)
  1312 -c_expr_test (Failed)
  1313 -thread_test (Failed)
Errors while running CTest
[0 built (1 failed), 0.0 MiB DL]
```

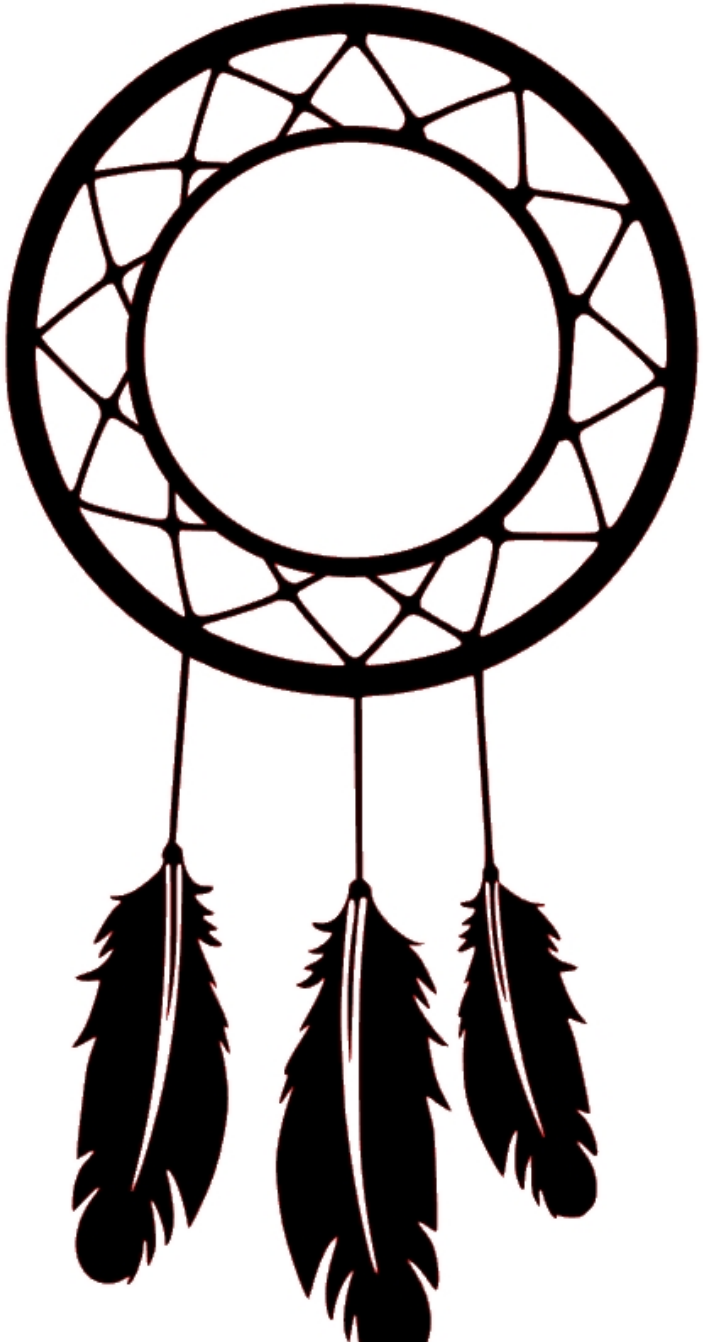
Testing

```
$ nix log /nix/store/
    ↪ ijpk5dbykpi8qnp30krqg5gwg8hbprnm-lean-3.4.2.
    ↪ drv
...
1231: ./test_single.sh: ./run_single.sh: /usr/bin/env: bad
    ↪  interpreter: No such file or directory
...
97% tests passed, 36 tests failed out of 1313
```

```
checkPhase = ''
  patchShebangs "../../tests"
  ctest -j$NIX_BUILD_CORES -V;
'';
```

Nix Logo

Dream Catcher



Lambda Capture

Lambda capture

The *captures* is a comma-separated list of zero or more *captures*, optionally beginning with the *capture-default*. The only capture defaults are

- **&** (implicitly capture the used automatic variables by reference) and
- **=** (implicitly capture the used automatic variables by copy).

The current object (`*this`) can be implicitly captured if either capture default is present. If implicitly captured, it is always captured by reference, even if the capture default is =. The implicit capture of `*this` when the capture default is = is deprecated. (since C++20)

The syntax of an individual capture in *captures* is

Distributed Builds

```
$ nix-build --builders ssh://10.233.1.2 -j0
  building '/nix/store/33
      ↪ van4xpnj5j8g4z4h5dl47ivnvfz3ah-lean-3.4.2.
      ↪ drv' on 'ssh://10.233.1.2'...
```

Distributed Builds

```
distributedBuilds = true;
buildMachines = [
{ hostName = "10.233.1.2";
  maxJobs = 3;
  system = "x86_64-linux";
  supportedFeatures = [ "kvm" ];
} ];
```

Nix Source

```
syswrite($to, pack("L<x4L<x4", 7, $includeOutputs ? 1
    ↪ : 0)) or die;
if (scalar @missing > 0) {
 print STDERR "copying ", scalar @missing, " missing
     ↪ paths from '$sshHost'...\n";
 writeInt(5, $to); # == cmdExportPaths
 writeInt(0, $to); #
 writeStrings(\@missing, $to);
 importPaths(fileno($from), 1);
}
```

Nix Source

```
void copyPaths(ref<Store> srcStore, ref<Store>
    ↪ dstStore, const PathSet & storePaths,
    RepairFlag repair, CheckSigsFlag checkSigs,
        ↪ SubstituteFlag substitute)
{
    PathSet valid = dstStore->queryValidPaths(
        ↪ storePaths, substitute);

    PathSet missing;
    for (auto & path : storePaths)
        if (!valid.count(path)) missing.insert(path);

    if (missing.empty()) return;

    Activity act(*logger, lvlInfo, actCopyPaths, fmt("
        ↪ copying %d paths", missing.size()));
```

Multiple Jobs

- default.nix

```
{
  nixpkgs ? import <nixpkgs> {},
  stdenv ? nixpkgs.stdenv,
  doCheck ? false
}:
with nixpkgs;
```

Multiple Jobs

- extra.nix

```
let
  nixpkgs = import <nixpkgs> {};
  build = import ./default.nix;
in with nixpkgs;
{
  lean = build {};
  clang = build { stdenv = overrideCC stdenv clang; };
}
```

Multiple Jobs

```
$ nix build -f extra.nix clang
[0/2 built, 1/4/8 copied (154.3/893.2 MiB), 0.0/165.9
    ↪ MiB DL] fetching llvm-5.0.2 from https:
```

```
[1 built, 8 copied (893.2 MiB), 0.0 MiB DL]
```

```
$ nix log ./result
...
--The CXX compiler identification is Clang 5.0.2
--The C compiler identification is Clang 5.0.2
```

Musl

```
musl = build { stdenv = pkgsCross.musl64.stdenv; };
```

```
$ nix build -f extra.nix musl
[1/2/6 built, 3 copied (334.1/334.1 MiB), 0.0/66.8 MiB
    ↪ DL] building x86_64-unknown-linux-musl-stage-
    ↪ final-gcc-debug-7.3.0 (buildPhase): g++ -fno-PIE
    ↪ ...
```

Musl

```
$ nix log ./result
...
--Check for working CXX compiler: /nix/store/6
    ↪ kb5kq1livcc6xzsl881ssi5qrf13dmn-x86_64-
    ↪ unknown-linux-musl-stage-final-gcc-debug-
    ↪ wrapper-7.3.0/bin/...
...
--Found GMP: /nix/store/
    ↪ s039f6082dpgribnkzgwydblmif3g28h-gmp-6.1.2-
    ↪ x86_64-unknown-linux-musl-dev/include
```

Musl

```
$ result/bin/lean --version
Lean (version 3.4.2, Release)
```

Clang Versions

```
clang6 = build { stdenv = overrideCC stdenv clang_6;
    ↪ };
clang7 = build { stdenv = overrideCC stdenv clang_7;
    ↪ };
```

```
$ nix build -f extra.nix clang7
[1 built, 15 copied (10.2 MiB), 0.0 MiB DL]
```

Packaging For Other Platforms

```
xenial32 = vmTools.runInLinuxImage (derivation {
  name = "lean-${lean.version}-xenial-i386.deb";
  system = builtins.currentSystem;
  diskImage = vmTools.diskImageFuns.ubuntu1604i386
    { extraPackages = [ "cmake" "libgmp-dev" ]; };
  src = lean.src;
  builder = ".";
```

Packaging For Other Platforms

```
  args = builtins.toFile "builddeb.sh" ''
    export PATH=/bin:/usr/bin
    cp -a $src lean
    mkdir build && cd build
    cmake ../lean/src
    make -j 12
    cpack -G DEB
    cp *.deb ../out
  '';
```

Packaging For Other Platforms

```
  QEMU_OPTS = "-smp 12";
  memSize = 4096;
});
```

Packaging For Other Platforms

```
$ nix-build extra.nix -A xenial32
...
Creating filesystem with 1048576 4k blocks and
    ↪ 262144 inodes
...
unpacking Debs...
/nix/store/n0skxhr3hdwr3rb5zw4i3nv0pma5hf6z-gcc-6-
    ↪ base_6.0.1-0ubuntu1_i386.deb...
/nix/store/0wzg0ds79cl8ql0lwnqas6jszp67rlkb-libgcc1_6
    ↪ .0.1-0ubuntu1_i386.deb...
...
```

Packaging For Other Platforms

```
Booting from ROM...
...
mounting Nix store...
mounting host's temporary directory...
starting stage 2 (/nix/store/
    ↪ iwq4vg0da1x84j2dk1y43vlcbplq2avf-vm-run-
    ↪ stage2)
...
++ cmake ../lean/src
--The CXX compiler identification is GNU 5.3.1
...
```

Packaging For Other Platforms

```
[ 99%] Linking CXX executable lean
[100%] Linking CXX executable lean_js
[100%] Built target lean
...
CPack: Create package
CPack: -package: /tmp/build/lean-3.4.2-linux.deb
    ↪ generated.
...
/nix/store/36w2fmibkgh1xvr74m3zpr65m4m8r8gy-lean-
    ↪ 3.4.2-xenial-i386.deb
```

Packages From Other Languages

Chapter 9. Support for specific programming languages and frameworks

Table of Contents

CC Wrapper

```
$ NIX_DEBUG=1 clang -c -x c <(echo "")
...
extra flags after to /nix/store/
     ↪ m95qssx1fylql22jixp76pcnmwa5w5al-clang-
     ↪ 5.0.1/bin/clang:
  -B/nix/store/m95qssx1fylql22jixp76pcnmwa5w5al-
       ↪ clang-5.0.1/lib
  -B/nix/store/1zv5dwifxg5fh08gif8ld3h9f40y8czh-glibc-
       ↪ 2.26-115/lib/
...
```

CC Wrapper

```
-D_FORTIFY_SOURCE=2
-fstack-protector-strong
--param
ssp-buffer-size=4
-fPIC
-fno-strict-overflow
-Wformat
-Wformat-security
-Werror=format-security
```

Docker

```
docker = dockerTools.buildImage {
  name = "lean";
  tag = lean.version;
  contents = lean;
  config.Env = { "PATH" = "/bin"; };
  config.Cmd = [ "/bin/lean" "--version" ];
};
```

Docker

```
$ nix build -f extra.nix docker
[5 built, 0.0 MiB DL]

$ docker load < result
f5697c6709b5: Loading layer [=====>] 96.99MB/96.99
    ↪ MB
Loaded image: lean:3.4.2

$ docker run --rm -i lean:3.4.2
Lean (version 3.4.2, Release)
```

Cross-compiling

- default.nix

```
nativeBuildInputs = with nixpkgs.buildPackages; [
    ↪ cmake python ];
buildInputs = with nixpkgs; [ gmp ];
```

Raspberry Pi

```
raspberrypi = build { nixpkgs = pkgsCross.raspberryPi;
    ↪ };
```

```
$ nix build -f extra.nix raspberrypi
[0/3 built, 1/15/25 copied (570.9/1177.8 MiB),
    ↪ 61.8/203.1 MiB DL] fetching armv6l-unknown-
    ↪ linux-gnueabihf-stage-static-gcc-debug-7.3.0
```

Raspberry Pi

```
$ file result/bin/lean
result/bin/lean: ELF 32-bit LSB executable, ARM, EABI5
    ↪ version 1 (GNU/Linux), dynamically linked
```

```
$ qemu-arm result/bin/lean --version
Lean (version 3.4.2, Release)
```

Windows

```
windows = build { nixpkgs = pkgsCross.mingwW64; };
```

```
$ nix build -f extra.nix windows
[1 built, 0.0 MiB DL]

$ file result/bin/lean.exe
result/bin/lean.exe: PE32+ executable (console) x86-64
```

Hydra

centos6-x86_64	✓	✓	✓	✗
centos7-x86_64	✓	✓	✓	✓
checkStyle	✓	✓	✓	✓
fetchDependencies	✓	✓	✓	✓
integrationTests	✗	✗	✗	✗
jessie-amd64	✓	✗	✗	✗
jessie-i386	✓	✗	✗	✗
jessie-src	✓	✓	✓	✓

Overview

Pros	Cons
- Nothing by default - Immutability by default - Amazing build and test environments - Decent desktop experience - Declarative DSL	- Learning Curve - No Native Windows - Lack of documentation for advanced features

Questions?

Nix: https://nixos.org