FAI - a tool for the fully automatic installation of Debian GNU/Linux

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Introduction

• Administration is the sum of installation, configuration and daily maintenance

• Installation is the basic administration task

• Bad system administration makes computers unusable

• Much time has to be spend in cluster installation and management

• Today, installation of masses of computers is a major challenge

• A scalable system administration procedure is a must
The real world

- More and more employees are working with a computer
- Commodity hardware is cheap and fast (and often faulty)
- Clusters become hip, but are often run without sysadmin staff
- Beowulf example: $26 \times 1$GHz Athlon, 256MB RAM, 20GB disk, Fast Ethernet switch, cables, shelf and DAT-drive bought for 20,000 Euro at the end of 2001 by an institute of physical chemistry
- Know-how is missing and few time is spend in planning a cluster
- Without a sysadmin, no time is spent in maintaining a running cluster (security patches, new OS version)
What is FAI?

• FAI does everything a sysadmin has to do (you!), before users can log in a brand new computer for the first time

• It is a collection of scripts and configuration files

• It installs the whole operating system and all applications

• It is an easy to handle installation tool for Beowulf clusters

• It’s neither a cluster management tool nor a job scheduling system

• It can’t plan your installation :-(

• But: **Plan your installation and FAI installs your plan! :–)**
Motivation

• A manual installation takes long time (several hours)

• You have to answers many questions

• Equal configuration data must be entered for every new computer again and again

• Repeating work is boring and leads to errors

• You can’t do multiple installations concurrently

• A manual installation does not scale!
• An automatic installation only takes several minutes

• It guarantees multiple identical configurations

• It allows quick reinstallation after replacement of defective hardware with same configuration as before

• You can install hundreds of machines with one command

• You can save much time! (And do other nice things)

• I’m too lazy for manual installations

• Watching a fully automatic installation is fun
How does FAI work?

A system administrator during a fully automatic installation
Requirements

- A computer with network interface card called install client
- An install server with BOOTP or DHCP, NFS and TFTP daemon
- Access to a local Debian mirror via NFS, FTP or HTTP
- Disk space on the install server:
  - FAI package 10 MB kernel, scripts and configuration data
  - Client nfsroot 100 MB made of the Debian base system
  - Debian mirror 2.5 GB a partial mirror for i386 only
- All install client share the same nfsroot
- Constant disk space
Sequence of an installation

- Install client boots linux using the nfsroot, without using the local hard disks
- Define classes and variables and load kernel modules
- Partition local hard disk (using setup硬化disks and sfdisk)
- Create file systems (mke2fs, mkswap, mkreiserfs)
- Debian command apt-get installs software and resolves package dependencies
- Configure operating systems and applications
• Save log files to the local disk and to the install server

• Boot the newly installed system

• Time for one installation without booting of a Dual Pentium II 400 MHz, 128 MB RAM, 10Mbit LAN
  – 90 MB software: 2 minutes
  – 520 MB software: 11 minutes
  – test 4 GB for bad blocks: 6 minutes

• The time for installation remains unchanged for one client and 100Mbit LAN.

• The amount of software determines the installation time.
Booting

• Via a bootable network card using TFTP and BOOTP, DHCP or PXE method

• Via a common boot floppy which is created by the command make-fai-bootfloppy

• Kernel parameters can be specified

• FAI parameters are passed via BOOTP or DHCP:
  – $FAI_LOCATION (T170): location of the configuration
  – $FAI_ACTION (T171): sysinfo, install, backup, ...
  – $FAI_FLAGS (T172): verbose, debug, sshd, createvt, reboot

• Remote access during the installation via ssh
/etc/bootptab:

.faiglobal:\
  :ms=1024:hd=/boot/fai:hn:bs=auto:rp=/usr/lib/fai/nfsroot:

.failocal:\
  :tc=.faiglobal:sa=kueppers:ts=rubens:\
  :T170="kueppers:/usr/local/share/fai":T171="sysinfo":\
  :sm=255.255.255.0:gw=134.95.9.254:\
  :dn=informatik.uni-koeln.de:\
  :ds=134.95.9.136,134.95.100.209,134.95.100.208:\
  :ys=rubens:yd=informatik4711.YP:\
  :nt=time.rrz.uni-koeln.de,time2.rrz.uni-koeln.de:

faiclient99:ha=0x02608c7b40d6:bf=faiclient99:\
  :tc=.failocal:T171="install":T172="sshd verbose"
The Configuration

• hostname, IP-address, hard disk partition layout, file systems, mount points, software to install, local configuration of operating system and applications

• local customization
  – root password, accounts, timezone, keyboard layout, special kernel, NTP, NIS, inetd, ftp, ssh, lpr, autofs, X11, lilo
  – /etc/fstab, /etc/exports, /etc/hosts.allow

• It is the sum of: classes, variables, scripts, templates

• Do you have a concept for all this?
The class concept

• For each host many system files must be installed

• For each system file several templates are available

• A class specifies which template to use

• An install client belongs to several classes

• The configuration is composed of classes

• The selection of configuration files for the disk partitioning, the software installation and for all configuration scripts also uses classes
• Classes can be defined as follows:

  **predefined classes:** DEFAULT, LAST and the hostname
  **stored in a file:** Classes are listed in a text file
  **dynamically generated:** Scripts can define classes depending on detected hardware and write them to stdout

• Adding a class easily expands the configuration for a host

• Examples of classes: COMPILER, FAI_BOOTPART, MBR, DATALESS, NOTEBOOK, DEBIAN_DEVEL, KERNEL_SOFT, BOOTP_SERVER, 4GB, NIS, BEOWULF
Variables

Variables define additional parameters

.../class/DEFAULT.var:
FAI_CONSOLEFONT=
FAI_KEYMAP=us-latin1
UTC=yes
time_zone=Europe/Berlin
rootpw='a3hxVqR5t1t9L'
moduleslist="3c59x"
kernelimage=kernel-image-2.2.19-idepci
printers="kyocera optra hp4si hp hpcolor juenger"

.../class/ATOMCLIENT.var:
# atom00 is the Beowulf master server
hserver=atom00
bserver=atom00
Hard disk configuration

- In /fai/disk_config/ a config file called 4GB exists:

```
# <type> <mountpoint> <size> [mount opt] [;extra opt]
disk_config hda
primary / 50 rw,errors=remount-ro ;-c
logical swap 100-200 rw
logical /var 150-200 rw
logical /usr 1500 rw
logical /tmp 100-300 ;-m 1
logical /home 700- rw,nosuid ;-m 0
logical /scratch 0- rw,nosuid ;-m 0 -i 50000
#logical /scratch preserve9 rw,nosuid ;-m 0 -i 50000
```
Features of the hard disk configuration

- Multiple hard disks can be specified in one config file
- Easy specification of size, mount point and options
- Fixed or variable partition size
- User data on a partition can be preserved
- Option for mkfs and mount, e.g. nosuid, ro, reiserfs
- Windows partitions can also be included to /etc/fstab
- Automatic generation of /etc/fstab
Software configuration

Installing software is done by the a small Perl script which uses the Debian command `apt-get`.

Example for the class COMPILE:

```bash
# COMPILE: packages for developing software
PACKAGES install
task-c++-dev task-debug
bin86 m4 g77 byacc cvs
```

- Actions: install, remove, taskinst
- Package dependencies are solved
- `dpkg --get-selections` format is also possible
Example for configuration scripts

.../scripts/DEFAULT:
#! /bin/sh
chmod 1777 $target/tmp
chown root:root $target/tmp

# create NIS/NONIS config
fcopy /etc/nsswitch.conf /etc/host.conf
ifclass NONIS && rm -f $target/etc/defaultdomain
if ifclass NIS; then
    echo $YPDOMAIN > $target/etc/defaultdomain
    rm -f $target/etc/yp.conf
    for s in $YPSRVR; do
        echo "ypserver $s" >> $target/etc/yp.conf
    done
fi

# copy default dotfiles for root account
fcopy /root/.bash_profile /root/.bashrc /root/.cshrc
Cfengine example

#! /usr/bin/cfengine
control:  actionsequence = ( editfiles )
editfiles:
any::
{  ${target}/etc/passwd
   LocateLineMatching "^root::.*"
   InsertLine "roott::0:0:root:/root:/usr/bin/tcsh"
   ReplaceAll "^root::" With "root:${rootpw}:"
   ReplaceAll "^roott::" With "roott:${rootpw}:"
}
{  ${target}/etc/default/rcS
   ReplaceAll "^UTC=.*" With "UTC=${UTC}"
}
HOME_CLIENT::
{  ${target}/etc/fstab
   HashCommentLinesContaining "^/home"
   AppendIfNoSuchLine "${hserver}:/home /home nfs"
}
Install templates of config files

- Many configuration files have prepared templates
- Each installation needs a different template
- A class determines which template to use
- Copying of these files using $fcopy$
- Extracting of archives using $ftar$

$fcopy$ /etc/nsswitch.conf /etc/host.conf
X11: $fcopy$ /etc/X11/XF86Config /etc/X11/Xserver
Hooks

• The installation process is divided in several tasks (eg. define variables, partition local disk, install software, mount Debian mirror, call config scripts, save log files, . . .)

• For each default task, you can define one or more hooks

• Hooks are selected by class names

• Hooks are called before the default task action is performed

• Hooks can extend a task or replace the default task by skipping it

• It is very easy to customize FAI to your local needs with hooks
Information about FAI

- Homepage: www.informatik.uni-koeln.de/fai

- CVS repository, very active Mailling list, examples of log files

- Additional software available during installation: lvm, raidtools, dump, restore, ext2resize, hdparm, parted, resize_reiserfs

- Access to Debian mirror via NFS, FTP oder HTTP

- FAI with action `sysinfo` can be used as a rescue system. It mounts all local partitions automatically using `/etc/fstab` if available

- Successful tests on SUN SPARC
Summary

• Fully unattended installation! No interaction needed

• Identical, consistent installations are guaranteed

• Easy creation of configuration using classes

• Constant disk space on install server

• Central repository of all configuration and log files are centrally stored on the install server

• Quick and easy reinstallation produces a cluster with up to date software, less security holes

• **FAI is a scalable method for installing Debian GNU/Linux**