

FreeBSD package management system

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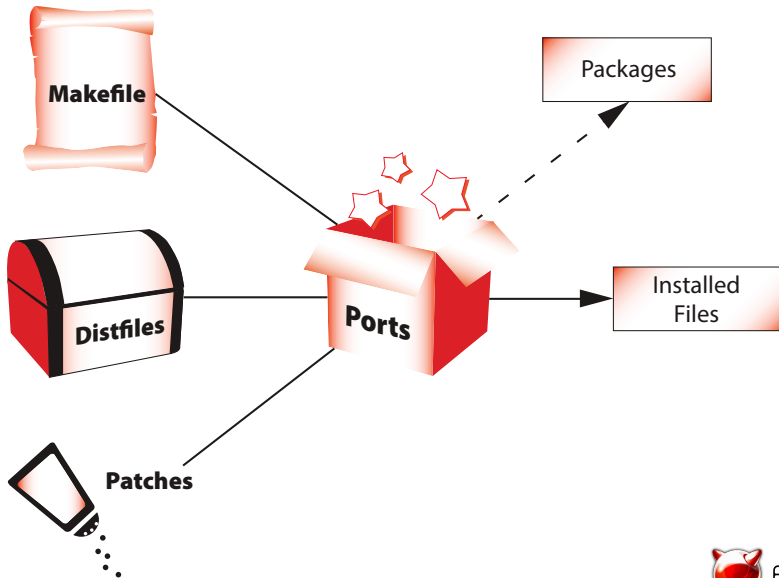
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Ports and packages

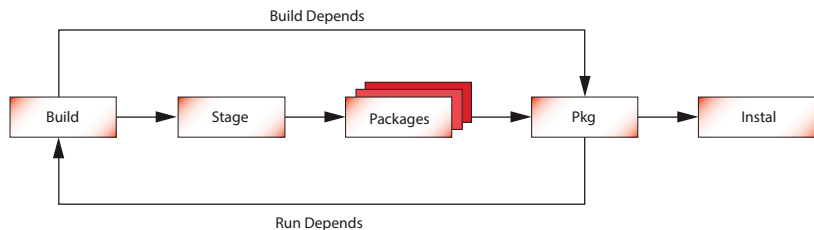
Ports is the comprehensive system of source packages.

- ▶ Mature.
- ▶ Clear and well defined.
- ▶ Simple (sometimes not).

Ports before pkg



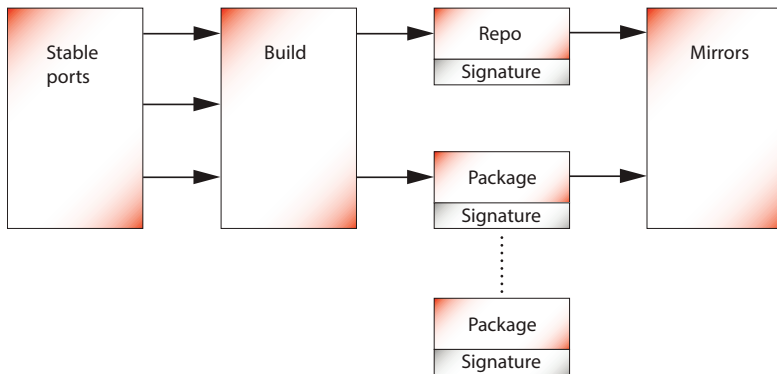
Planned ports and pkg interaction



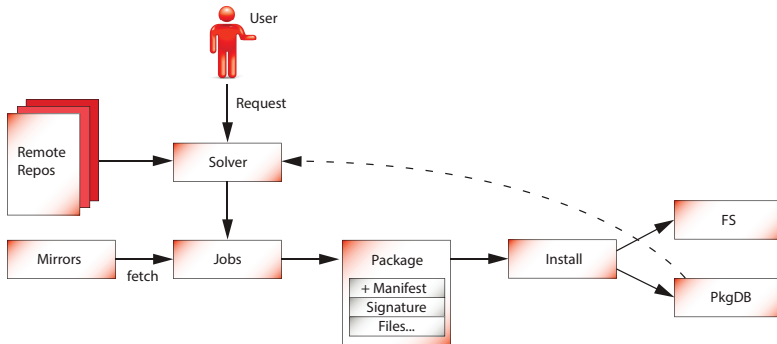
Ports and packages

- ▶ Ports are used to build packages.
- ▶ Dependencies are resolved by pkg, not make.
- ▶ Stable branch of ports has an appropriate stable branch of packages.
- ▶ Encourage users to install software from binary packages.
- ▶ But do not prevent them from building custom packages from the ports.

Repositories creation



Pkg architecture



The current problems with pkg

- ▶ Legacy ports support (with no staging, for example).
- ▶ Plain dependencies style.
- ▶ Immature codebase.
- ▶ Naive solver.

The problems of the solver in pkg

- ▶ Absence of conflicts resolving/handling;
- ▶ No alternatives support;
- ▶ Can perform merely a single task: install, upgrade, remove or autoremove, so install task cannot remove packages for example.

The existing work

There are many examples of solvers, for example:

- ▶ `libsolv` - the complete solver and package management library;
- ▶ Apt solvers interface;
- ▶ Mancoosi - a European research project that compares and study different solvers;

External solvers

To interact with an external solver we have chosen CUDF format used in the Mancoosi project:

```
package: devel/libblah  
version: 1  
depends: x11/libfoo
```

```
package: security/blah  
version: 2  
depends: devel/libblah  
conflicts: security/blah-devel
```

We need an internal solver!

Alternatives:

- ▶ Write own logic of dependencies and conflicts resolution?

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Alternatives:

- ▶ Write own logic of dependencies and conflicts resolution?
- ▶ Use some existing solution?

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- ▶ Use some existing solution?
- ▶ Use some known algorithm?

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Use SAT solver for packages management

$$(x_1 \parallel \neg x_2 \parallel x_3) \& (x_3 \parallel \neg x_1) \& (x_2)$$

Making a SAT problem

- ▶ Assign a variable to each package: package A $\rightarrow a_1$, package B $\rightarrow a_2$
- ▶ Interpret a request as a set of unary clauses:
 - ▶ Install/Upgrade package A $\rightarrow (a_1)$
 - ▶ Delete package B $\rightarrow (\neg a_2)$
- ▶ Convert dependencies and conflicts to disjunct clauses

Converting dependencies and conflicts

- ▶ If package A depends on package B (versions B_1 and B_2), then we can either have package A not installed or any of B installed:

$$(\neg A \parallel B_1 \parallel B_2)$$

- ▶ If we have a conflict between versions of B (B_1 , B_2 and B_3) then we ensure that merely one version is installed:

$$(\neg B_1 \parallel \neg B_2) \& (\neg B_1 \parallel \neg B_3) \& (\neg B_2 \parallel \neg B_3)$$

The solving of SAT problem

Some rules to follow to speed up SAT problem solving.

- ▶ Trivial propagation - solve unary clauses;
- ▶ Unit propagation - solve clauses with only a single unsolved variable;
- ▶ Conflicts learning - if we assign some free variable and detect a conflict during unit propagation, we can fallback and learn that this variable must be negated;
- ▶ Package specific assumptions.

SAT problem propagation

- ▶ Trivial propagation - direct install or delete rules.

$$(\neg A \parallel B_1 \parallel B_2) \& (A) \& (\neg C) \& (\neg A \parallel \neg D)$$

Assume A as *true* and C as *false*.

- ▶ Unit propagation - simple depends and conflicts.

$$(\neg A \parallel B) \& (A) \& (\neg C) \& (\neg A \parallel \neg D)$$

Assume B as *true* and D as *false*, as A is true and it depends on B and conflicts with D .

Conflicts driven learning

To handle alternatives it is required to test all variables unassigned:

1. full depth-first enumeration of possible values;
2. fallback if a conflict found;
3. remember which assignment caused conflict;
4. make negative assignment for the learned variable and go to the first step.

Package specific assumptions

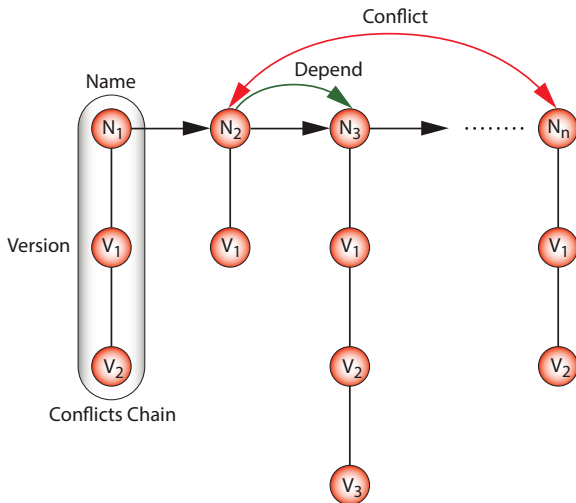
Pure SAT solvers cannot deal with package management as they do not consider several packages peculiarities:

- ▶ try to keep installed packages (if no direct conflicts);
- ▶ do not install packages if they are not needed;
- ▶ prefer high priority packages and repositories over low priority ones.

These options also improve SAT performance providing a good initial assignment.

Packages universe

We convert all packages involved to a packages universe of the following structure:



Package management task

- ▶ A request is splitted to install/upgrade and delete requests which could be passed simultaneously to the solver;
- ▶ A conflicts between packages are detected with a repository creation;
- ▶ All depends, reverse and conflicts of the requested packages are analyzed and the package universe is created;
- ▶ Each package is defined by its name and the digest of significant fields (version, options and so on);

Solvers and Pkg

- ▶ Pkg may pass the formed universe to an external CUDF solver:
 - ▶ convert versions;
 - ▶ format request;
 - ▶ parse output.
- ▶ Alternatively the internal SAT solver may be used:
 - ▶ convert the universe to SAT problem;
 - ▶ formulate request;
 - ▶ ???
 - ▶ PROFIT

Perspectives

- ▶ Using pkg solver for ports management.
- ▶ New dependencies and conflicts format.
- ▶ Better support of multiple repositories .
- ▶ Provides and alternatives.
- ▶ Test different solvers algorithms using CUDF.

New dependencies format

Alternatives



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Thank you for your attention!
Questions?

