Managing the Complexity of the Open Source Infrastructure

from EDOS to Mancoosi

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Outline

1. The Open Source Infrastructure and its Complexity
2. EDOS
3. Mancoosi

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Complex Software Systems

A particular kind of software systems which is of peculiar interest to software engineers are complex systems: *large number* of components, which have to be deployed together and *change frequently*.

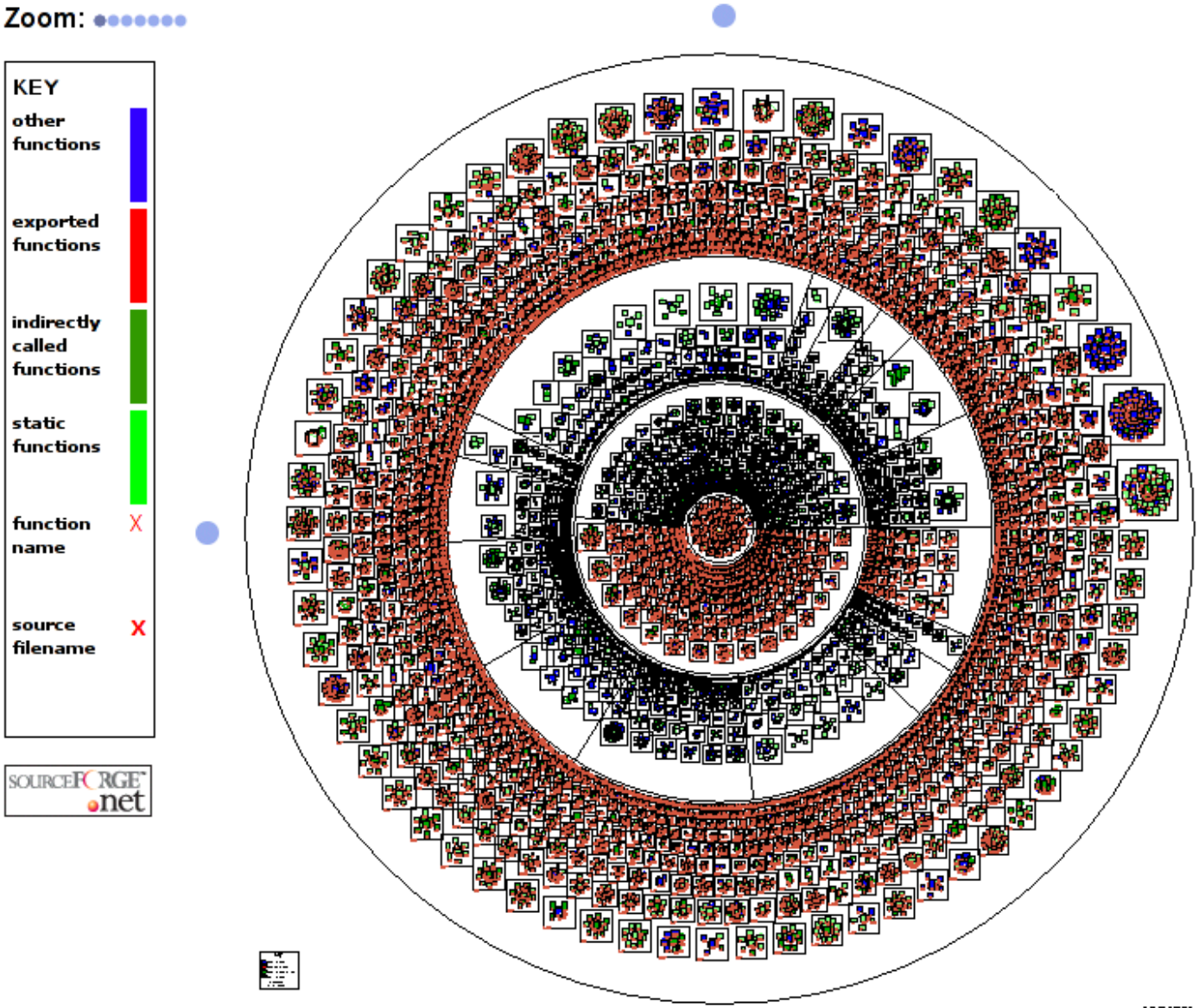
The free/open source software (FOSS) infrastructure is a complex system *archetype*:

- no central authority / software architect
- quick (*release early, release often*) and distributed development
- strong component interdependency
- large code bases freely accessible (for developers, students, researches, ...)

Some FOSS facts

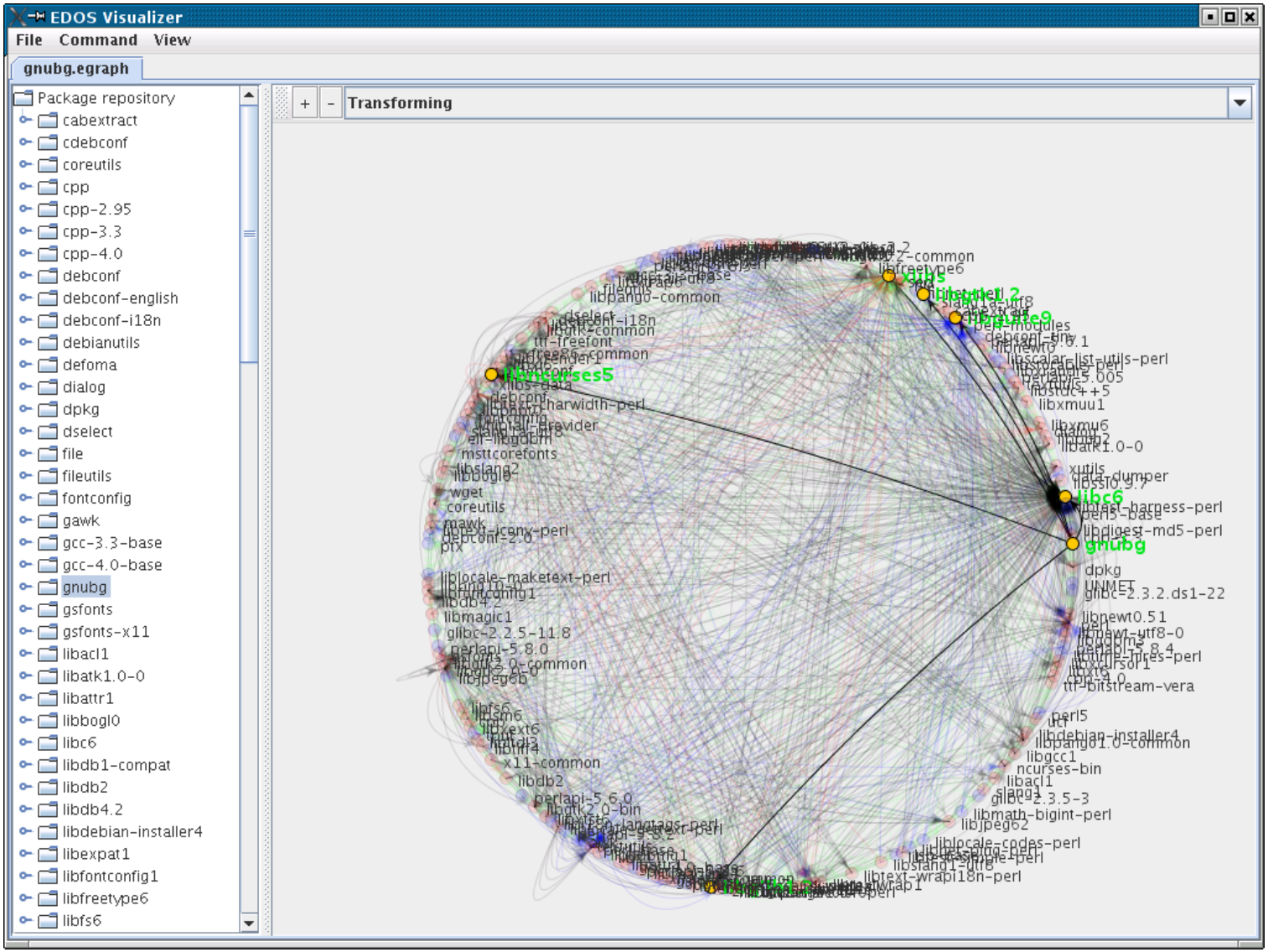
FOSS: complex software . . .

[kernel mapper project]



Some FOSS facts (cont.)

FOSS: complex interdependencies . . . [EDOS visualizer]



Some FOSS facts (cont.)

FOSS: large numbers (components/developers) . . .

SourceForge.net: 123,736 projects, 1,342,153 "users"

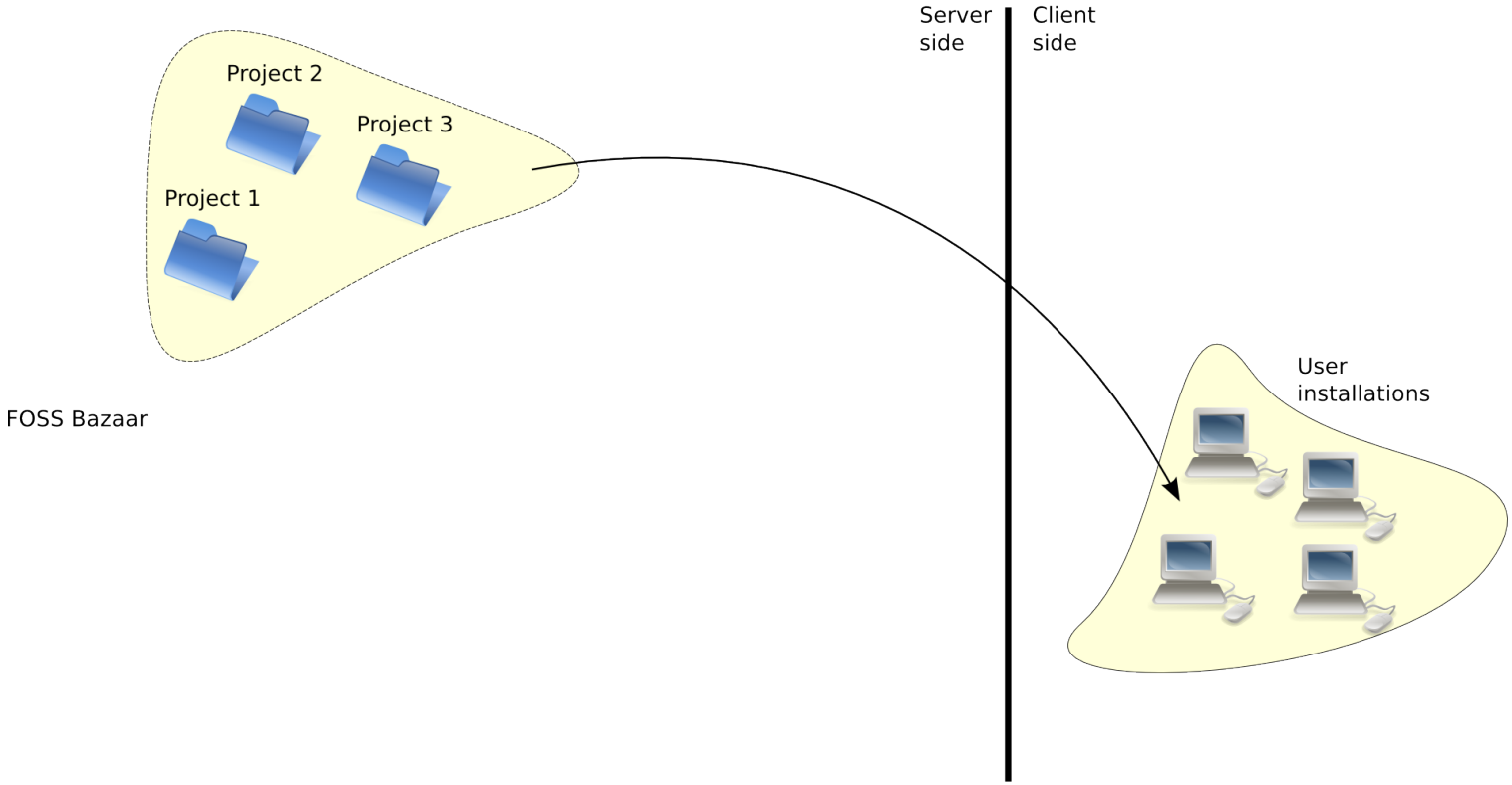
Numbers like that have the potential to radically change the way we produce and study software, in particular the complex systems of the future.

In this talk we will focus on just *one* of this aspect: distribution management.

Before distributions

In the beginning it was the tarball . . .

Before the advent of distributions, the *peculiar* way to install free software on client machine was:

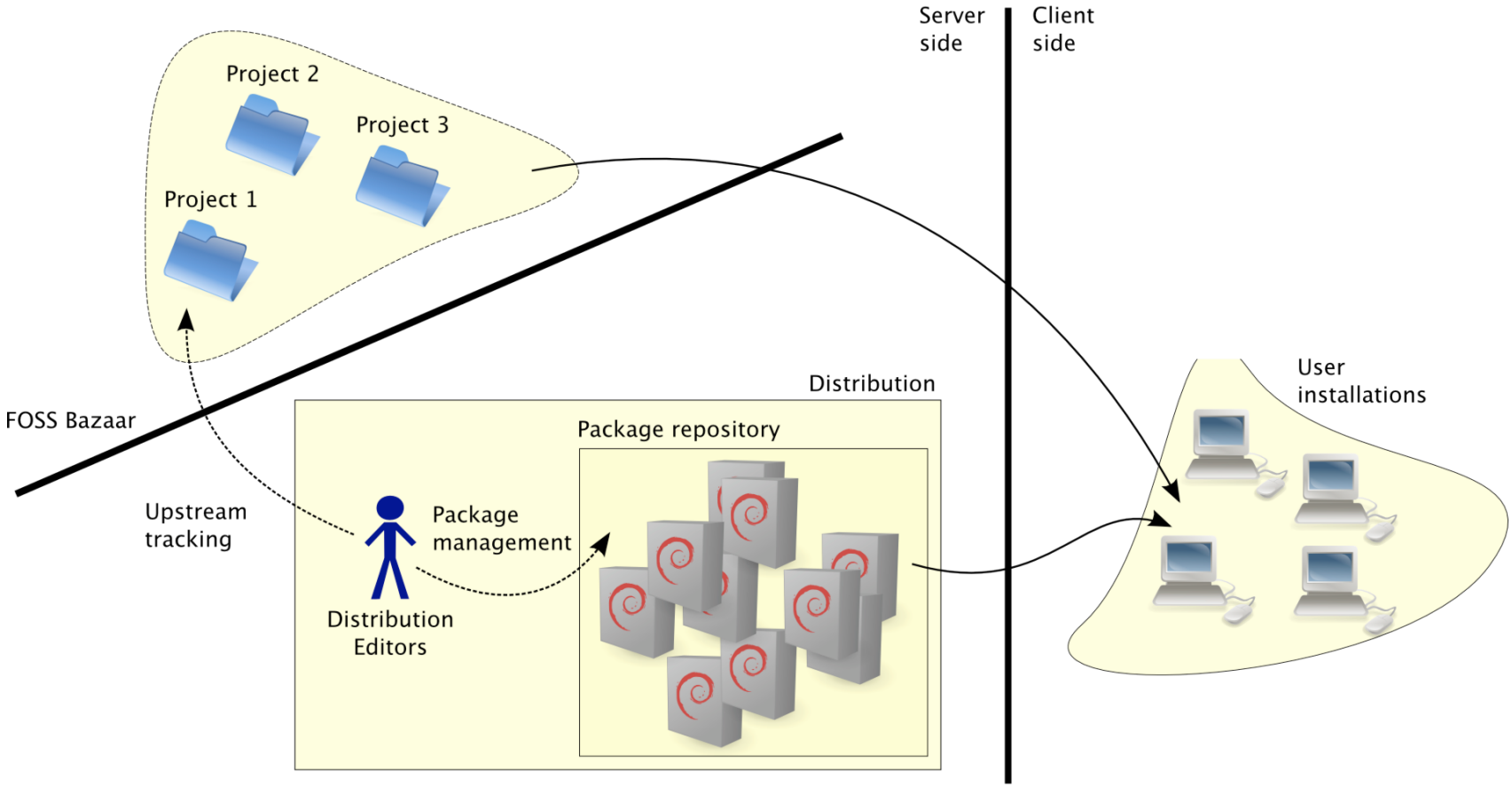


. . . but:

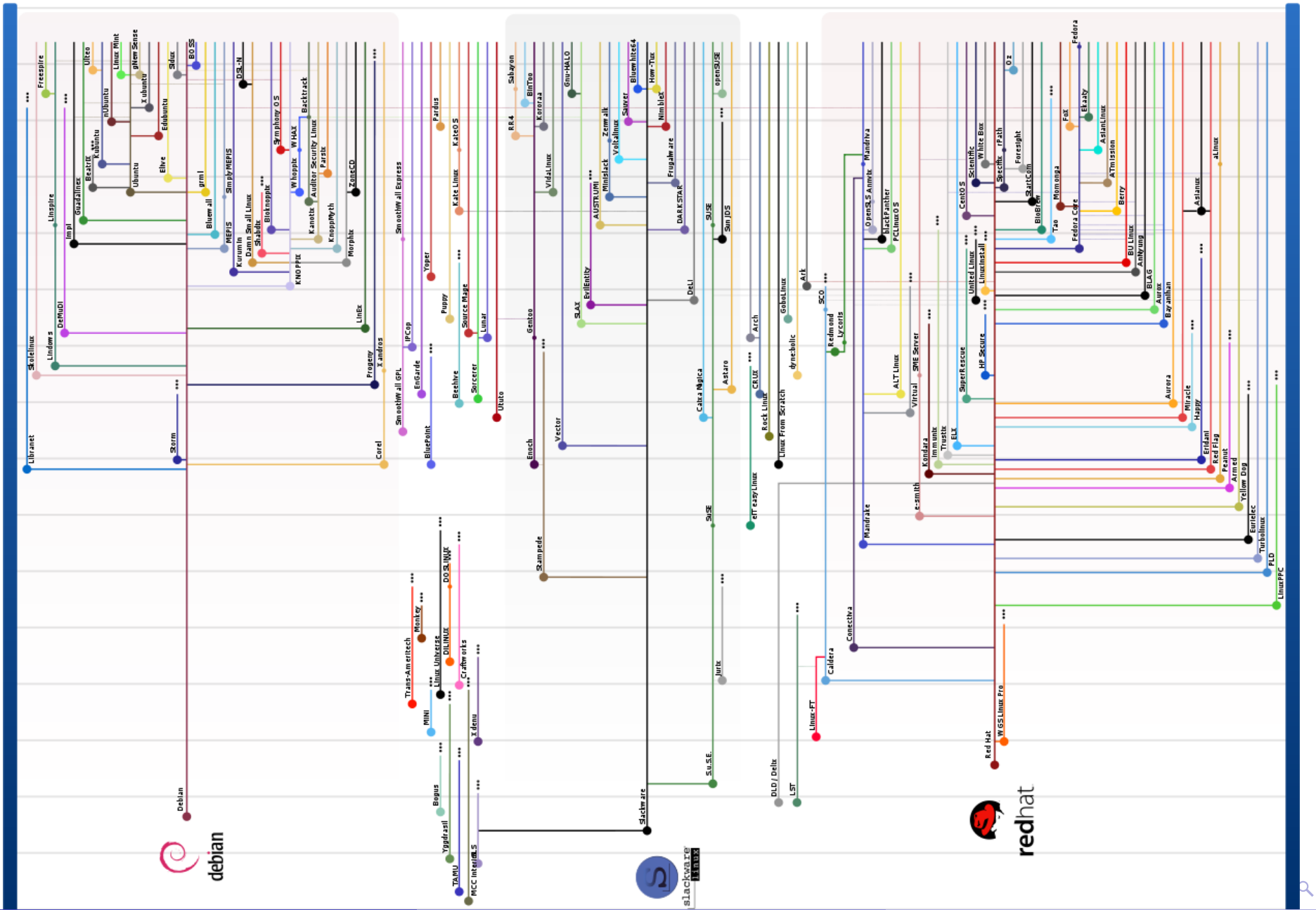
- no *standard version* enforcement on client side
- frequent needs: download, configure, build, . . .
- too slow, too complex, too fragile!

GNU/Linux distributions

as a reflex to the aforementioned problems, GNU/Linux distributions have born as *intermediaries* between FOSS projects and their users



Distributions: a “somehow” successful idea . . .



The distribution editor role

upstream tracking follow source evolution "upstream"
in general: developer ≠ package maintainer

integration offer to the users ("downstream") a *coherent* collection of packages
this implies handling *dependencies* properly

testing at all level (build-failures, test suites, user testing, . . .)

distribution quick software diffusion, preserving past history

. . . ain't easy!

> *the "desirable" release cycles of 6/12 months need dozen of man-years*

Central notion in distributions (to abstract over the complex underlying infrastructure): package, together with package management software . . .

Packages, metadata, installation

Package =
- some files
- some scripts
- metadata
  - Identification
  - Inter-package rel.
    - Dependencies
    - Conflicts
  - Feature declarations
  - Other
    - Package maintainer
    - Textual descriptions
    - ...

Example

```
Package: aterm
Version: 0.4.2-11
Section: x11
Installed-Size: 280
Maintainer: Göran Weinholt ...
Architecture: i386
Depends: libc6 (>= 2.3.2.ds1-4),
  libice6 | xlibs (>> 4.1.0), ...
Conflicts: suidmanager (<< 0.50)
Provides: x-terminal-emulator
...
```

- a package is the *elemental component* of modern distribution systems (not GNU/Linux specific)
- a working *system* is deployed by installing a package set ($\approx$ 1000/2000 for GNU/Linux distro)

Packages and their problems

Package-related problems

- component coherence (distribution) SE, solvers, ...
- gradual installation (deployment) evolution algo, constraint, ...
- choose the desired system in the (large) solution space SE, ...
- graphing/visualizing system state HCI, ...
- master system evolution:
  - install/remove components solvers, ...
  - manage inter-package relationships solvers, languages, ...
  - component configuration SCM, VCS, ...
  - replicate, reproduce system state SE, semantics, ...
- ...

Each line is an open door on some research domain!

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Sample installation

Phase	Trace
User request	`# apt-get install aterm`

Constraint resolution	`Reading package lists... Done`
	`Building dependency tree... Done`
	`The following extra packages will be installed:`
	`  libafterimage0`
	`The following NEW packages will be installed`
	`  aterm libafterimage0`
	`0 upgraded, 2 newly installed, 0 to remove and 1786 not upgraded.`
	`Need to get 386kB of archives.`
	`After unpacking 807kB of additional disk space will be used.`
	`Do you want to continue [Y/n]? Y`

Package retrieval	`Get: 1 http://debian.ens-cachan.fr testing/main libafterimage0 2.2.8-2 [301kB]`
	`Get: 2 http://debian.ens-cachan.fr testing/main aterm 1.0.1-4 [84.4kB]`
	`Fetched 386kB in 0s (410kB/s)`

Pre-configuration	`{`

Unpacking	`Selecting previously deselected package libafterimage0.`
	`(Reading database ... 294774 files and directories currently installed.)`
	`Unpacking libafterimage0 (from .../libafterimage0_2.2.8-2_i386.deb) ...`
	`Selecting previously deselected package aterm.`
	`Unpacking aterm (from .../aterm_1.0.1-4_i386.deb) ...`

Configuration	`Setting up libafterimage0 (2.2.8-2) ...` `Setting up aterm (1.0.1-4) ...`

- *each* phase can fail (it actually happens quite often . . .)
- efforts should be made to identify errors as early as possible

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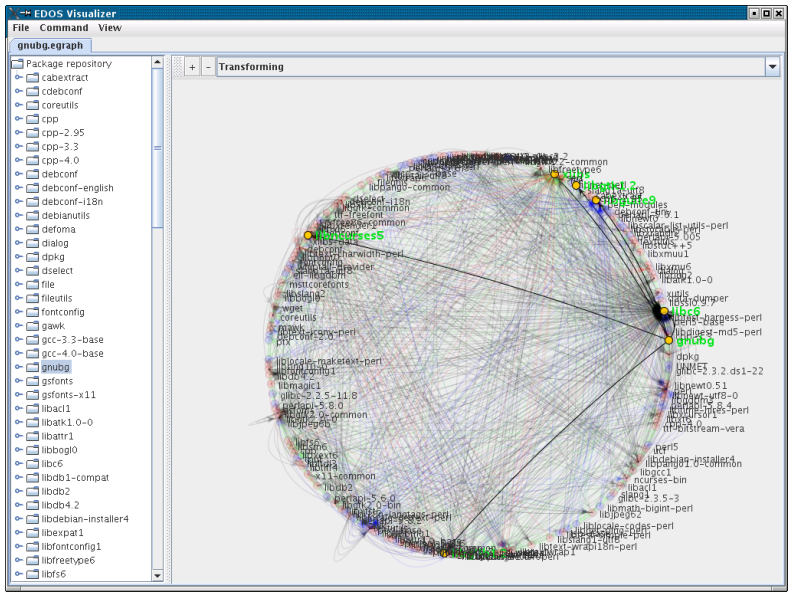
Installation intricacies

In state of the art distributions:

- knowing if the installation process terminate without errors is undecidable (reason: configuration scripts)
- there is no guarantee that distribution repositories (e.g. DVD or online repo) contains only installable packages
- a large number of errors faced by users are dependency resolution errors
  - more than 20,000 paquets (and 10,000 sources) in Debian
  - more than 200.000 inter-package relationships (dependencies of varying "strenght")

Inter-package relationships are complex . . .




```
Package: gnubg
Version: 0.14.3+20060923-4
Depends: gnubg-data,
ttf-bitstream-vera,
libartsc0 (>= 1.5.0-1), ...,
libgl1-mesa-glx | libgl1, ...
Conflicts: ...
```

And this changes *everyday*!

The EDOS and Mancoosi projects have attacked the errors of the *error resolution* phase, using *formal methods* to formalize and address them.

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The EDOS project timeline

- 2005-08 1st version of `ceve` and `EDOSlib`
- 2005-09 WP2D1: package system analysis, reduction to boolean constraint problem, NP-completeness
- 2005-11 1st version of `edos-debcheck`, integrated with a SAT-solver
- 2006-02 EDOS start tracking Debian via `anla`, with daily reports
- 2006-03 WP2D2: encoding as a boolean Constraint Programming problem, state of the art package manager comparison
- 2006-09 Paper: *Managing the Complexity of Large Free and Open Source Package-Based Software Distributions*, 21th IEEE/ACM International Conference on Automated Software Engineering
- 2006-09 1st version of `tart`, an optimizing allocator of packages in several medias (CD, DVD, ..)
- 2006-12 EDOS WP2 utils presentation at Debian QA meeting in Extremadura: `edos.debian.net` was born
- 2007-06 end of EDOS; about 100.000 OCaml LOCs written

Team: Jaap Boender, Berke Durak, Xavier Leroy, Fabio Mancinelli, Ralf Treinen, Jerôme Vouillon

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 ...
The following packages will be REMOVED:
  autoconf2.13 frozen-bubble frozen-bubble-lib gconf2 gnomemeeting itk3.1-dev
  libbonoboui2-0 libbonoboui2-common libdigest-md5-perl libforms0.89 libgconf2-4
  libgnome2-0 libgnome2-common libgnomeui-0 libgnomevfs2-0 libgnomevfs2-common
  libgtk1.2-dev libgtk2.0-0png3 libgtk2.0-dev libmime-base64-perl
  libpango1.0-dev libsdl-mixer1.2-dev libsdl-perl libsdl-ttf1.2-dev
  libsdl1.2-dev libsmpeg-dev libstorable-perl nautilus tk8.3-dev tktable-dev
  x-window-system x-window-system-core xaw3dg-dev xlib6g xlib6g-dev xlibmesa-dev
  xlibmesa3 xlibosmesa3 xlibs-dev xlibs-pic xpdf xpdf-reader
The following NEW packages will be installed:
  armagetron-common debconf-i18n fb-music-high fontconfig intltool-debian
  libaiksaurus-data libaiksaurus0c102 libeel2-data libfilehandle-unget-perl
  libfontconfig1 libforms1 libgdbm3 libgnutls7 libgsf-1 libice-dev libice6
  libidl0 liblzo1 libmagick5.5.7 libmail-mbox-messageparser-perl
  libmysqlclient12 libncursesw5 libnet-daemon-perl libnewt0.51 libpaper1
  libplrpc-perl libsdl-console ...

75 packages upgraded, 80 newly installed, 42 to remove and 858  not upgraded.
Need to get 67.1MB of archives. After unpacking 26.9MB will be used.
Do you want to continue? [Y/n] Abort.
```

An upgrade problem example

. . . but now it's time to look at the *end-user's* problems!

```
# sudo apt-get install  debhelper
Reading Package Lists... Done
Building Dependency Tree... Done
The following extra packages will be installed:
 armagetron armagetron-common autoconf bonobo-activation codebreaker debconf
 debconf-i18n debconf-utils dialog esound-common fb-music-high fontconfig
 frozen-bubble-data grepmail gv intltool-debian libaiksaurus-data
 libaiksaurus0c102 libatk1.0-0 libatk1.0-dev libbonobo-activation4 libbonobo2-0
 libbonobo2-common libdb3 libdbd-mysql-perl libdbi-perl libeel2-data libesd0
 ...
The following packages will be REMOVED:
  autoconf2.13 frozen-bubble frozen-bubble-lib gconf2 gnomemeeting itk3.1-dev
  libbonoboui2-0 libbonoboui2-common libdigest-md5-perl libforms0.89 libgconf2-4
  libgnome2-0 libgnome2-common libgnomeui-0 libgnomevfs2-0 libgnomevfs2-common
  libgtk1.2-dev libgtk2.0-0png3 libgtk2.0-dev libmime-base64-perl
  libpango1.0-dev libsdl-mixer1.2-dev libsdl-perl libsdl-ttf1.2-dev
  libsdl1.2-dev libsmpeg-dev libstorable-perl nautilus tk8.3-dev tktable-dev
  x-window-system x-window-system-core xaw3dg-dev xlib6g xlib6g-dev xlibmesa-dev
  xlibmesa3 xlibosmesa3 xlibs-dev xlibs-pic xpdf xpdf-reader
The following NEW packages will be installed:
  armagetron-common debconf-i18n fb-music-high fontconfig intltool-debian
  libaiksaurus-data libaiksaurus0c102 libeel2-data libfilehandle-unget-perl
  libfontconfig1 libforms1 libgdbm3 libgnutls7 libgsf-1 libice-dev libice6
  libidl0 liblzo1 libmagick5.5.7 libmail-mbox-messageparser-perl
  libmysqlclient12 libncursesw5 libnet-daemon-perl libnewt0.51 libpaper1
  libplrpc-perl libsdl-console ...

75 packages upgraded, 80 newly installed, 42 to remove and 858  not upgraded.
Need to get 67.1MB of archives. After unpacking 26.9MB will be used.
Do you want to continue? [Y/n] Abort.
```

The Mancoosi project [http://www.mancoosi.org]

project strep FP7 (2008–2011)

focus *coherence* and maintenance of a FOSS distribution

installation (user point of view)

- Utils for package installation management (package managers / meta-installer)
  - installation
  - removal
  - upgrade
  - downgrade
  - ...

Project Overview

Transactional updates

WP2 formalization of the *effects* of package installation/removal/. . . on a working system

WP3 development of utilities enabling the "upgrade" process to become transactional

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Project Overview

Upgradeability

WP4 conceiving of optimized algorithms for the upgrade (in particular for the dependency resolution phase)

WP5 set up of a corpus/knowledge base of upgrade problem; then: federation of researchers/practitioners on an international dependency resolution competition (inspiring examples: SAT competition, SAT race, TPTP, . . .)

Project Overview

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Project Partners

Mancoosi Team

Offspring & related works

The basic ideas/achievements developed in EDOS, which are at the origin of Mancoosi, have been largely adopted in the practice of software distribution (not necessarily tied to the world of GNU/Linux distributions):

Opium package manager exploiting SAT solving and CP to solve upgrade problems for the *Linspire* GNU/Linux distribution. Most notably: the first meta-installer which is *complete* wrt the upgrade problem (unfortunately the code is not "easily" available ...)

Zypp idem for *OpenSuse*

Eclipse idem for the plugins of the Eclipse platform

Apache the Apache project has a similar under development project for components of the various Apache-related projects

Questions?

looking for something else than Q & A time?
. . . ok, here is ~~some SPAM~~ a friendly reminder: `http://www.mancoosi.org`