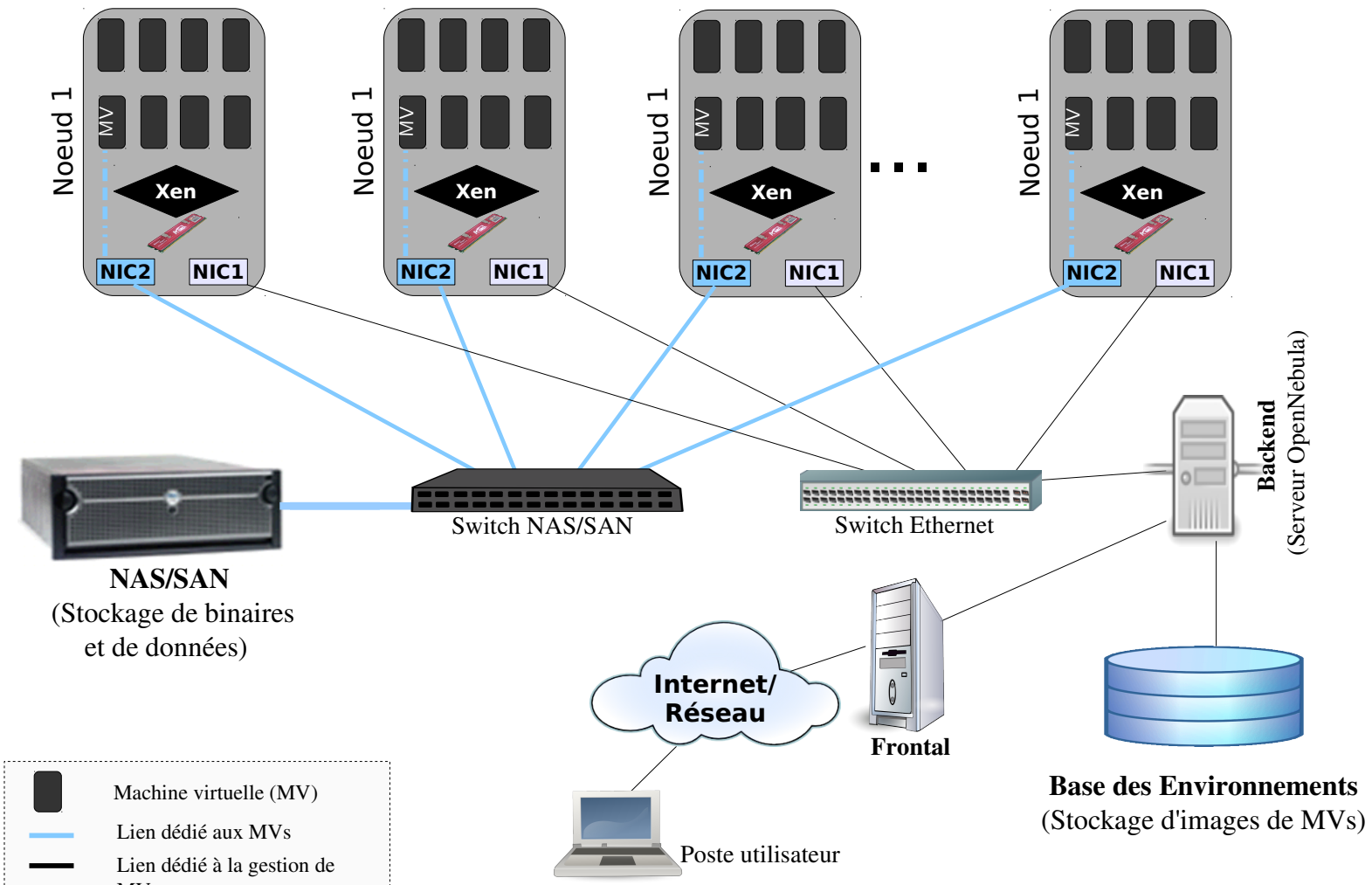
Constructing Software Environments

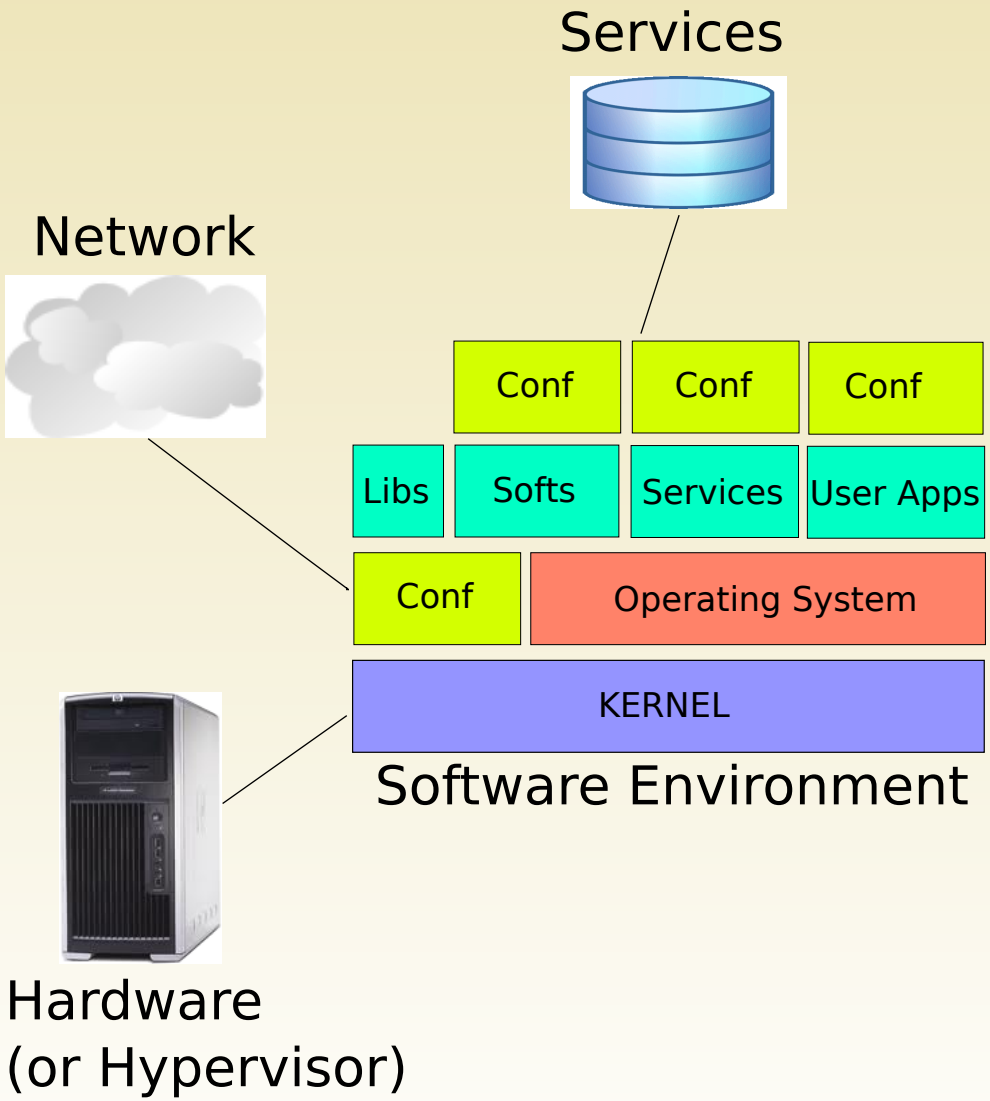
Production and User Environments in Grid'5000

Joseph Emeras Olivier Richard

Virtual Machines Environments in Clouds (and Grids)



Software Environment Images



Outline

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Environment Images

Why?

- Portability on heterogeneous platforms
- Security
- Experiments reproducibility

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How?

Different approaches:

- construct from scratch
- converge from existing

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Different approaches:

- construct from scratch
- converge from existing

What?

- Softwares
- Configurations
- Files
- Versions, Data Provenance?

Environment Images

Virtual Machines but also physical machines.

The Grid'5000 case:

- Production environments (compute nodes)
- User environments
- Service Machines environments

Outline

CFEngine

Concepts

- Configuration Management System
- From a policy specification: automate configuration and maintenance of computers
- Operating System-independent interface
- Describe the **FINAL** state rather than the **changes chain**
  - Promise
  - system will end up with a predictable result whatever its initial state
  - need to describe everything required in the system
- Possible actions: file operations, install package, execute command

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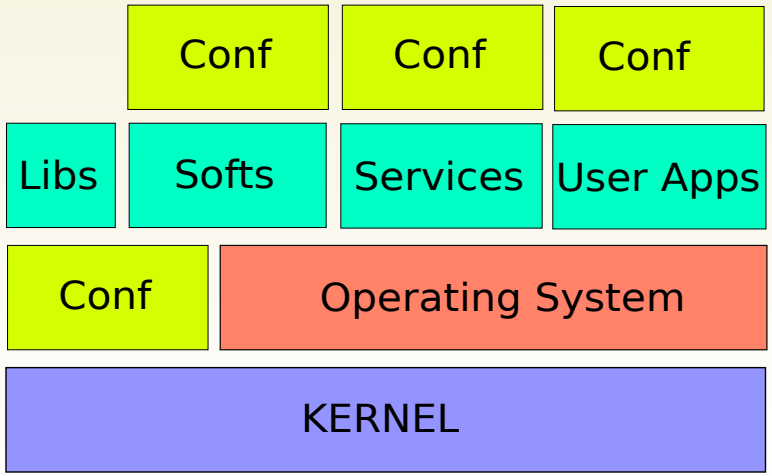

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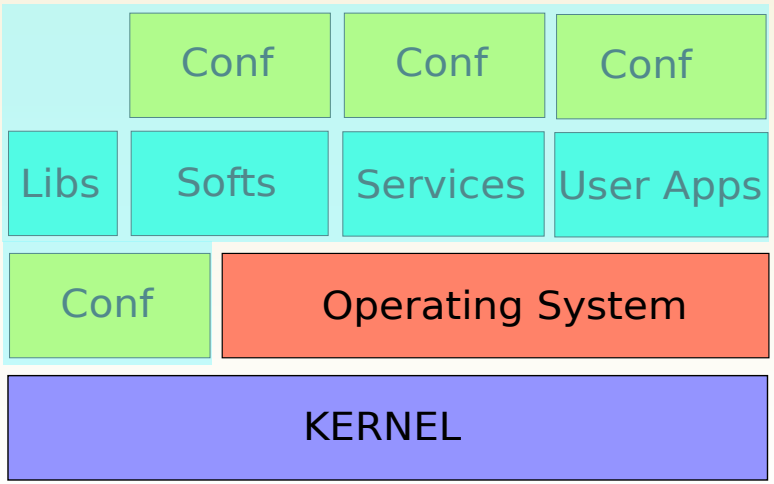
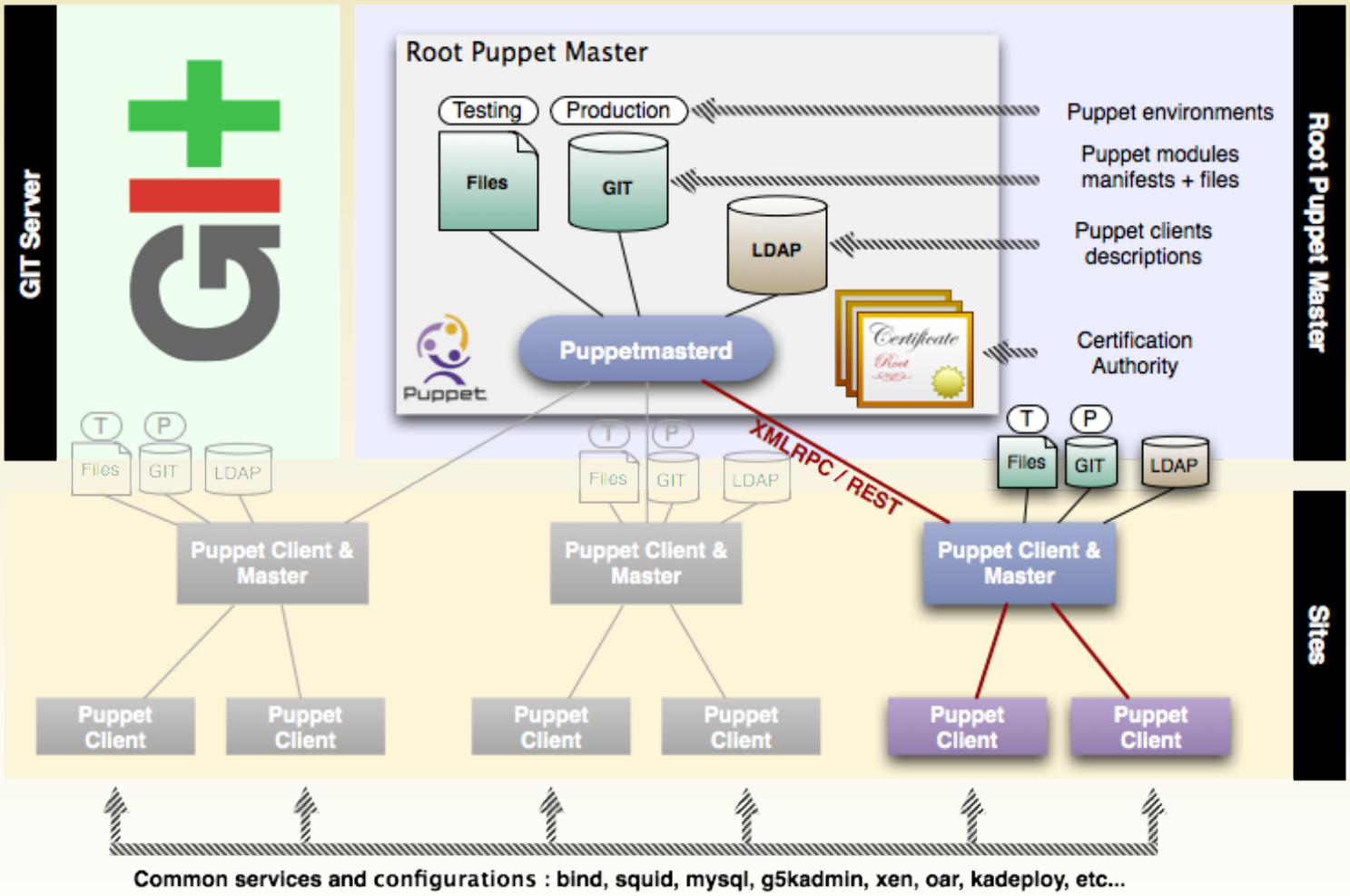


Puppet

- Automated machines configuration management
- Centralized environment specification
- Automatic clients resynchronization



Puppet

Concepts

- Same base concept as in CFEngine: focus on the **final** state
- RAL: Resource Abstraction Layer (Puppet DSL)
  - configuration in high-level terms: users, services and packages
  - platform independent language
  - support for Ruby
- Manifests: declaration of the conditions the environment requires
- Inheritance and dependencies

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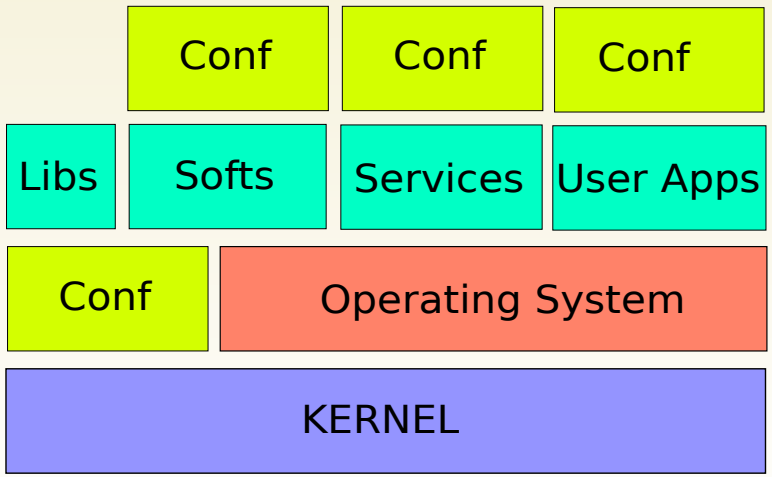

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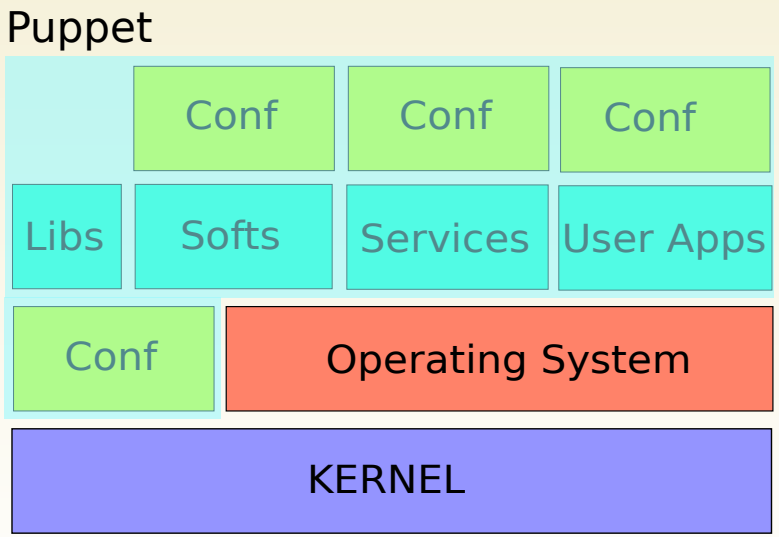

Chef

Concepts

- Both High-Level and more Technical vision
- Describe the **“changes chain”**
- Files, users, packages management operations simplified
- Powerful Ruby based recipes:
  - platform independent
    - some operations are, some not
    - recipes can “make themselves” platform independent (see next slide examples)
  - use of code
  - (re-)configurable/definable DSL
- Client/Server + Solo mode
- “Recipes” are grouped into “Cookbooks”
- Chef loads a cookbook as a git repository archive (can be remote)

Chef Examples

Example: High-level

```
case node[:platform]
when "ubuntu", "debian"
  include_recipe "setup::apt"
end
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```
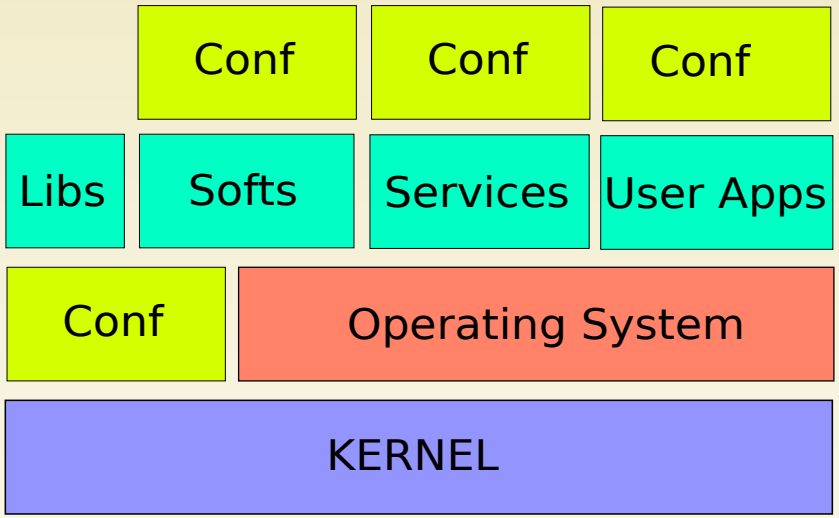

Example: install packages

```
%w{oar-common oar-doc oar-libs oar-node}.each do |pkg|
  package pkg do
    action :install
    version "2.2.16-2"
    options "--force-yes"
  end
end
```

Chef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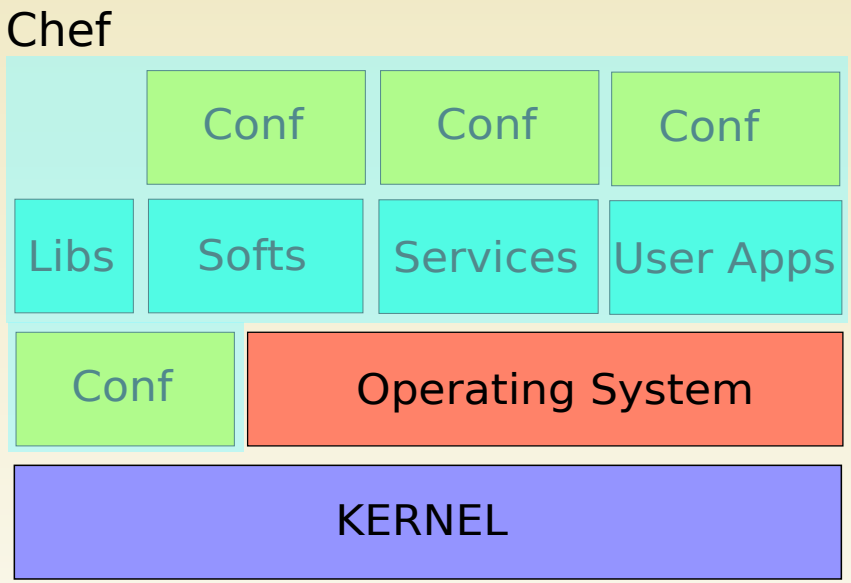
Chef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Juju (formerly Ensemble)

In traditional West African religion, use of objects (charms) to perform witchcraft.

Concepts

- Package management on a higher level, around services
- Automate services deployment and configuration (cloud targeted)
- Link the services between themselves
- Ubuntu specific: Personal Package Archive (PPA)
- Charms (formulas) manage the services install/configuration part

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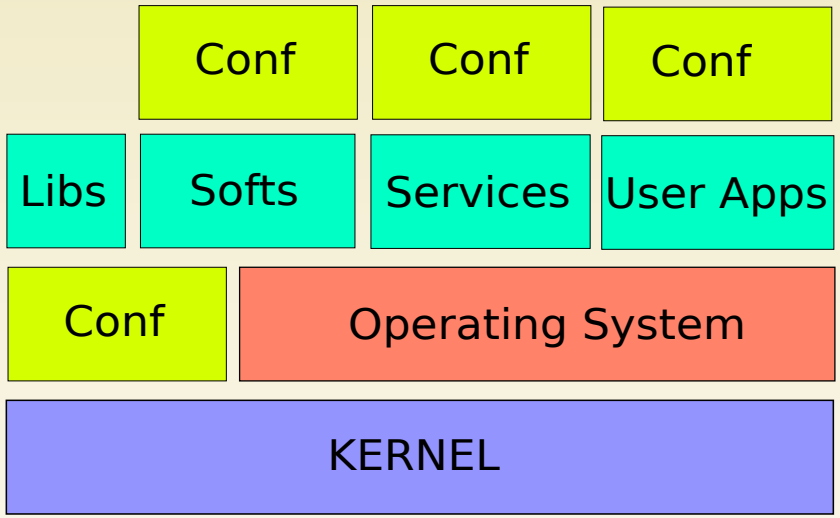
Charms

- Description of a service integration and reaction to juju events (services linking)
- Metadata
  - info, version
  - **dependencies**
- Hooks (code)
  - install, start, stop
  - relation management (services linking)

Juju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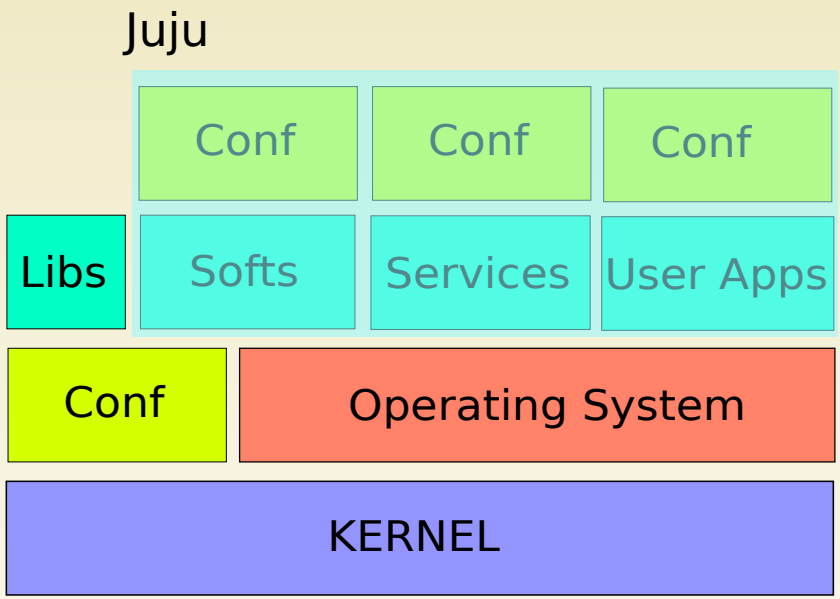
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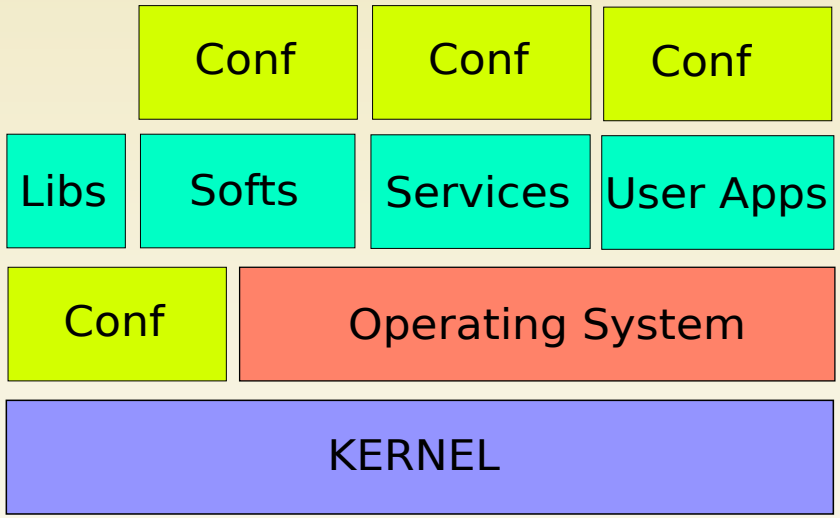
UShareSoft UForge

Concepts

- Commercial solution (but a restricted free account is available)
- Generate software appliances for several OS in several output formats
  - CentOS, Debian, Ubuntu, Fedora ...
  - Amazon, cloud.com, KVM, raw, VirtualBox, Xen, VMWare, iso ...
- 2 ways:
  - online: simple default image generator
  - UForge: custom image generator (choose applications to install)
- REST API for automating and streamlining software build
- Custom bootscripts + auto or custom environmental configuration
- Software image templates: update, clone and share
- Easy but blackbox

UForge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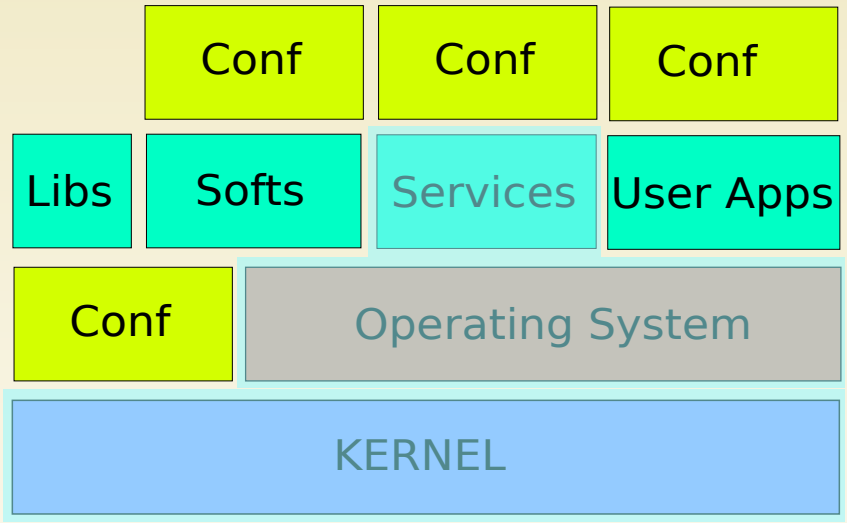
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Kameleon

Concepts

- Model the software environment: recreate it **in the same way**
- From scratch or from an existing "basis" environment
- Kameleon describes the **"changes chain"**

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Entities

- Recipe (environment description: high level, semantic, YAML)
  - combination of steps that lead to environment construction
- Steps (low level, technical, shell code)
  - one technical action (software installation, configuration ...)

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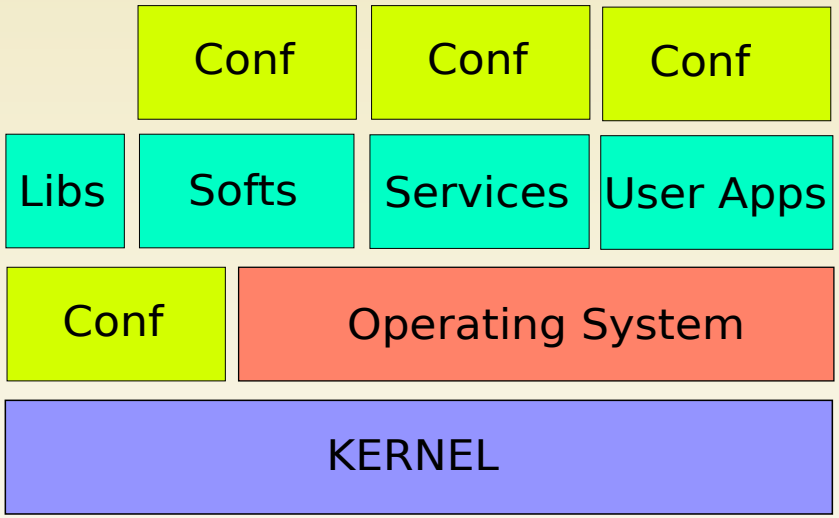
More about Kameleon

- Recipes and steps for Debian, OAR, SLURM, G5K
- Output formats: KVM, Grid'5000, Xen, VirtualBox, raw, iso
- Able to load, modify and save a UForge image

Kameleon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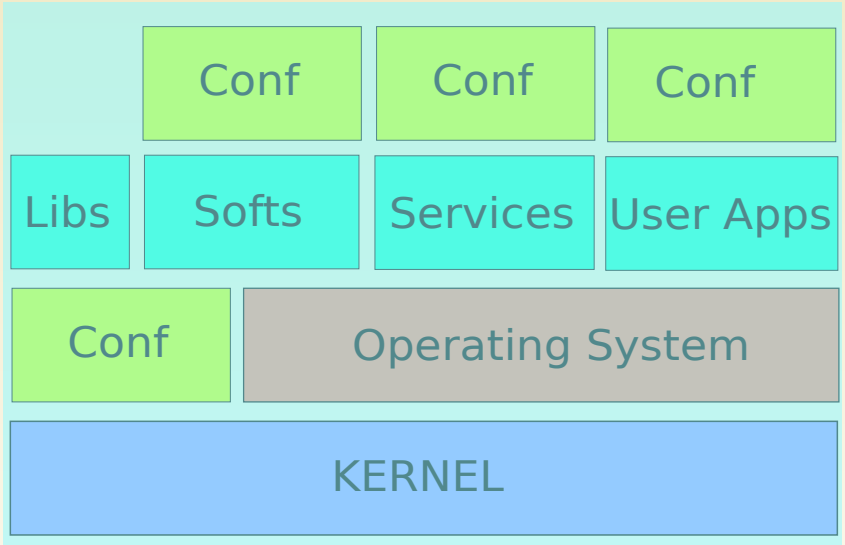
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Other tools

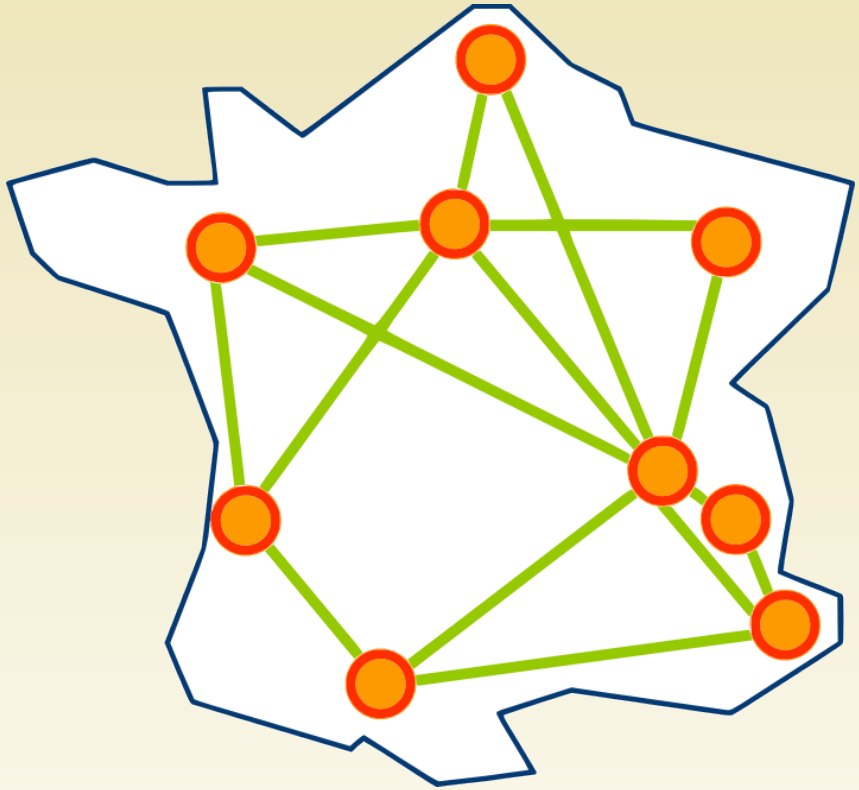
Difficult to know them all!

- Quattor (CERN)
- RBuilder (CernVM)
- VMBuilder (Ubuntu)
- Kiwi (OpenSuse - http://kiwi.berlios.de/)
- Probably more than we may imagine...

Outline

A nation-wide platform

9 sites



Sites

Bordeaux, Grenoble, Lille, Lyon, Nancy, Orsay, Rennes, Sophia, Toulouse

(+Brazil and Luxembourg)

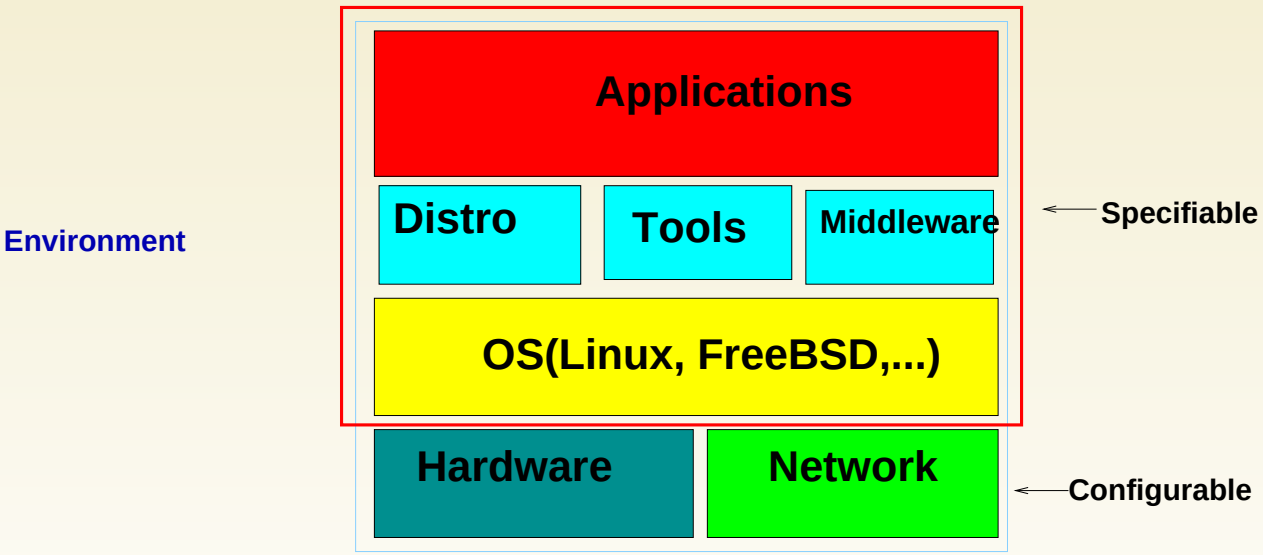
Grid'5000 Basic Design Concepts

- Research Platform dedicated to Experiments
- Large-Scale and distributed
- Heterogeneous hardware resources
- Dedicated network links between sites
  - isolate Grid'5000 from the rest of the Internet
  - let packets fly inside Grid'5000 without limitation
- **Deep reconfiguration** mechanism for experiments on all layers of the software stack
- User has **full control** of the reserved experimental resources: deployable environments

Management of the environments

Users can use:

- Default production environment
- One of the environments provided by the staff
- An environment created by another user
- An environment they created themselves



Grid'5000 environments management by the Tech Team

Service Nodes Environments

- Services: NFS, Mysql, OAR, Kadeploy...
- Configured with Puppet.
- Deployed with Capistrano (tool for deploying web applications, basically: Makefile+ssh).

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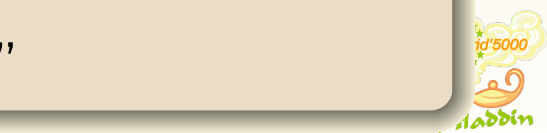
Compute Nodes Environments

Production environments: environment installed on the compute nodes.
User environment: special environments deployable on the compute nodes.
Management: on a node of the platform itself

- manual bootstrap
- chroot, ruby and Chef install
- configuration via Chef
- different recipes for different environment "flavors"



Example

Grenoble Production environment

```
{
  "grid5000": { "site": "grenoble" },
  "kaenv": {
    "version": "1.0",
    "name": "prod",
    "site": "grenoble",
    "description": "Debian 6. Production environment. Generated with Chef.",
    "author": "support-staff@lists.grid5000.fr",
    "kernel": "/boot/vmlinuz-2.6.32-5-amd64",
    "initrd": "/boot/initrd.img-2.6.32-5-amd64",
    "postinstall": "/grid5000/postinstalls/userpostinstall-prod.tgz|tgz| \
                    traitement.ash /rambin"
  },
  "oar": { "version": "2.4" },
  "recipes": [ "setup", "oar", "g5kchecks", "ganglia", "kernel", "nvidia", \
               "fastnetwork::infiniband", "fastnetwork::openmpi" , \
               "g5kcode" , "g5ksubnets", "drivers::initramfs-up" ]
}
```

Other option: Kameleon

Full Kameleon

- Use of Kameleon to generate environment from scratch.
- Customize it.
- Output format: Grid'5000.
- Bootstrap, chroot and export as deployable image is managed by Kameleon.

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Mix Chef-Kameleon

- Use of Kameleon to manage minimal distrib install.
- Step for installing Chef.
- Retrieve Grid'5000 cookbooks.
- Apply Chef cookbooks inside Kameleon run (chroot).

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Questions, thoughts and problems risen

Cloud computing pushes towards using virtual machines.
Grid has default configured environment.
Use provided software environments.

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- Loose efficiency
- Reproducibility impacted?
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- Paranoia from the users too... (Tony Cass' "trusted images" talk)

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Reproducibility

Thank you for your attention

Examples

Entities:

Promises

```
promiser:
      CFEngine_word => user_defined_value;
```

Bodies

```
body CFEngine_word user_defined_value
{
      CFEngine_word => user_defined_value;
      CFEngine_word => user_defined_value;
}
```

Bundles

Set of Promises

CFEngine file management and code execution

```
files:
  "/tmp/promiser"
    perms => myexample;


body perms myexample
{
mode => "644";
owners => { "mark", "sarah", "angel" };
groups => { "users", "sysadmins", "mythical_beasts" };

#And Command Execution:
cfruncommand => "$(sys.workdir)/root/myscript.sh";
}
```

CFEngine packages install

```
control:
    any::
          actionsequence = ( packages )
          DefaultPkgMgr = ( rpm )
          RPMcommand = ( /bin/rpm )
          RPMInstallCommand = ( "/usr/bin/yum -y install %s" )


packages:
    any::
          ganglia-gmond action=install

    grid::
          lcg-CA action=install
```

Puppet

```
class kadeploy::server inherits kadeploy {

  package {
    ["kadeploy-server", "tftpd-hpa", "syslinux"]:
      ensure => installed,
      require => [User["deploy"], File["source kadeploy"],
                  Exec["sources update"]];
  }

  file {
    "/var/lib/tftpboot/kernels":
      ensure => directory,
      mode => 775, owner => root, group => deploy,
      require => Package["tftpd-hpa"];
    "/var/lib/tftpboot/pxelinux.cfg":
      ensure => directory,
      mode => 775, owner => root, group => deploy,
      require => Package["tftpd-hpa"];
  }
```

Chef

```
execute "apt-get update" do
  command "apt-get update"
end

%w{ oar-common oar-node }.each do |pkg|
  package pkg do
    action :install
    version "2.4.0"
    options "--force-yes"
  end
end

execute "usermod -U oar" do
  command "usermod -U oar"
end
```

Juju Metadata

```
name: drupal
revision: 1
summary: "Drupal CMS"
description: |
    Installs the drupal CMS system, relates to the mysql charm
    provided in examples directory. Can be scaled to multiple
    web servers
requires:
  db:
    interface: mysql
```

Juju Hooks: install

```
#!/bin/bash

set -eux # -x for verbose logging to juju debug-log
juju-log "Installing drush,apache2,php via apt-get"
apt-get -y install drush apache2 php5-gd libapache2-mod-php5 \
php5-cgi mysql-client-core-5.1 a2enmod php5
/etc/init.d/apache2 restart
juju-log "Using drush to download latest Drupal"
cd /var/www && drush dl drupal --drupal-project-rename=juju
```

Juju Hooks: relation-changed

```
#!/bin/bash
set -eux # -x for verbose logging to juju debug-log
hooksdir=$PWD
user=‘relation-get user‘
password=‘relation-get password‘
host=‘relation-get host‘
database=‘relation-get database‘
# All values are set together, so checking on a single
# value is enough
# If $user is not set, DB is still setting itself up,
# we exit awaiting next run
[ -z "$user" ] && exit 0
juju-log "Setting up Drupal for the first time"
cd /var/www/juju && drush site-install -y standard \
--db-url=mysql://$user:$password@$host/$database \
--site-name=juju --clean-url=0
cd /var/www/juju && chown www-data sites/default/settings.php
open-port 80/tcp
```

Kameleon Recipe

Recipe sample: Creation of a KVM Debian image

```
# ### debian.yaml Kameleon recipe sample ###
global:
 distrib: debian
 # Debian specific
 debian_version_name: squeeze
 distrib_repository: http://ftp.fr.debian.org/debian/
 #
 # Architecture
 arch: amd64
 kernel_arch: "amd64"
 #
steps:
 - bootstrap
 - system_config
 - root_passwd
 - mount_proc
 - kernel_install
 - strip
 - umount_proc
 - build_appliance:
    - clean_udev
    - create_raw_image
    - create_nbd_device
    - mkfs
    - mount_image
    - copy_system_tree
    - install_grub
    - umount_image
    - save_as_raw
 - clean
```

Kameleon Steps

Debian Kernel installation step

```
kernel_install:
 - kernel-img_conf:
   - write_file:
     - /etc/kernel-img.conf
     - |
       do_symlinks = yes
       relative_links = yes
       do_bootloader = yes
       do_bootfloppy = no
       do_initrd = yes
       link_in_boot = no
 - kernel_install:
   - exec_chroot: bash -c "DEBIAN_FRONTEND
     =noninteractive apt-get -y --force-yes
     install linux-image-$$kernel_arch"
```

Debian basis installation step

```
bootstrap:
 - debootstrap:
   - exec_appliance:  debootstrap --arch=
     $$arch $$debian_version_name
     $$chroot/ $$distrib_repository
```