The Nix Package Manager

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November 12, 2009
- Nix: purely functional package manager
- NixOS: Linux distribution based on Nix
- Hydra: continuous build system based on Nix
- http://nixos.org/
What’s wrong with other package managers?

- Upgrading a package is dangerous
- Hard to have multiple versions of a package installed at the same time
- Upgrades are not atomic
- No rollbacks
- Incomplete dependency info
- Only root can install packages
- ...
Nix: Purely functional package management

Nix is a purely functional package manager.

- Purely functional language to describe how to build packages and their dependencies
- Build results only depend on declared inputs.
- Packages never change after they have been built.
Main idea: store all packages in isolation from each other:

/nix/store/rpdqxnilb0cg...-firefox-3.5.4

Paths contain a 160-bit **cryptographic hash** of all inputs used to build the package:

- Sources
- Libraries
- Compilers
- Build scripts
- ...

```
/nix/store
  └── 19w6773m1msy...-openssh-4.6p1
        └── bin
              └── ssh
              └── sbin
                   └── sshd
        └── smkabrbibqv7...-openssl-0.9.8e
              └── lib
                    └── libssl.so.0.9.8
        └── c6jbqm2mc0a7...-zlib-1.2.3
              └── lib
                    └── libz.so.1.2.3
        └── im276akmsrhv...-glibc-2.5
              └── lib
                    └── libc.so.6
```
Nix expressions

```nix
{ stdenv, fetchurl, openssl, zlib }:

stdenv.mkDerivation {
  name = "openssh-4.6p1";
  src = fetchurl {
    url = http://.../openssh-4.6p1.tar.gz;
    sha256 = "0fpjlr3bfjnd0y94bk442x2p...";
  };
  buildCommand = "
    tar xjf $src
    ./configure --prefix=$out --with-openssl=$openssl
    make; make install"
}
```
Nix expressions

**all-packages.nix**

```nix
openssl = import ../development/libraries/openssl {
    inherit fetchurl stdenv perl;
};

openssl = import ../development/libraries/openssl {
    inherit fetchurl stdenv perl;
};

stdenv = ...;
openssl = ...;
zlib = ...;
perl = ...;
}
```
Evaluating the `openssh` variable will produce an OpenSSH package in the Nix store.

```
all-packages.nix

openssh = import ../tools/networking/openssh {
    inherit fetchurl stdenv openssl zlib;
};

openssl = import ../development/libraries/openssl {
    inherit fetchurl stdenv perl;
};

stdenv = ...;
openssl = ...;
zlib = ...;
perl = ...;
```
User operations

➤ To build and install OpenSSH:

```bash
$ nix-env -f all-packages.nix -i openssh
```

➤ When a new version comes along:

```bash
$ nix-env -f all-packages.nix -u openssh
```

➤ If it doesn’t work:

```bash
$ nix-env --rollback
```

➤ Delete unused components:

```bash
$ nix-collect-garbage
```
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$ nix-collect-garbage
Users can have different sets of installed applications.

**nix-env** operations create new **user environments** in the store.

We can atomically switch between them.

These are roots of the garbage collector.
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- Users can have different sets of installed applications.
- *nix-env* operations create new **user environments** in the store.
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```
/path
```

```
/nix/store
- pp56i0a01si5...-user-env
  - bin
    - firefox
    - ssh
- l9w6773m1msy...-openssh-4.6p1
  - bin
    - ssh
  - rpdqxnilb0cg...-firefox-3.5.4
  - bin
    - firefox
  - aqn3wygq9jzk...-openssh-5.2p1
    - bin
      - ssh
  - i3d9vh6d8ip1...-user-env
    - bin
      - ssh
    - firefox
```

```
(nix-env --remove-generations old)
```
User environments

- Users can have different sets of installed applications.
- `nix-env` operations create new **user environments** in the store.
- We can atomically switch between them.
- These are roots of the **garbage collector**.

```
PATH

/nix/.../profiles

current

/nix/store

rpdqxnilb0cg...-firefox-3.5.4
  /bin
  firefox

aqn3wygq9jzk...-openssh-5.2p1
  /bin
  ssh

i3d9vh6d8ip1...-user-env
  /bin
  ssh
  firefox

(nix-collect-garbage)
```
This is a **source deployment model** (like Gentoo), but...

We get **binary deployment** by sharing pre-built components.

On the producer side:

```
$ nix-push $(nix-instantiate all-packages.nix) \n   http://server/cache
```

On the client side:

```
$ nix-pull http://server/cache
$ nix-env -f all-packages.nix -i openssh
```

Installation will now reuse pre-built components, **iff** they are exactly the same.
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On the client side:

```
$ nix-pull http://server/cache
$ nix-env -f all-packages.nix -i openssh
```

Installation will now reuse pre-built components, **iff** they are exactly the same.
Finding runtime dependencies

/nix/store
  └── l9w6773m1msy...-openssh-4.6p1
      ├── bin
      │   └── ssh
      ├── sbin
      │   └── ssd
      └── smkabrbibqv7...-openssl-0.9.8e
          └── lib
              └── libssl.so.0.9.8
  └── c6jbqm2mc0a7...-zlib-1.2.3
      └── lib
          └── libz.so.1.2.3
  └── im276akmsrhv...-glibc-2.5
      └── lib
          └── libc.so.6
Finding runtime dependencies

```
/nix/store
  19w6773m1msy...-openssh-4.6p1
    bin
      ssh
    sbin
      sshd
  smkabrbibqv7...-
    lib
      libssl.so.0
  c6jbqm2mc0a7...-
    lib
      libz.so.1.2.3
  im276akmsrhv...-glibc-2.5
    lib
      libc.so.6
```

Contents of 19w6...-openssh-4.6p1/bin/ssh

```
... 72 74 00 5f 65 6e 64 00 2f 6e 69 78 2f 73 74 6f |rt._end./nix/sto|
    72 65 2f 35 6d 6a 30 35 31 30 66 78 6a 76 32 71 |re/c6jbqm2mc0a7q|
    33 79 71 6c 71 76 79 72 70 68 37 37 49 79 6e |3yqlqvyrph774iyn|
    6b 6e 63 2d 33 6a 69 78 6a 69 78 2f 73 74 6f 2f |klf-zlib-1.2.3/l|
    69 62 3a 2f 6e 69 78 2f 73 74 6f 72 65 2f 32 6b |ib:/nix/store/sm|
    38 76 6a 6a 37 31 64 68 6d 38 73 72 33 67 6b 79 |kabrbibqv7sr3gky|
    68 7a 33 64 67 7a 31 37 33 76 35 78 6b 67 2d 6f |hz3dgz173v5xk-o|
    70 65 6e 73 73 6c 2d 30 2e 39 2e 38 6b 2f 6c 69 |penssl-0.9.8e/ll|
...```
Finding runtime dependencies

```
/nix/store
  l9w6773m1msy...-openssh-4.6p1
    bin
      ssh
    sbin
      sshd
  smkabrbibqv7...
    lib
      libssl.so.0
  c6jbqm2mc0a7...
    lib
      libz.so.1.2.3
  im276akmsrhv...-glibc-2.5
    lib
      libc.so.6
```

Contents of l9w6...-openssh-4.6p1/bin/ssh

```
... 72 74 00 5f 65 6e 64 00 2f 6e 69 78 2f 73 74 6f |rt._end./nix/sto|
      72 65 2f 35 6d 6a 30 35 31 30 66 78 6a 76 32 71 |re/c6jbqm2mc0a7q|
      33 79 71 6c 71 76 79 72 70 68 37 37 49 79 6e |3yqlqyrvph774iyn|
      6b 6c 66 2d 7a 6c 69 62 2d 31 2e 32 2e 33 2f 6l|klf-zlib-1.2.3/|
      69 62 3a 2f 6e 69 78 2f 73 74 6f 72 65 2f 32 6b|ib:/nix/store/sm|
      38 76 6a 6a 37 31 64 68 6d 38 73 72 33 67 6b 79|kabrbibqv7sr3gky|
      68 7a 33 64 67 7a 31 37 33 76 35 78 6b 67 2d 6f|hz3dgz173v5xkg-o|
      70 65 6e 73 73 6c 2d 30 2e 39 2e 38 6b 2f 6c 69|penssl-0.9.8e/li|
...```
Nix Packages collection

Nixpkgs

- Contains Nix expressions for \( \geq 2100 \) existing Unix packages.
  - Development tools: GCC, Perl, Mono, ...
  - Libraries: Glibc, GTK, Qt, X11, ...
  - Applications: Firefox, OpenOffice, ...
  - Servers: Apache \texttt{httpd}, PostgreSQL, ...
- On Linux/x86, fully bootstrapped (no external dependencies).
NixOS

Taking it all the way

▶ Since we can build packages...
▶ ...why not build all the other stuff that goes into a system configuration?
  ▶ i.e. configuration files, system startup scripts, Linux’s initial ramdisk, ...
▶ As long as it’s pure, we can build it!
▶ Result: NixOS, a Linux distribution that uses Nix to build all static parts of the system.
NixOS

Consequences

▶ All static parts are stored under /nix/store; no /lib, /usr, ...
▶ Upgrades are non-destructive; can roll back.
▶ Upgrades are atomic.
▶ Stateless: upgrading equivalent to reinstalling from scratch.
▶ Deterministic: can easily reproduce a configuration on another machine.
File Edit Options Buffers Tools Help

boot = {};
grubDevice = "/dev/sda4";
kernelModules = ["acpi-cpufreq" "cpufreq_powersave"];

NixOS

[eelco@tyros:~$ /etc/nixos/configuration.nix &]

[eelco@tyros:~$ ls -l /bin/]
total 0
lrwxrwxrwx 1 root root 59 mrt 4 14:13 sh -> /nix/store/ylmnj7n98vz3lrip2qp8nq8jw29sbcs-bash-3.2/bin/sh

[eelco@tyros:~$ cat /proc/version]
Linux version 2.6.20-skas3-v9-pre9-default (nix@scratchy) (collect2: ld returned 1 exit status) #1 SMP Thu Feb 8 17:23:43 UTC 2007

[eelco@tyros:~$ ls -l /usr/]
ls: cannot access /usr: No such file or directory

[eelco@tyros:~$ ls -l /lib/]
ls: cannot access /lib: No such file or directory

NixOS
NixOS
Nix expression for *ssh_config*

```nix
{ config, pkgs }:

pkgs.writeText "ssh_config" ''
  SendEnv LANG LC_ALL ...
  ${if config.services.sshd.forwardX11 then ''
    ForwardX11 yes
    XAuthLocation ${pkgs.xorg.xauth}/bin/xauth
    '' else ''
    ForwardX11 no
    ''
  }

''
```
Example

Nix expression for ssh_config

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  SendEnv LANG LC_ALL ...
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    ForwardX11 yes
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    ''
  } else ''
''
''
''
Laziness in action!
```
Example

Nix expression for ssh_config

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{ config, pkgs }:

pkgs.writeText "ssh_config" 
  SendEnv LANG LC_ALL ...
  ${if config.services.sshd.forwardX11 then ''
    ForwardX11 yes
    XAuthLocation "${pkgs.xorg.xauth}/bin/xauth"
  '' else ''
  ForwardX11 no
  ''
}
```

Nix store

```
/nix/store
  33lcnh62y1l3...-ssh_config
  kyv6n69a40q6...-xauth-1.0.2
  bin
  xauth
```
Example

Nix expression for ssh_config

```nix
{ config, pkgs }:

pkgs.writeText "ssh_config"

SendEnv LANG LC_ALL ...

${if config.services.sshd.forwardX11 then ''
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  XAuthLocation /nix/store/kyv6n69a40q6...-xauth-1.0.2/bin/xauth
'' else ''
  ForwardX11 no}

Nix store

Generated file: 33lcnh62yll3...-sshd_config

SendEnv LANG LC_ALL ...
ForwardX11 yes
XAuthLocation /nix/store/kyv6n69a40q6...-xauth-1.0.2/bin/xauth
```
NixOS build time dependency graph

Nix expressions to build each part of the system: system packages, applications, their dependencies, kernel modules, initrd, configuration files, Upstart jobs, boot scripts, ...
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The system configuration file

/etc/nixos/configuration.nix

```nix
{
  boot.loader.grub.bootDevice = "/dev/sda";
  fileSystems = singleton
    { mountPoint = "/";
      device = "/dev/sda1";
    };
  swapDevices = [ { device = "/dev/sdb1"; } ];
  services.sshd.enable = true;
  services.sshd.forwardX11 = true;
}```
The system configuration file

```
/etc/nixos/configuration.nix

{  
    boot.loader.grub.bootDevice = "/dev/sda";
    fileSystems = singleton
        {  
            mountPoint = "/";
            device = "/dev/sda1";
        }
    ;
    swapDevices = [
        
    ];
    services.sshd.enable = true;
    services.sshd.forwardX11 = true;
}
```

End-user perspective

- Edit configuration.nix.
- Run nixos-rebuild.
- This builds system.nix and runs its activation script.
- Non-destructive; various rollback/test mechanisms.
GNU GRUB version 0.97  (636K lower / 129984K upper memory)

NixOS — Default
Windows
NixOS — Configuration 269 (2009-08-11 23:21:10 - 2.6.27.29-default)
NixOS — Configuration 268 (2009-08-11 18:24:09 - 2.6.27.29-default)
NixOS — Configuration 267 (2009-08-05 10:47:20 - 2.6.27.29-default)
NixOS — Configuration 266 (2009-08-05 10:35:27 - 2.6.27.29-default)
NixOS — Configuration 265 (2009-08-05 10:35:06 - 2.6.27.29-default)
NixOS — Configuration 264 (2009-08-04 15:27:25 - 2.6.27.29-default)
NixOS — Configuration 263 (2009-08-04 15:07:21 - 2.6.27.29-default)
NixOS — Configuration 262 (2009-08-04 14:11:27 - 2.6.27.29-default)
NixOS — Configuration 261 (2009-08-04 10:42:23 - 2.6.27.29-default)
NixOS — Configuration 260 (2009-08-04 10:29:25 - 2.6.27.29-default)

Use the ↑ and ↓ keys to select which entry is highlighted.
Press enter to boot the selected OS, 'e' to edit the commands before booting, or 'c' for a command-line.
Hydra: Continuous build system based on Nix
- Checks out projects from repos and builds them
- Build jobs described by Nix expressions
- Main advantage: builds all dependencies of a job
### View patchelf:trunk

[Edit][Latest]

Showing results 1 - 10 out of 48.

<table>
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<th>Debian 4.0 (x86_64)</th>
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</tr>
</tbody>
</table>
Release patchelf-0.5


**Debian 4.0 (i386)**

- Debian package patchelf_0.5-1_i386.deb [details, contents]

**Debian 4.0 (x86_64)**

- Debian package patchelf_0.5-1_amd64.deb [details, contents]

**Debian 5.0 (i386)**

- Debian package patchelf_0.5-1_i386.deb [details, contents]

**Debian 5.0 (x86_64)**

- Debian package patchelf_0.5-1_amd64.deb [details, contents]

**Fedora 10 (i386)**

- Source RPM package patchelf-0.5-1.src.rpm [details, contents]

**Fedora 10 (x86 64)**

- RPM package patchelf-0.5-1.i386.rpm [details, contents]
<table>
<thead>
<tr>
<th>Nr</th>
<th>What</th>
<th>Duration</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Build of /nix/store/pmqiadrvsn3yms8vcf7wvvpn17x5q3sw-dbus-conf</td>
<td>1s</td>
<td>Succeeded (log, raw, tail)</td>
</tr>
<tr>
<td>3</td>
<td>Build of /nix/store/sp6rqqhj4yyiy8yyzg58f670h9q7sv1zn-hal-fdi</td>
<td>2s</td>
<td>Succeeded (log, raw, tail)</td>
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<tr>
<td>4</td>
<td>Build of /nix/store/v49jbb9v2z951zkcxaysn27qcd9al-y-udev-rules</td>
<td>2s</td>
<td>Succeeded (log, raw, tail)</td>
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<tr>
<td>6</td>
<td>Build of /nix/store/8g99xxw9755qxiyl9c08dmmka5aj3bl-upstart-dbus</td>
<td>1s</td>
<td>Succeeded (log, raw, tail)</td>
</tr>
<tr>
<td>1</td>
<td>Build of /nix/store/gkpc52jff0i3bhwysap9508dk153w0y9k-xine-lib-1.1.16.3.tar.bz2</td>
<td>3s</td>
<td>Succeeded (log, raw, tail)</td>
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<tr>
<td>7</td>
<td>Build of /nix/store/3n6j8mwaq2fxysshg0rwz0y5zhkf87l5-upstart-hal</td>
<td>1s</td>
<td>Succeeded (log, raw, tail)</td>
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<tr>
<td>8</td>
<td>Build of /nix/store/gq82n5jcdf37s6xvybkkx5bwywgc6cdxj-udev.conf</td>
<td>1s</td>
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<tr>
<td>10</td>
<td>Build of /nix/store/91ghxyd9w972c7d7jvngklsqjb4qxam-upstart-udev</td>
<td>1s</td>
<td>Succeeded (log, raw, tail)</td>
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<tr>
<td>11</td>
<td>Build of /nix/store/zy8rd7g5py65bg1lg77crlnxm99gr2dy-local-cmds</td>
<td>1s</td>
<td>Succeeded (log, raw, tail)</td>
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<tr>
<td>12</td>
<td>Build of /nix/store/a591mhlm8693p5nikfac21756ys6wp2k-upstart-nixos-manual</td>
<td>1s</td>
<td>Succeeded (log, raw, tail)</td>
</tr>
<tr>
<td>9</td>
<td>Build of /nix/store/mmwhg9awxx18ikqcg4hlvij6q8jl2jxc-xine-lib-1.1.16.3</td>
<td>4m 28s</td>
<td>Succeeded (log, raw, tail)</td>
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<tr>
<td>5</td>
<td>Build of /nix/store/8mx4nmffh887tmn3vnr5ir7v8777shgf39-xorg-server-1.5.3</td>
<td>8m 17s</td>
<td>Succeeded (log, raw, tail)</td>
</tr>
<tr>
<td>13</td>
<td>Build of /nix/store/w907hzq25n23p4477c8n50ghf2c6vqkh-phonon-4.3.1</td>
<td>1m 20s</td>
<td>Succeeded (log, raw, tail)</td>
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<tr>
<td>15</td>
<td>Build of /nix/store/galwlc26393m1ln8lyznbw63474x3fm8-xf86-input-evdev-2.2.2</td>
<td>7s</td>
<td>Succeeded (log, raw, tail)</td>
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<tr>
<td>16</td>
<td>Build of /nix/store/fmk4mij52cvl25c5830xxkwjgahg-xf86-video-vesa-2.2.0</td>
<td>29s</td>
<td>Succeeded (log, raw, tail)</td>
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<tr>
<td>17</td>
<td>Build of /nix/store/sxgn177x0a1lh5pmw88yabery7qm1lllj-xserver.conf</td>
<td>2s</td>
<td>Succeeded (log, raw, tail)</td>
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<tr>
<td>14</td>
<td>Build of /nix/store/5nnpd51ms19si3wzyvlxjvzl3anpqg-kdelibs-4.2.4</td>
<td>41m 24s</td>
<td>Succeeded (log, raw, tail)</td>
</tr>
<tr>
<td>18</td>
<td>Build of /nix/store/0ram1lknjxibjigjafsvvvb9yrvd-kdebase-runtime-4.2.4</td>
<td>8m 39s</td>
<td>Succeeded (log, raw, tail)</td>
</tr>
<tr>
<td>19</td>
<td>Build of /nix/store/d1s9rmb0yfg4nj76ahnxgb1mplvvr-kdeplatforms-4.2.4</td>
<td>8m 35s</td>
<td>Succeeded (log, raw, tail)</td>
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<tr>
<td>21</td>
<td>Build of /nix/store/2ynn52k3v77x29rmy0cilymfn4mlsd-kdebase-runtime-4.2.4</td>
<td>11m 44s</td>
<td>Succeeded (log, raw, tail)</td>
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<tr>
<td>20</td>
<td>Build of /nix/store/rihh5ch0w28zcq4cyvdqghm5mvqyc6-kdebase-workspace-4.2.4</td>
<td>27m 39s</td>
<td>Succeeded (log, raw, tail)</td>
</tr>
<tr>
<td>22</td>
<td>Build of /nix/store/1w7jbwzlj0k97wxc8a66xy24d255zlvlv-system-path</td>
<td>48s</td>
<td>Succeeded (log, raw, tail)</td>
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<tr>
<td>23</td>
<td>Build of /nix/store/v16jmzvh0m5cardkncvcpzpypc9ydl0w-bashrc.sh</td>
<td>4s</td>
<td>Succeeded (log, raw, tail)</td>
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<tr>
<td>24</td>
<td>Build of /nix/store/r3hs63dcrryn1bgeztrqrrl11p7mc6hyl-xsession</td>
<td>13s</td>
<td>Succeeded (log, raw, tail)</td>
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<tr>
<td>25</td>
<td>Build of /nix/store/q83xqr6p84bfxf3m593d3jcbhpfvnrw-slim.cfg</td>
<td>4s</td>
<td>Succeeded (log, raw, tail)</td>
</tr>
<tr>
<td>26</td>
<td>Build of /nix/store/aglqnxmaq13n6q2iy5v3xmmpvaiw37v-upstart-xserver</td>
<td>2s</td>
<td>Succeeded (log, raw, tail)</td>
</tr>
<tr>
<td>27</td>
<td>Build of /nix/store/cvfbnnbpcps1lfhrlgh05jlrj1jwc5fc5vz-upstart-jobs</td>
<td>3s</td>
<td>Succeeded (log, raw, tail)</td>
</tr>
<tr>
<td>28</td>
<td>Build of /nix/store/0xs3y221omlm7w6n6bbbh3avx4hgr-etc</td>
<td>5s</td>
<td>Succeeded (log, raw, tail)</td>
</tr>
</tbody>
</table>
Nix: safe package management, atomic upgrades, rollbacks, multi-user, portable, ...

NixOS: safe upgrades, atomic upgrades and rollbacks, reproducibility, ...

Hydra: builds dependencies of a continuous build job automatically, ...

More information / download

- http://nixos.org/
- NixOS ISO images for x86, x86_64 are available.