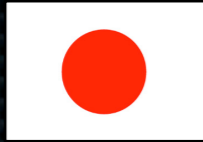
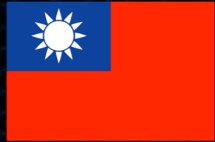




財團法人資訊工業策進會  
INSTITUTE FOR INFORMATION INDUSTRY



THE  
LINUX  
FOUNDATION



**FreedomHEC Taipei 2008**

台湾和日本的祝愿友好的交谈

# “Secure Linux” Primer

November 21, 2008

原田季栄 (Toshiharu Harada)

株式会社NTTデータ (NTT DATA CORPORATION)



```
% whoami
```

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- My name is Toshiharu Harada (原田 季栄)

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- “Secure Linux” implementations are not children’s toys, but not so difficult either (if only you get interested)

# % whatis

- At first, I was planning to talk on my own project, TOMOYO Linux. It is one of the “secure Linux” implementations
- “Secure Linux” implementations are not children’s toys, but not so difficult either (if only you get interested)
- I noticed that most tough parts are understanding the concept of “secure Linux” and having interests for it



% about

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1. Fundamental information on Linux security will be shown by **illustrations**

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# % about

1. Fundamental information on Linux security will be shown by **illustrations**
2. The core concept behind “secure Linux” will be explained
3. Summaries for available implementations will be shown as well as tools to explore them



ReadMe

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- This presentation is designed not to require special knowledge

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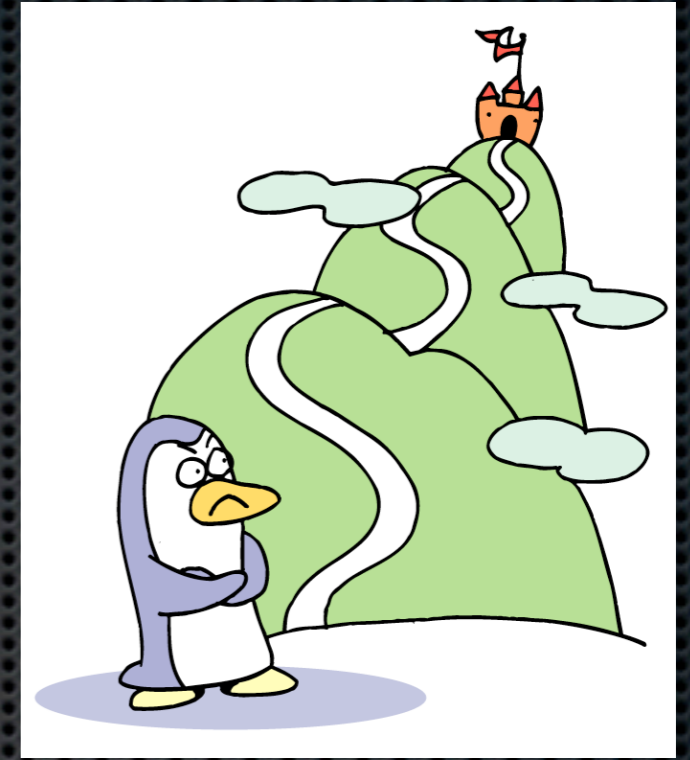
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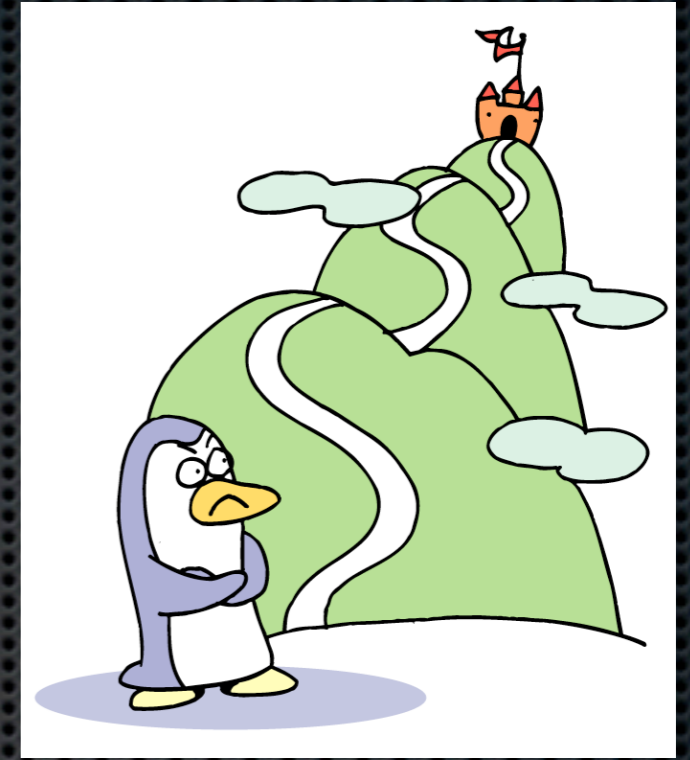
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- Please relax and **enjoy!**

# “Secure Linux”

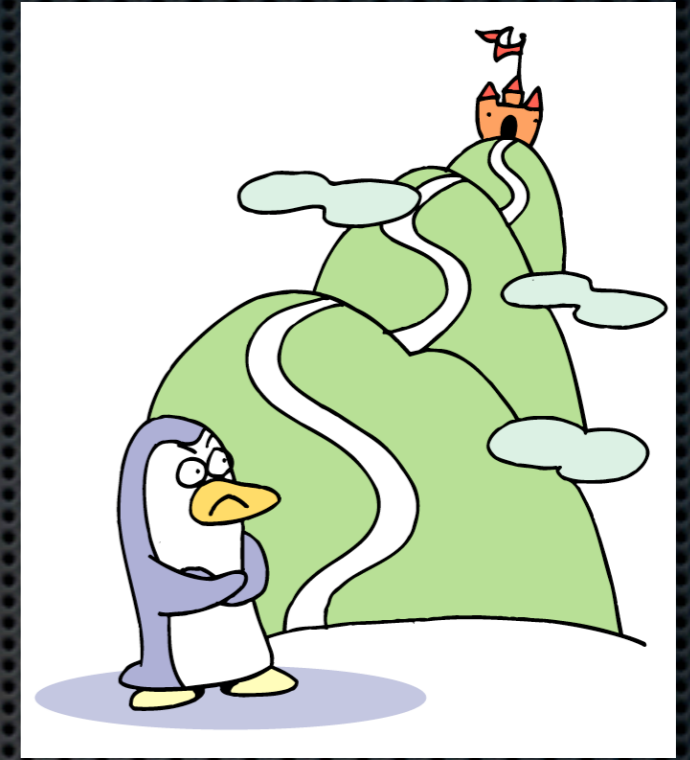




“Secure Linux”  
does NOT exist

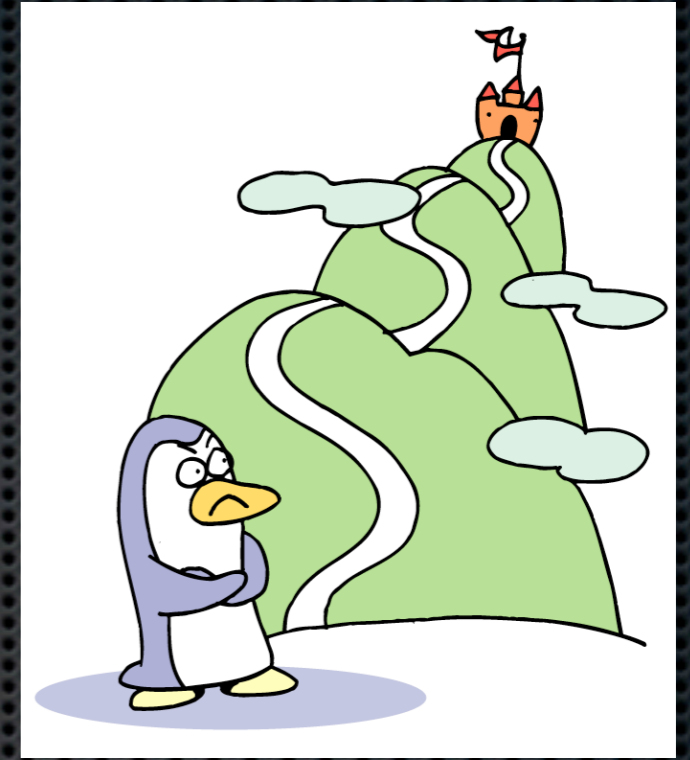


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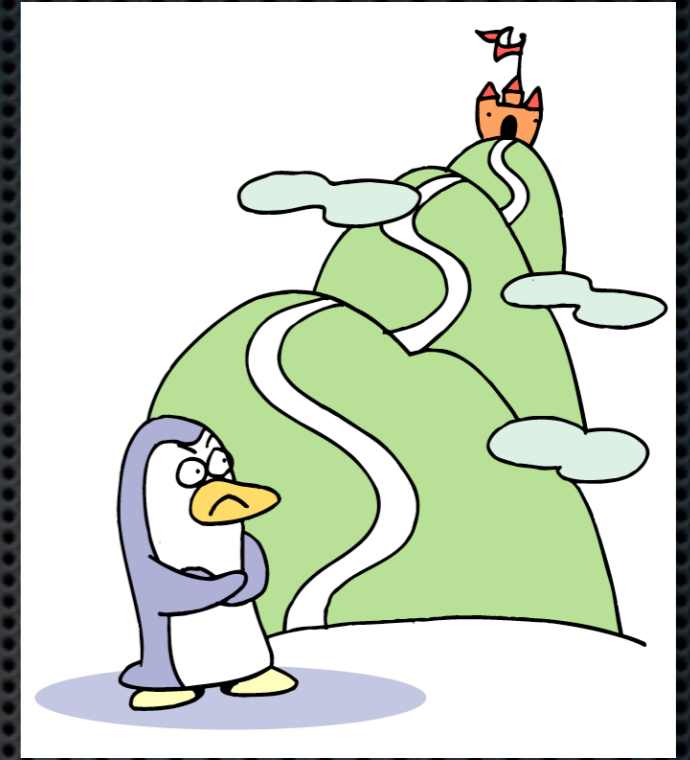
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# “Secure Linux” does NOT exist



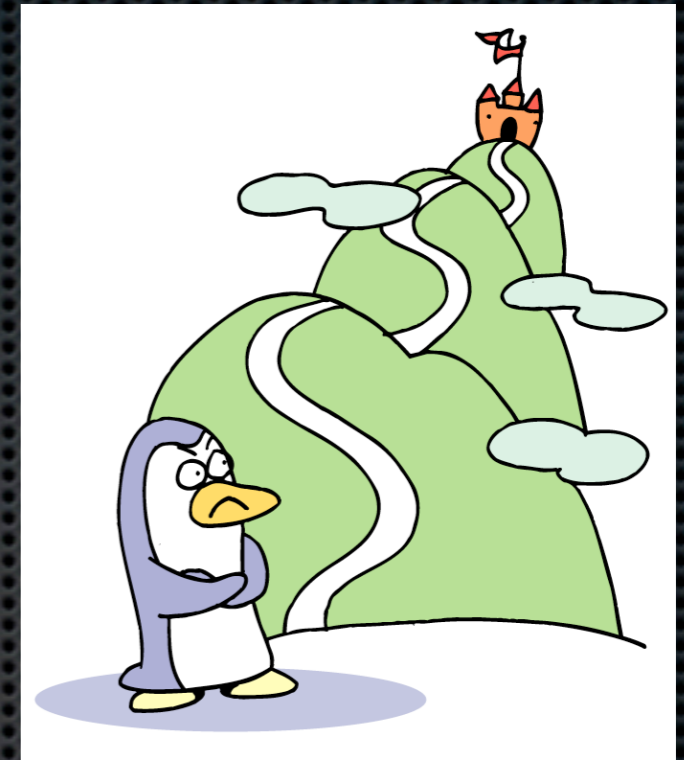
- It's the ultimate goal that we can never reach
- Still we can step forward toward the goal

# “Secure Linux” does NOT exist



- It's the ultimate goal that we can never reach
- Still we can step forward toward the goal
- Why?

# “Secure Linux” does NOT exist



- It's the ultimate goal that we can never reach
- Still we can step forward toward the goal
- Why?
- That's the way open source is (you can never improve MS\$ Windows \*) security

# “SELinux” is one of the “secure Linux” attempts

- SELinux (Security-Enhanced Linux) developed by NSA is distinguished and respected from other attempts towards the goal
- What makes SELinux so special?
  - It's “in-tree” (part of the standard Linux source code)
  - It's fully functional and most powerful

Any other “in-tree”?

# Any other “in-tree”?

- **Smack** (Simplified Mandatory Access Control Kernel) developed by **Casey Schaufler** is the other “in-tree” implementation



# Any other “in-tree”?

- **Smack** (Simplified Mandatory Access Control Kernel) developed by **Casey Schaufler** is the other “in-tree” implementation
- You can't use SELinux and Smack at the same time. This is due to the limitation of **LSM** (security framework of Linux)

How about “out-of-tree”?

# How about “out-of-tree”?

- Yes. There are many

# How about “out-of-tree”?

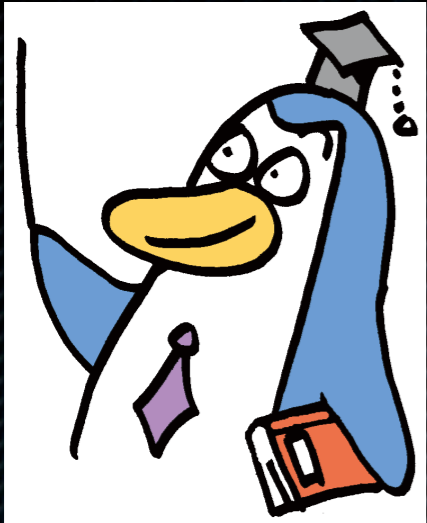
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- **AppArmor** by NOVELL and **TOMOYO Linux** by NTT DATA CORPORATION are now trying to be in-tree (now)

# How about “out-of-tree”?

- Yes. There are many
- **AppArmor** by NOVELL and **TOMOYO Linux** by NTT DATA CORPORATION are now trying to be in-tree (now)
- **LKML** (Linux Kernel Mailing List), is the place to propose new functionalities and discuss Linux program (not for the fight)

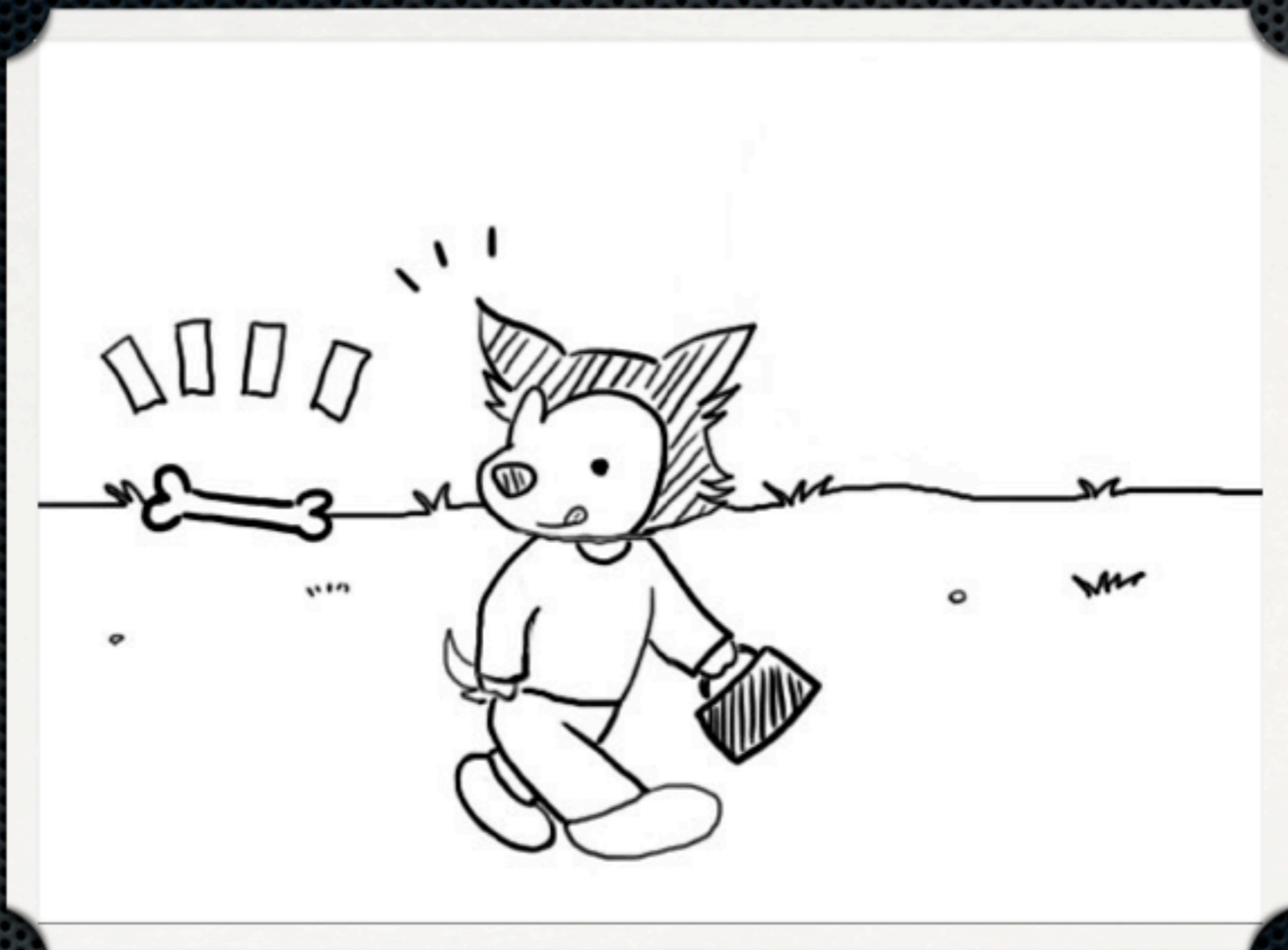
# Chapter 1

Why do we need to enhance Linux security?



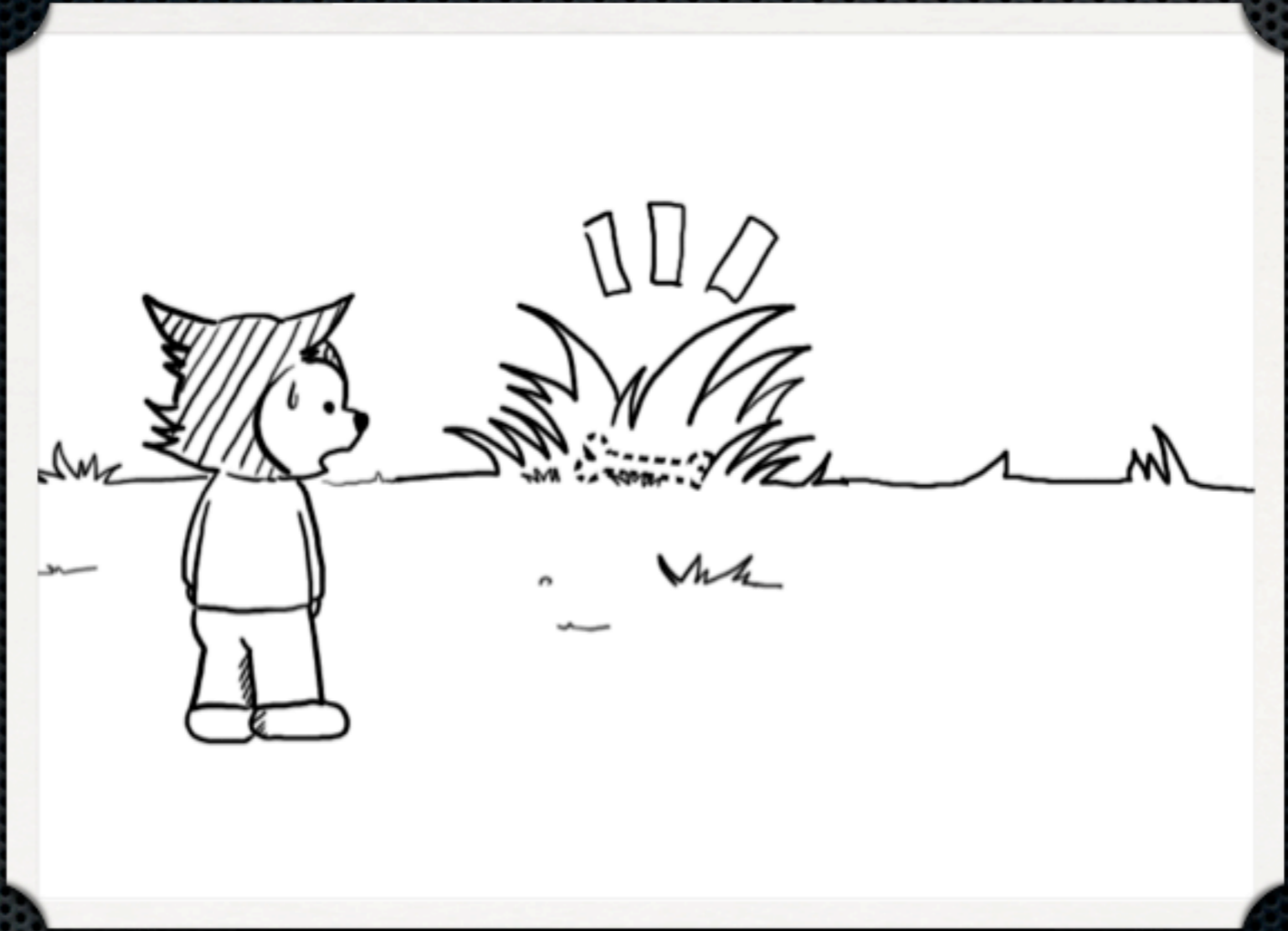
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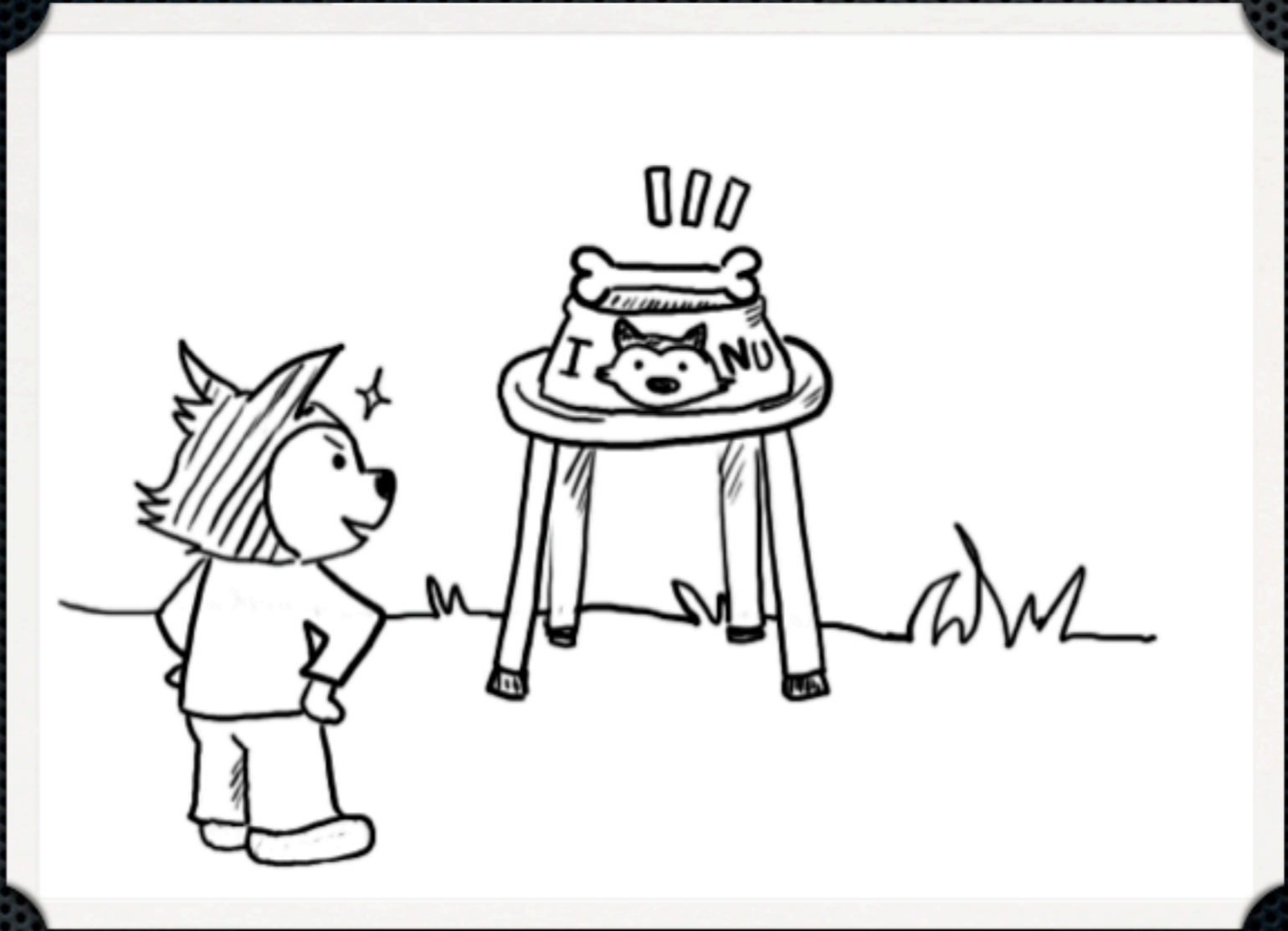
Why do we need to enhance Linux security?



































Now let's review and  
see what happened

什么事, 让我们审查







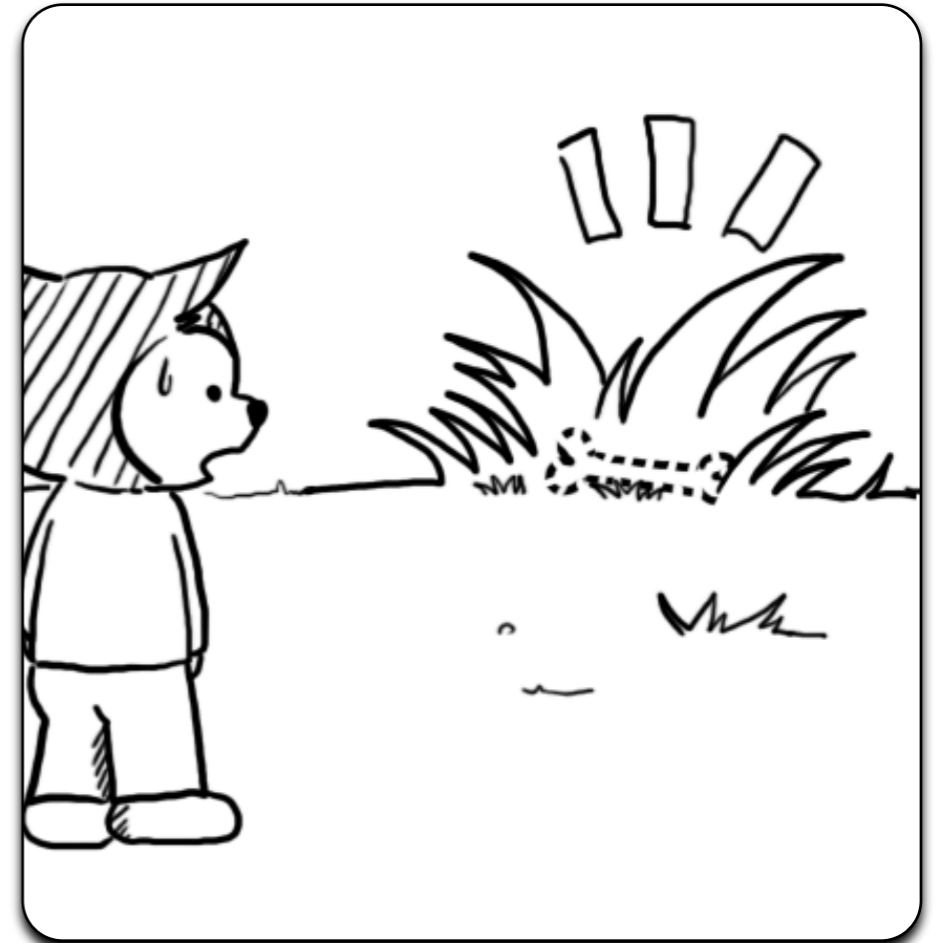




is better than



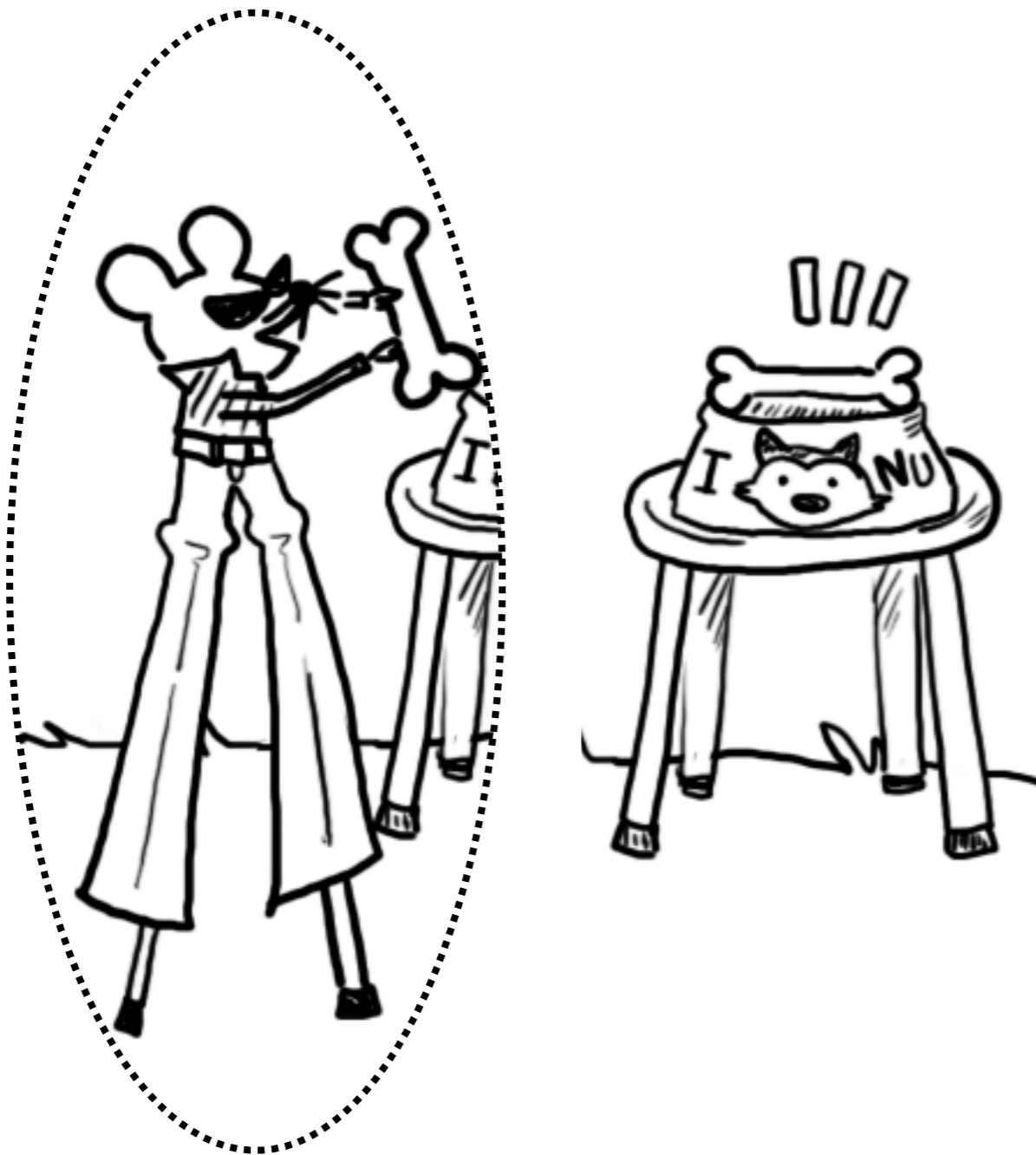
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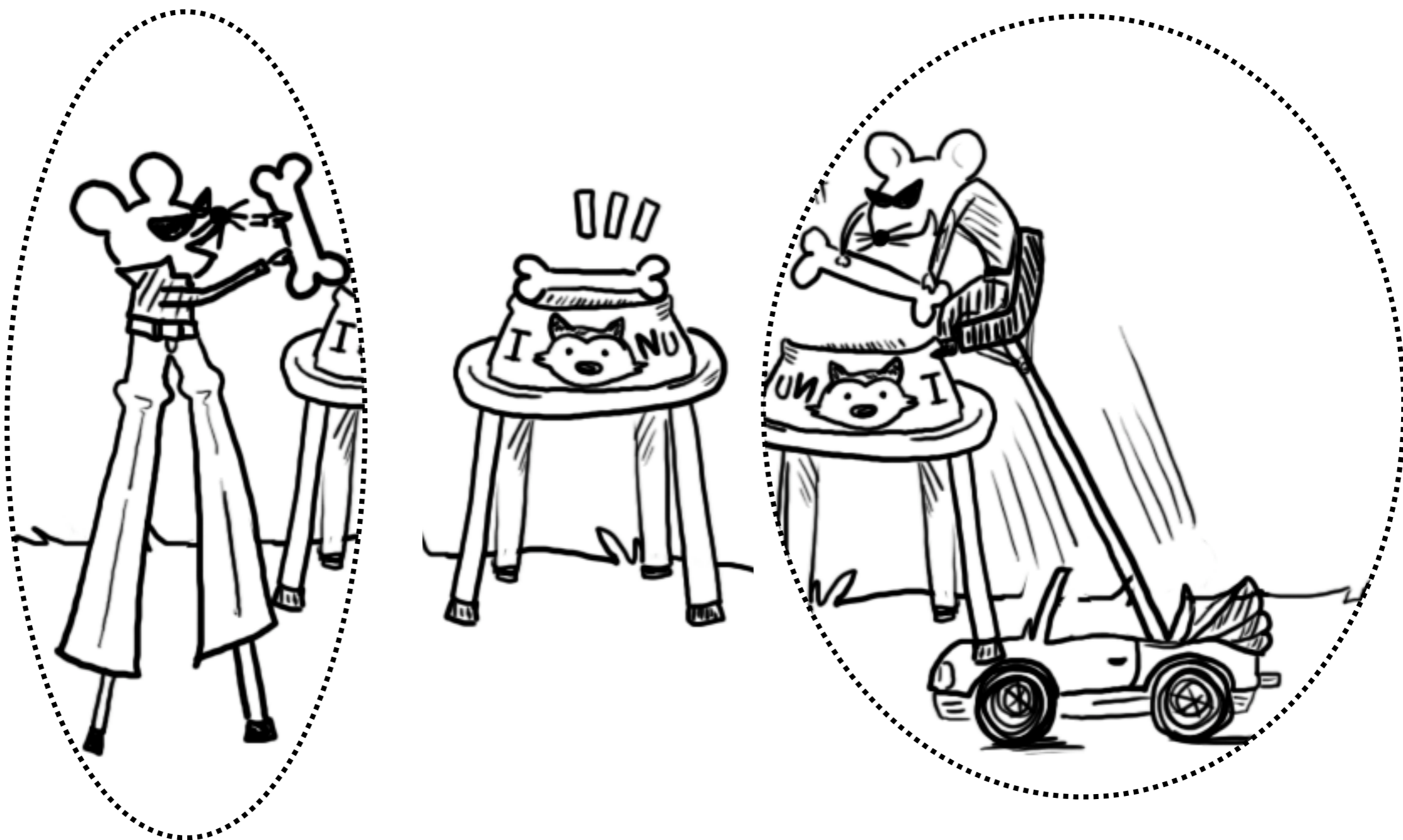
but was insufficient  
这是不够的



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# DAC



The owner can set the access attributes for his/her resource. This is called DAC (Discretionary Access Control).

This is DAC

```
% chmod 600 my_diary
```







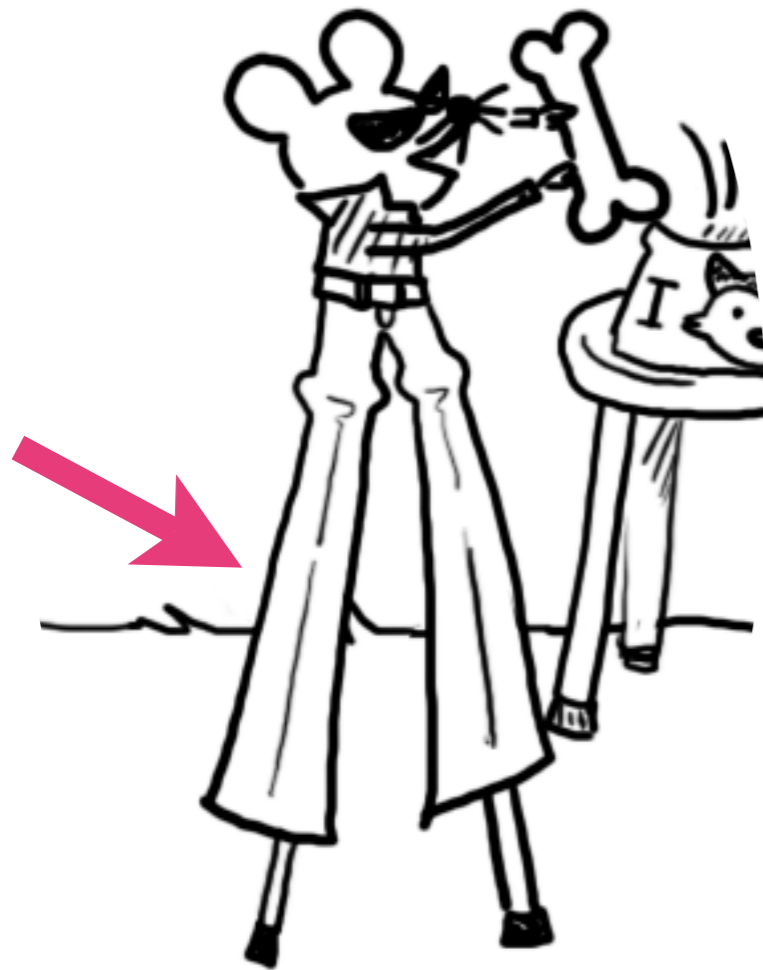
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- DAC can be overridden
- You should set DAC carefully, but **should not over trust it**

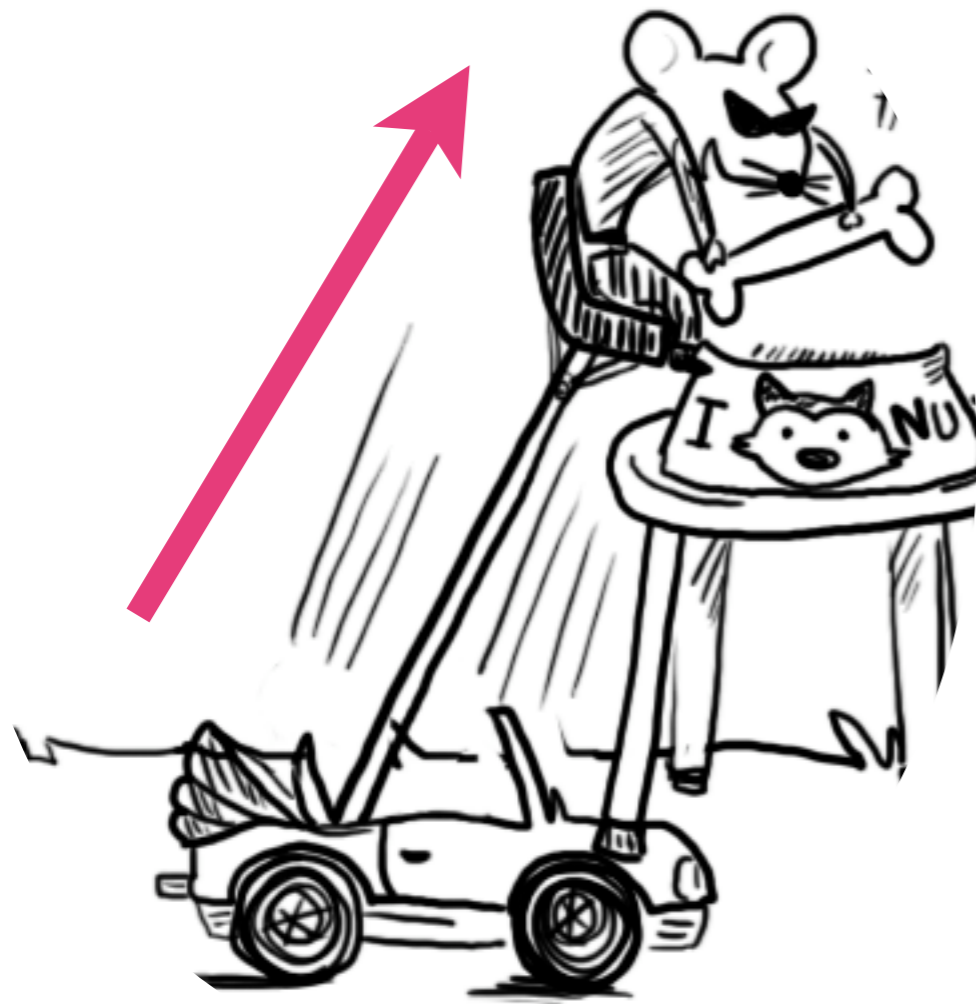


- DAC can be overridden
- You should set DAC carefully, but **should not over trust** it
- When is DAC broken?



# root user

root user is not affected by DAC. root user is the God (if your Linux is not “security enhanced” Linux)



# setuid

a process invoked by a program with “**setuid root**” attribute will be given root **privilege**

You might think  
你可能会认为

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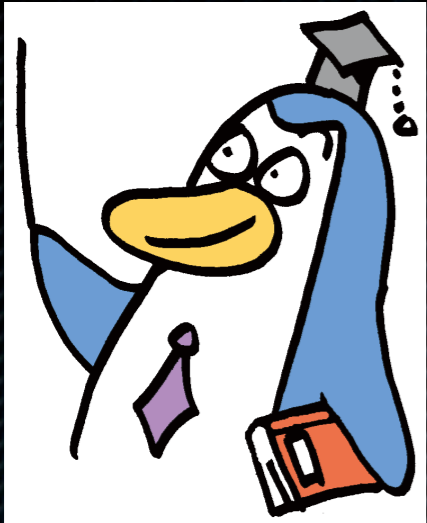
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- getting rid of **root** user and **setuid** mechanisms , but it does not work
- there are tasks for root
- you can change your password because **passwd** command is **setuid** root
- yes, we do need **privileges**

# Chapter 2

Learn basics of “Mandatory Access Control” and “Least Privilege” principle



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# Lessons Learned

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# Lessons Learned

- Good old security called DAC (Discretionary Access Control) is **insufficient**
- If someone steals root **privilege** of your system, you are no longer the administrator of your system (you are out of luck)
- Eliminating root account and privileges can not be the answers



# Least Privilege

## 最少的權限

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- So the issue is **how to limit and control the privileges**

# Least Privilege

## 最少的權限

- So the issue is **how to limit and control the privileges**
- It has been studied and is now well known as **“Least Privilege”** principle (common to every operating systems)

# MAC (Mandatory Access Control)

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- The shortcomings of DAC and potential threats DAC can cause have been studied for over twenty years

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- The shortcomings of DAC and potential threats DAC can cause have been studied for over twenty years
- **MAC** has been introduced to achieve the Least Privilege principle
  - **DAC**: Discretionary Access Control
  - **MAC**: **Mandatory** Access Control

# How MAC works?

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- MAC controls/limits access requests in kernel



# How MAC works?

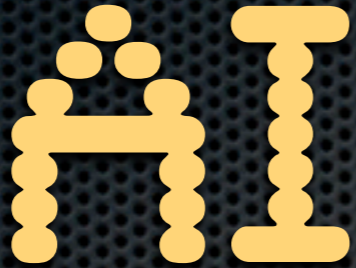
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- “Control” means **judgements** to eliminate/reject inadequate access requests

# How MAC works?

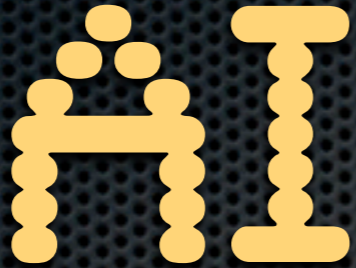
- MAC controls/limits access requests in kernel
- “Control” means **judgements** to eliminate/reject inadequate access requests
- **But how can MAC distinguish inadequate requests from others?**

**MAC is a mechanism**

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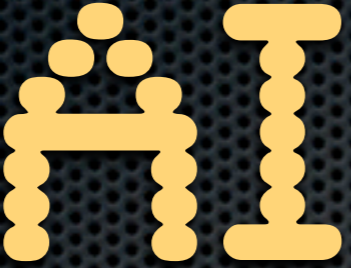
not  ;-) huh!

# MAC is a mechanism

not  ;- ) huh!

- MAC cannot distinguish inadequate requests from others

# MAC is a mechanism

not  ;-) huh!

- MAC cannot distinguish inadequate requests from others
- **It is always human** to judge whether requests are adequate (needed) or not

**So, you need to write “Policy”**

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- Administrators have to tell MAC good and bad request in terms of access rule definitions



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- Administrators have to tell MAC good and bad request in terms of access rule definitions
- Those definitions are generally called “policy” (“profiles” in AppArmor, Smack “access rules” in Smack)
- If MAC is an engine of a car, policy is a fuel. You need to manage policies

**Policy is important**

# Policy is important

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# Policy is important

- MAC just works as it was told
- If you forget to give required access, your system will fail to serve (that's why some people turn off SELinux)
- If you give excessive access, you will give crackers more chances to intrude
- Let's see some images

Hmm... Vase is guarded.  
OK. I'm going to take the cash box





“secure Linux” is installed, but no rules



Can't sleep, drink, take a bath ...



Perfectly “Locked”



**MAC is not only for  
security**

# MAC is not only for security

- “secure Linux” implementations work to reject inappropriate access request

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# MAC is not only for security

- “secure Linux” implementations work to reject inappropriate access request
- “inappropriate” includes
  - malicious access (cracking)
  - operation error (such as “`rm -rf *`”)



# MAC is good for ...



reducing the damages by cracking



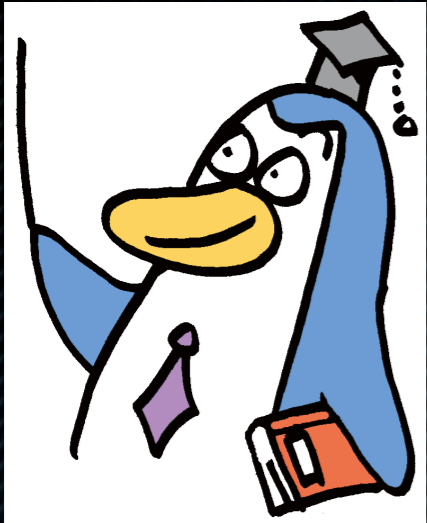
rejecting wrongly operations



storing fine grained audit logs

# Chapter 3

label-based v.s. pathname-based



# Chapter 3

label-based v.s. pathname-based

# label vs. pathname

- There are two kinds of implementations for Linux MAC, **label-based** and **pathname-based**

# Label-based Security



1. define “label” first
2. specify policy using labels

“label” is stored as **xattr** (extended attributes). As inode is trustable as DNA (Deoxyribo Nucleic Acid), label information stored bound with inode is trustworthy

# Pathname-based Security

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- In pathname-based MAC like TOMOYO Linux and AppArmor, policies are written and stored using “pathname”. No need to manage labels

# Pathname-based Security

- In pathname-based MAC like TOMOYO Linux and AppArmor, policies are written and stored using “pathname”. No need to manage labels
- Though they are a lot easier to use, keep it in mind that “pathname” is subjected to change by operations such as `mount` and `chroot` (handle with care)



**Which is better?**

# Which is better?

- From **information flow control** point of view, label-based approach is superior

# Which is better?

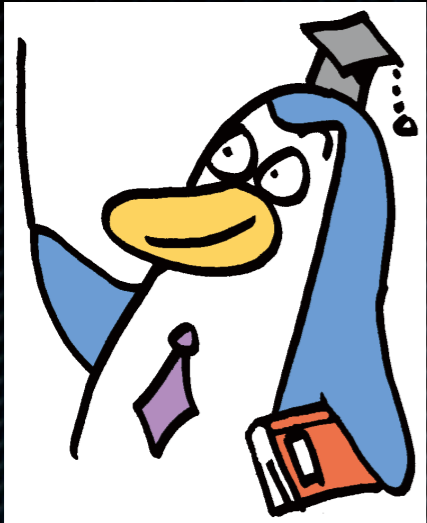
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- While label-based approach has good history and academically proven, pathname-based MAC is just two years old

# Which is better?

- From **information flow control** point of view, label-based approach is superior
- While label-based approach has good history and academically proven, pathname-based MAC is just two years old
- Hopefully, pathname-based should be incorporated and work together with labels in the future

# Chapter 4

Available MAC implementations for Linux



# Chapter 4

Available MAC implementations for Linux

# SELinux

<http://www.nsa.gov/selinux/>



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- Security-Enhanced Linux



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- Security-Enhanced Linux
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- Developed mainly by **National Security Agency** and other smartest people in the world
- RHEL5 has acquired Common Criteria certifications

# SELinux

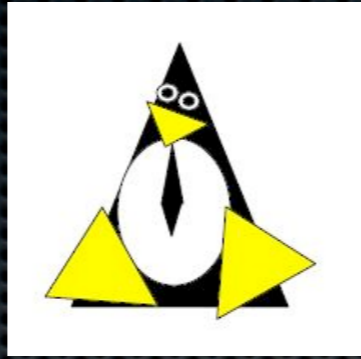
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- Ottawa Linux Symposium 2008 (OLS2008) paper by James Morris is an ideal introduction and summary of SELinux
  - “Have You Driven an SELinux Lately?”

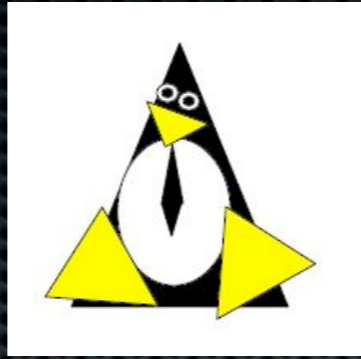
# Smack

<http://schaufler-ca.com/>



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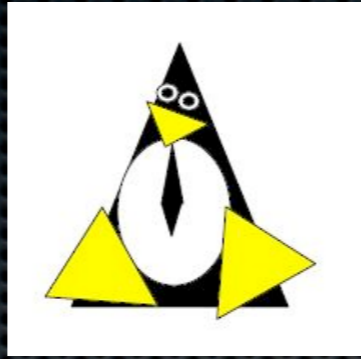
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- “Simplified Mandatory Access Control Kernel”

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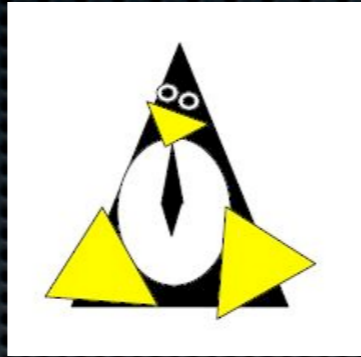
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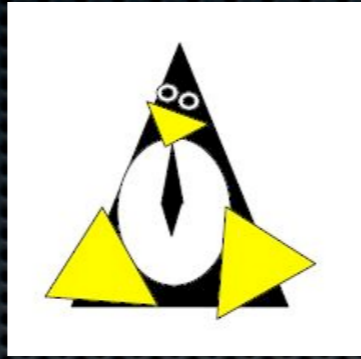


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- “Simplified Mandatory Access Control Kernel”
- The second “in-tree” MAC implementation to Linux (since 2.6.25)
- Developed by an individual, Casey Schaufler
- Functionalities are drastically simplified as its name says

# AppArmor

<http://en.opensuse.org/AppArmor>

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- **Pathname-based** MAC implementation like TOMOYO Linux
- Project of NOVELL
- Not intended to protect the whole system. Aimed to protect specific services like web server
- **Available on OpenSUSE, Ubuntu and others**

# TOMOYO Linux

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**TOMOYO加油**

**More detail?**

**想知道更多吗？**

# More detail?

# 想知道更多吗？

- You can not compare them unless you play with them (at least one of them)

# More detail?

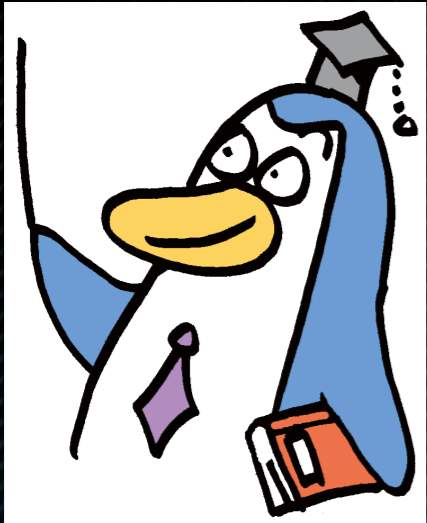
## 想知道更多吗？

- You can not compare them unless you play with them (at least one of them)
- I have my version of a simplified comparison chart (hope this helps)
- <http://tomoyo.sourceforge.jp/wiki-e/?WhatIs>



# Chapter 5

Prepare your journey



# Chapter 5

Prepare your journey

# You need tools to survive



The image shows a browser window with the title "Thunderbird - Reclaim your inbox". The address bar shows the URL "http://www.mozilla.com/en-US/thunderbird/". The browser has several tabs open: "Thunderbird - Reclaim ...", "LXR / The Linux Cross ...", and "Git - Fast Version Contr...". The main content area features the Mozilla logo and navigation links for "Products", "Add-ons", "Support", "Community", and "About". The central heading is "Thunderbird 2", followed by the text: "Mozilla's Thunderbird 2 email application is more powerful than ever. It's now even easier to organize, secure and customize your mail." To the right is a large blue bird logo holding a yellow envelope. Below this is a green button with a download icon and the text "Download Thunderbird 2.0.0.17 for Mac OS X, English (US) (18.7MB)". Underneath the button is a link for "Release Notes - Other Systems & Languages". The bottom section has a heading "Keep Your Vital Information Organized" and a paragraph about Thunderbird 2's features. To the right of this section are two quotes from eWeek and InformationWeek. At the bottom left, there is a heading "Secure and Protect Your Mail".

Thunderbird - Reclaim your inbox

http://www.mozilla.com/en-US/thunderbird/

Thunderbird - Reclaim ... LXR / The Linux Cross ... Git - Fast Version Contr...

mozilla Products Add-ons Support Community About

## Thunderbird 2

Mozilla's Thunderbird 2 email application is more powerful than ever. It's now even easier to organize, secure and customize your mail.



 **Download Thunderbird**  
2.0.0.17 for Mac OS X, English (US) (18.7MB)

[Release Notes - Other Systems & Languages](#)

### Keep Your Vital Information Organized

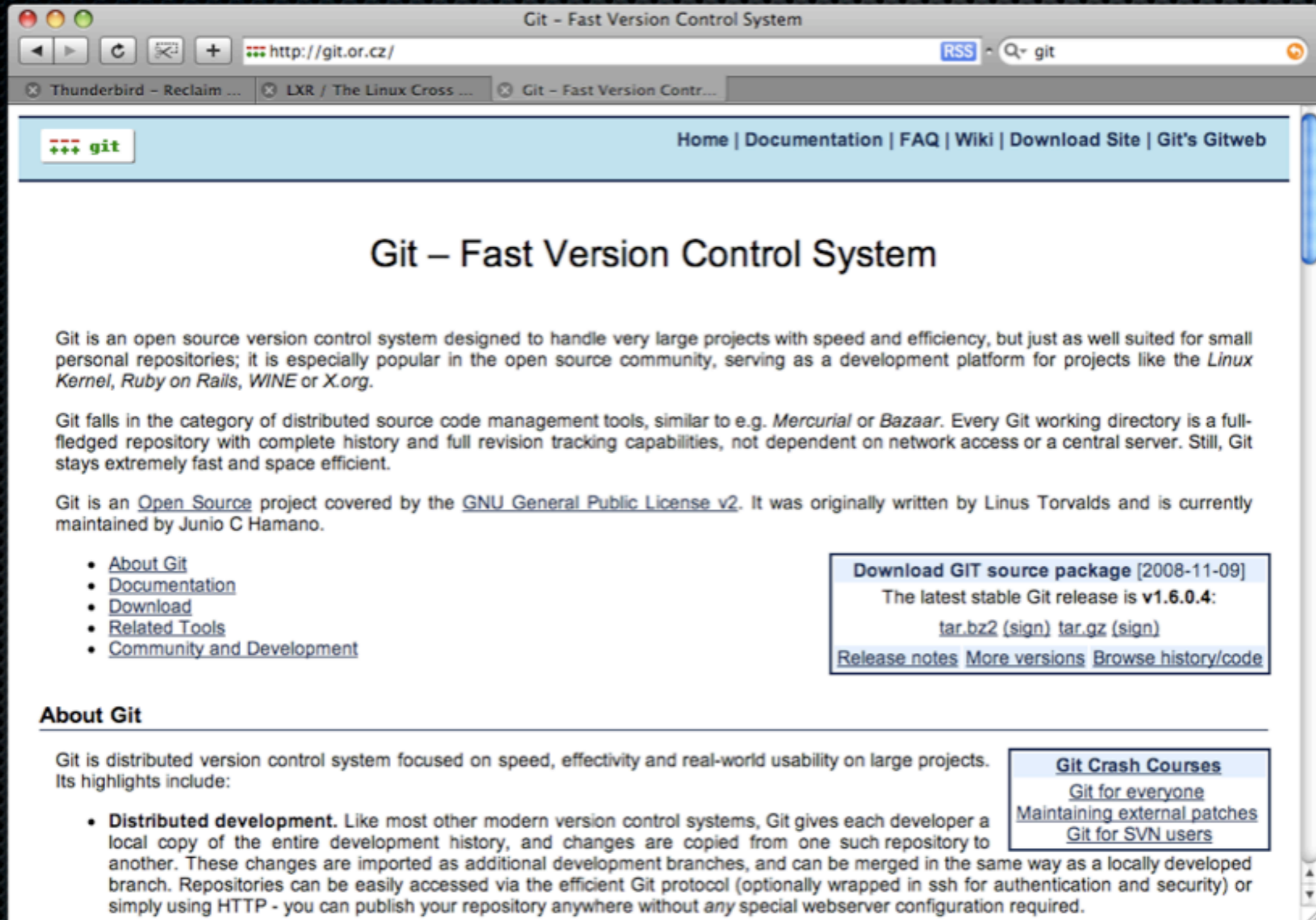
Thunderbird 2 features many new enhancements to help you better manage your unruly inbox, and stay informed. Thunderbird 2 scales to the most sophisticated organizational needs while making it easy to find what you need.

*"If you think there's nothing more that can be added to an email client -- except for the fabled seek-out-and-destroy-spam option -- prepare to be pleasantly surprised. The new Thunderbird comes with numerous new features."*  
[Steven Vaughan-Nichols, eWeek, Dec. 15, 2006](#)

*"Mozilla, the developer of the free Thunderbird e-mail client, has taken a good program and made it better with the release of the version 2.0 beta 1."*  
[Ron Miller, InformationWeek, Dec. 18, 2006](#)

### Secure and Protect Your Mail

# You need tools to survive



The image shows a screenshot of a web browser displaying the Git homepage. The browser window title is "Git - Fast Version Control System" and the address bar shows "http://git.or.cz/". The page features a navigation bar with links for Home, Documentation, FAQ, Wiki, Download Site, and Git's Gitweb. The main heading is "Git - Fast Version Control System". Below this, there are three paragraphs of introductory text. A sidebar on the left contains a list of links: About Git, Documentation, Download, Related Tools, and Community and Development. A callout box on the right highlights the latest stable release, v1.6.0.4, with download links for tar.bz2 and tar.gz, and links to release notes, more versions, and browse history/code. Below the main text, there is a section titled "About Git" which describes the system's focus on speed and usability, followed by a list of highlights including distributed development. A second callout box on the right lists "Git Crash Courses" with links for "Git for everyone", "Maintaining external patches", and "Git for SVN users".

Git - Fast Version Control System

Home | Documentation | FAQ | Wiki | Download Site | Git's Gitweb

## Git - Fast Version Control System

Git is an open source version control system designed to handle very large projects with speed and efficiency, but just as well suited for small personal repositories; it is especially popular in the open source community, serving as a development platform for projects like the *Linux Kernel*, *Ruby on Rails*, *WINE* or *X.org*.

Git falls in the category of distributed source code management tools, similar to e.g. *Mercurial* or *Bazaar*. Every Git working directory is a full-fledged repository with complete history and full revision tracking capabilities, not dependent on network access or a central server. Still, Git stays extremely fast and space efficient.

Git is an [Open Source](#) project covered by the [GNU General Public License v2](#). It was originally written by Linus Torvalds and is currently maintained by Junio C Hamano.

- [About Git](#)
- [Documentation](#)
- [Download](#)
- [Related Tools](#)
- [Community and Development](#)

**Download GIT source package [2008-11-09]**  
The latest stable Git release is **v1.6.0.4**:  
[tar.bz2 \(sign\)](#) [tar.gz \(sign\)](#)  
[Release notes](#) [More versions](#) [Browse history/code](#)

### About Git

Git is distributed version control system focused on speed, effectivity and real-world usability on large projects. Its highlights include:

- **Distributed development.** Like most other modern version control systems, Git gives each developer a local copy of the entire development history, and changes are copied from one such repository to another. These changes are imported as additional development branches, and can be merged in the same way as a locally developed branch. Repositories can be easily accessed via the efficient Git protocol (optionally wrapped in ssh for authentication and security) or simply using HTTP - you can publish your repository anywhere without *any* special webserver configuration required.

**Git Crash Courses**  
[Git for everyone](#)  
[Maintaining external patches](#)  
[Git for SVN users](#)

# You need tools to survive

LXR / The Linux Cross Reference

http://lxr.linux.no/

LXR Welcome to lxr.linux.no -- the Linux Cross Reference [Prefs](#)

**Welcome to lxr.linux.no**  
LXR (formerly "the Linux Cross Referencer") is a software toolset for indexing and presenting source code repositories. LXR was initially targeted at the Linux source code, but has proved usable for a wide range of software projects. lxr.linux.no is currently running an experimental fork of the LXR software.


**Browse the code**  
These are the browsable source code repositories at lxr.linux.no:

- [Linux 2.6.11 and later](#)
- [Linux 2.5.0 - 2.6.11](#)
- [Linux 0.01 - 2.4.31](#)
- [SYSLINUX](#)
- [coreboot v2 \(formerly LinuxBIOS v2\)](#)
- [coreboot v3 \(formerly LinuxBIOS v3\)](#)
- [Mac OS X Darwin/xnu](#)
- [Perl](#)

**LXR Source code**  
For the interested, the source code is available as a git repository at <git://lxl.linux.no/git/lxrng.git>. Not all of the functionality present in mainline LXR is available in this version, and the documentation is unfortunately rather sparse. Don't hesitate to contact [lxr@linux.no](mailto:lxr@linux.no) with any questions, though.

**Thanks**  
[Perl](#), [CPAN](#), [PostgreSQL](#), [Xapian](#) and [Excuberant Ctags](#) are invaluable components of the lxr.linux.no infrastructure. Additionally, [Linpro AS](#) generously provides the hardware and network connectivity required.

**About**  
lxr.linux.no is provided as a non-profit service to the public in the hope that it is found useful. It is herded by Arne Georg Gleditsch in his spare time.



**What's new**

*2008-06-02*  
Problems concerning a change of ip address unfortunately left lxr.linux.no unavailable for (at least) the past day or so. As they say, we apologize for the inconvenience. Things should be back in working order now, but if you experience connectivity-related issues please holler.

*2008-02-28*  
Thanks to Ahmed S. Darwish and Fred Koehler, there are now actually two step-by-step guides to choose from for anyone wanting to try out LXRng under Ubuntu 7.10. Ahmed S. Darwish has [published a guide on his blog](#), while Fred Koehler [contributed the following document](#). A big thank you to both of them.

*2008-02-27*  
The PostgreSQL engine backing lxr.linux.no has been upgraded to the latest version, 8.3.0. One of the improvements likely to benefit a large LXR installation is the ability to cluster tables based on arbitrary indexes. Site statistics certainly show fewer "slow" queries than before the upgrade.

# To know about the journey

**HOW TO PARTICIPATE IN THE LINUX  
COMMUNITY** A new guide by Jon Corbet



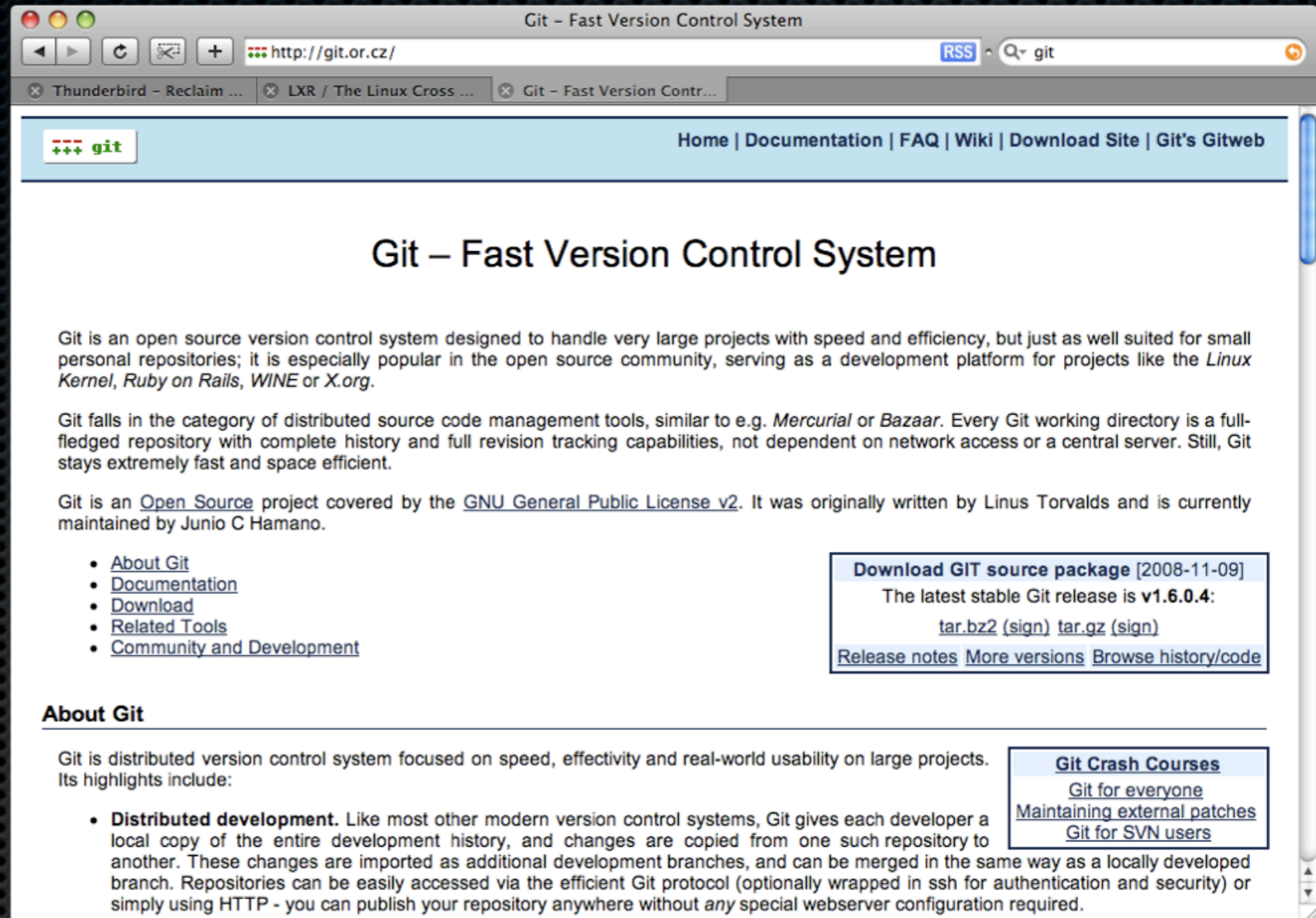
- It's already there. Read or die
- “How and why to work with the Kernel community” by Harald Welte at FreedomHEC Taipei 2008 (yesterday)
- “The Relationship Between kernel.org Development and the Use of Linux for Embedded Applications” by Andrew Morton at Embedded Linux Conference 2008

# Mail



- Subscribe LKML and choose other related lists
- LKML is real huge and high traffic
- Unless you want to read *\*every\** messages, you will need thread-safe mail program
- My recommendation is Thunderbird

# git



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- “git” is the standard Linux version control system for Linux
- Junio Hamano, maintainer of the git gave talk at FreedomHEC Taipei (yesterday)



# LXR (Cross Reference Linux)



- Now Linux kernel has more than **10 millions of lines**
- If you just want to learn Linux, you don't have to download/git clone the mainline kernel
- LXR lets you browse/search Linux source code from your browser

A screenshot of a web browser showing the LXR website homepage. The browser address bar shows 'http://lxr.linux.no/'. The page title is 'LXR | Welcome to lxr.linux.no -- the Linux Cross Reference'. The main content includes a welcome message, a list of browsable source code repositories (Linux 2.6.11 and later, Linux 2.5.0 - 2.6.11, Linux 0.01 - 2.4.31, SYSLINUX, coreboot v2, coreboot v3, Mac OS X Darwin/xnu, Perl), a 'What's new' section with dates, and an 'About' section.

LXR | Welcome to lxr.linux.no -- the Linux Cross Reference

Welcome to lxr.linux.no

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A screenshot of a web browser showing the TOMOYO Linux Cross Reference website. The browser address bar shows 'http://tomoyo.sourceforge.jp/cgi-bin/lxr/source/'. The page title is 'TOMOYO Linux Cross Reference Linux/'. The main content includes navigation links, version and architecture information, and a table of source code repositories.

Linux/

~ [ [source navigation](#) ] ~ [ [identifier search](#) ] ~ [ [freetext search](#) ] ~ [ [file search](#) ] ~

**TOMOYO Linux Cross Reference**

**Linux/**

Version: ~ [ [linux-2.6.27.6-ccs-1.6.5](#) ] ~ [ [linux-2.4.36.9-ccs-1.6.5](#) ] ~ [ [ccstools-1.6.5](#) ] ~ [ [policy-sample](#) ] ~

Architecture: ~ [ [i386](#) ] ~ [ [alpha](#) ] ~ [ [m68k](#) ] ~ [ [mips](#) ] ~ [ [ppc](#) ] ~ [ [sparc](#) ] ~ [ [sparc64](#) ] ~

Name	Size	Last modified (GMT)	Description
<a href="#">Documentation/</a>		2008-11-13 17:56:21	
<a href="#">arch/</a>		2008-11-13 17:56:21	
<a href="#">block/</a>		2008-11-13 17:56:21	
<a href="#">crypto/</a>		2008-11-13 17:56:21	
<a href="#">drivers/</a>		2008-11-13 17:56:21	
<a href="#">firmware/</a>		2008-11-13 17:56:21	
<a href="#">fs/</a>		2008-11-16 13:32:49	
<a href="#">include/</a>		2008-11-11 00:00:00	
<a href="#">init/</a>		2008-11-13 17:56:21	
<a href="#">ipc/</a>		2008-11-13 17:56:21	
<a href="#">kernel/</a>		2008-11-16 13:32:49	

# Trademarks

- Linux® is a registered trademark of Linus Torvalds in the United States and other countries.
- AppArmor® is a registered trademark of Novell, inc in the United States and other countries.
- TOMOYO® is a registered trademark of NTT DATA CORPORATION in Japan.



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**Special thanks to**

*かえる工房 of NTT DATA CORPORATION*



# 謝謝

FreedomHEC 2008 is such a nice conference. I'm very happy to be here and appreciated the heartfelt supports by Huang Chao Lung, Mei-Li Chen, other staff and the sponsors.  
Hope you keep working and see again soon

Linux加油

台灣加油、日本加油

亞細亞加油







Global IT Innovator

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NTT DATA GROUP

再見

再見

This slides available at

<http://tomoyo.sourceforge.jp/taipei2008/>