

Binary Code and Source Code

- Binary code
 - Machine language (native code)
 - Example of instruction set directly executable by CPU
 - Represented by hexadecimal numbers
 - Byte-code
 - Executed by virtual machine
 - Used for Java, etc.
- Source code
 - Programming language
 - Understandable to people
 - Modifiable
 - Requires conversion to binary code
 - Conversion by compiler, byte-code compiler or interpreter

```
0010000 0a29 2020 2020 2023 6874 7369 6920 2073 0010020 2061 6574 706d 726f 7261 2079 6168 6b63 0010040 7520 746e 6c69 7720 2065 6163 206e 696c 0010060 6576 7720 7469 2068 6874 2065 6564 6166 0010100 6c75 2074 6573 7261 6863 7020 7461 7368 0010120 200a 2020 6920 2066 205b 4c24 5f44 494c 0010140 5242 5241 4e59 3233 505f 5441 2048 3b5d 0010160 7420 6568 0a6e 2020 2020 2020 5320 5359 0010200 4554 5f4d 444c 4c5f 4249 4152 5952 334e 0010240 5952 334e 5f32 4150 4854 200a 2020 2020 0010240 5952 3465 6f70 7472 5320 5359 4554 5f4d 0010340 445c 4c5f 4249 4152 5952 334e 5f32 4150 4854 200a 2020 2020 0010360 4854 200a 2020 2020 444c 4c5f 4249 4152 0010340 445c 4c5f 4249 4152 5952 334e 5f32 4150 4464 44c 4c5f 4249 4152 6952 3346 5f32 4150 46854 200a 2020 2020 0010340 4854 200a 2020 2020 2020 444c 4c5f 4249 0010340 4152 5952 334e 5f32 4150 4854 3a3d 2422 0010360 6473 705f 6f72 2267 243a 444c 4c5f 4249
```



Compilers and Interpreters

- Compiler
 - Converts source code to binary code during compiling
 - Advantages of compiled languages
 - Low overhead during execution; high-speed execution
 - Drawback of compiled languages
 - Changes in source code require recompiling
- Interpreter (scripting languages are also a type of interpreted language)
 - Source code interpreted at each execution
 - Advantages of interpreted languages
 - No compiling required; easy to create codes
 - Drawbacks of interpreted languages
 - Inferior performance during execution; not suited for large-scale systems
 - Some interpreted languages are first compiled each time to an intermediate language before being executed



Programming Languages

- Major compiled languages
 - C language
 - Object-oriented extensions of C
 - C++
 - Objective-C
 - Conversion from C -> Assembler* -> Machine language
 - *Assembly language corresponds nearly code-for-code with machine language, but is designed for people to read
 - FORTRAN, Pascal
 - Programming languages that use byte-code interpreter (Virtual Machine type)
 - Java, C# (.Net)
- Major interpreted languages
 - Perl, PHP, Python, BASIC, LISP, Ruby and many others



OSS and Proprietary Software

- Software as a product
 - Difference between software product and 'goods'
- Issues with software products
 - Problems such as illegal copy and piracy
- Countermeasures
 - What were the countermeasures against such issues in the past?
- Emergence of Open Source
 - Spotlighted as a novel software paradigm
 - Turning point of software business



Software as a Product

- Traditionally, software had a strong "freebie" element
 - Accessories to hardware
 - OS, applications and other minute software
 - Basic reservations about paying for immaterial goods
- Commoditization of computers (from mid-90s)
 - Package software became commonplace
 - Proprietary software emerged as product
- Difference between software and material goods
 - Negligible cost to copy
 - Rampant illegal copying and piracy
 - Difference between software and information content (music, film)
 - Software requires 100% integrity (zero tolerance for "noise" or data corruption)



Issues with Software Products

- Illegal copying, piracy
 - Casual copying
 - Particularly rampant in Asia (but incidence is not necessarily zero in US/Europe)
 - Accelerated by developments in P2P technology
 - Winny
 - WinMX
 - gnutella
 - Demise of copyright system?

- Vulnerabilities
 - Security holes
 - Bugs
 - Increased complexity of software



Countermeasures

- Measures against illegal copying
 - Hardware-based solutions
 - USB dongles, etc.
 - Copy protection technology
 - Superdistribution systems
 - Digital watermarks
 - Software-based countermeasures
 - License keys
 - Serial keys
 - Non-technology solutions
 - Comprehensive licensing agreements
 - Educational initiatives

- Measures to address vulnerabilities
 - Patches
 - Security patches
 - Bug patches
 - Automatic updates
 - Cost of maintenance cannot be ignored



Emergence of OSS

- Freedom to copy
 - Solution to piracy issue
 - Does not equate to discarding copyright
 - Software use managed through license
- Can counter the risk of vulnerabilities
 - Fixes implemented by worldwide developer base
 - If you have the expertise, you can fix it yourself
- Paradigm shift in software products
 - Shift toward being paid for services
 - Support services
 - Customization
 - Provide total solutions



Levels of Releasing Source Code

1. Readable source code

- Useful for technology acquisition and checking security holes
- Ex. Early Unix, Shared Source (Microsoft)

2. Modifiable source code for local use

- For customization or tuning
- Embedded use is permitted
- Source code may not be redistributed

3. Freely usable, modifiable and redistributable source code

- Qualifies as OSS
- Enables smooth implementation of bazaar-style joint development
- Distributable as part of a distribution



Benefits of Releasing Source Code

- Benefits for developers and development projects
 - Can turn to others for help
 - Someone is likely to debug the software
 - Someone is likely to add new features
 - Someone is likely to modify the source code out of need
 - Someone is likely to handle maintenance
- Benefits for users
 - For users capable of modifying source code
 - Ability to fix by oneself if problem occurs (maybe)
 - Ability to perform detailed customization (maybe)
 - Learn operating principles and acquire technology
 - Other users
 - Indirectly benefit from releasing of source code



Truth and Misunderstanding about OSS

- "Open Source" is a proper noun
 - That is also trademarked
- "Free Software" and "Free Beer"
 - Freedom and free-of-charge
- Is it adequate only publishing source code?
 - More than just releasing source code
- OSS movement is neither totalism nor communism
 - Based on selfish idea rather than altruistic
 - cf. "Benefits of Releasing Source Code"



Growth of Linux Market

- Internet servers
 - Web, e-mail, DNS, firewalls
 - Already established in this field
- Workgroup servers
 - File sharing, client-server systems
 - Deployment rapidly increasing as segment enters growth period
- Servers for backbone systems
 - High reliability servers for large-scale tasks
 - Finance, telecommunications, e-government, etc.
 - Studies by OSDL's Carrier Grade Linux (CGL) working group, etc.
 - Serious deployment began in 2003

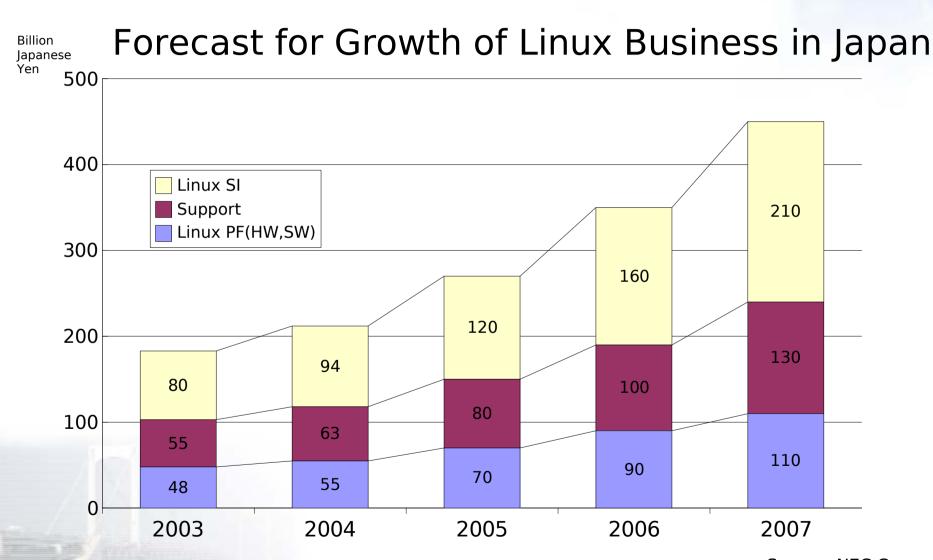


Growth of Linux Market (Cont'd)

- Science and technology computing
 - Simulations, analysis, data mining
 - Linux share rapidly growing; field naturally suited to Linux
 - Previously ranked third in TOP500 list of fastest supercomputers
 - Linux Networx (2300CPU, 7.6TFlops)
 - Linux used lately for grid systems research
- Desktop Linux
 - Major factors: Spread of OSS office suites, low cost PCs, etc.
 - Many issues to clear before spread of Linux in Asia
- Embedded Linux
 - Dedicated terminals for specialized applications, information appliances, PDAs, mobile phones
 - Hard disk video recorders, Sharp's Zaurus PDA, etc.



Linux Market in Japan



Source: NEC Corporation



Types of Systems Development Using OSS

- Market penetration and reasons for OSS system adoption
 - More than half of small-scale servers adopt OSS
 - Major reasons are relatively lower cost and stability of OSS
- Typical OSS system structures
 - LAMP/LAPP systems
 - Java-based systems
 - Conventional applications for OSS servers



Market Penetration and Reasons for OSS System Adoption

- Adoption of OSS systems on small-scale servers
 - Where are OSS systems used?
 - (Source: Survey by Nikkei Business Publications)
 - Web servers: 60%
 - Workgroup file servers: 50%
- Reasons for adopting OSS systems
 - Low cost: 65%
 - Stable operation: 50%
 - Security: 30%
 - Ease of remote operation: 25%



LAMP and LAPP Systems

- Web service development accounts for large percentage of Open Source development
 - Ranks high in FLOSS-JP Survey
- Typical system configurations
 - LAMP systems development
 - Linux OS, Apache Web server, MySQL database, PHP script language
 - LAMP stands for Linux, Apache, MySQL, PHP
 - LAPP systems development
 - Linux OS + Apache Web server + PostgreSQL database + PHP script language
 - LAPP stands for Linux, Apache, PostgreSQL, PHP



Java-Based Systems

- Lower development costs
 - Use Open Source Tomcat in place of commercial servlet engines
 - Side benefit of using Java: reduced OS dependency
- System configuration
 - Linux + Apache + Tomcat
 - Comparatively small-scale systems
 - Used to implement systems comparable to LAMP systems
 - Large-scale systems
 - Extensive use of J2EE or frameworks
 - Use Linux for running environment
 - Frequently rely on commercial components to implement complex business logic



Conventional Applications for OSS Servers

- Information sharing services, operation of portal sites
 - Apache used for Web server
 - Various modules can be used to provide diverse services
 - Small-scale system integration
 - Workgroup server: Combination of standalone OSS servers provides adequate service level
- Use of package LAMP systems
 - CMS, business application packages, etc.Closer inspection frequently reveals LAMP or LAPP system underneath



(3) Major OSS and Distibutions

- OS and middleware
 - OS (Operating System) : the basis of systems
 - Middleware: software parts between applications and OS
- Servers
 - OSS became popular initially as server applications
- Desktops
 - OSS applications are expected to be suited for desktops
- Development environment
 - Cost merits for starting development easily
- Major Linux distributions
 - Providing an overview of Linux distributions



OS (Operating System)

- Linux
 - The leading open source OS
- FreeBSD/NetBSD/OpenBSD
 - Honorable descendants of BSD
- Darwin
 - Open source OS kernel as a basis of Mac OS X
- Other open source OS
 - OpenBeOS (Haiku), Plan 9, GNU/Hurd, etc.
- Other OS Trends
 - Microsoft's shared source and activities of Sun Microsystems regarding its product Solaris



- Unix for PC, brainchild of Linus Torvalds
 - Created in 1991
 - Bazaar-style development; ported to various platforms ranging from embedded to mainframe
 - Architectures supported:
 - x86, PPC, Alpha, MIPS, SPARC, etc.
- Strict definition and wider definition
 - Strict definition: Linux kernel
 - Wider definition: Linux package (distribution) with applications
 - cf. "About Distributions"
 - Diverse range of Linux systems popular worldwide



FreeBSD, NetBSD, OpenBSD

- BSD : Berkeley Software Distribution
 - Unix-compatible OS created by William Joy(Bill Joy) and Chuck Haley
 - Based on Unix V6 with networking enhanced
 - Highly influential on development of today's Internetrelated technologies
- FreeBSD/NetBSD/OpenBSD
 - Open Source OS'es derived from BSD
- Features
 - FreeBSD: Emphasis on stability; frequently used for servers, etc.
 - NetBSD: Runs on diverse platforms
 - OpenBSD: Emphasis on security
 - FreeBSD derivatives: DragonFly BSD, Firefly BSD, etc.



Other OS Trends

- Shared Source Initiative
 - Microsoft's strategic response to OSS
 - Source code for Microsoft products released through individual agreements with governments, universities and enterprises
 - Prohibits release of modified source code
 - Not free to redistribute
 - Completely removed from OSS; does not fit definition of OSS
- Developments in Solaris OS
 - Source code released as OpenSolaris in June 2005
 - Some codes only available in binary files; not fully OSS



Middleware

- Web application frameworks
 - Middleware as a framework for constructing Web applications
 - JBoss, Tomcat, etc...
- libraries
 - Software libraries as enormous assets
 - Example of libraries
 - Widget set, graphics library, etc.



Web Application Frameworks

- Tomcat
 - Part of Apache Jakarta Project
 - Type of servlet container
 - Servlet: Mechanism for running Java programs on Web servers
- JBoss
 - Implements Java for J2EE
 - J2EE: Platform for enterprise Java deployment
 - Simplifies deployment of Enterprise JavaBeans (EJB)
 - EJB: Java software component implemented on server side
 - Developed by JBoss Inc.



Servers

- Web server
 - Apache
- Mail servers
 - MTA
 - ML server
 - POP3/IMAP
- DB server
 - PostgreSQL/MySQL/Fire bird
- DNS
 - BIND

- File shareing
 - Samba/WebDAV
- LDAP
 - OpenLDAP
- Mining server
 - namazu
- CMS
 - XOOPS/Zope
- Business applications
 - E-Learning, ecommerce and many others



Web (HTTP) Servers

Apache

- De facto standard for HTTP servers
 - 72% market share (according to E-soft survey of May http://www.securityspace.com/s_survey/data/200505/index.html
- History
 - Developed in 1995 by Rob McCool at NCSA
 - Development stalled when McCool later left NCSA
 - Developers in various places began modifying Apache
 - These developers got in touch and started up Apache Project
 - Name originates from "a patchy" server and the Apache Native Indian tribe
- Features
 - Light, fast and reliable (uses modules)
 - Runs on many platforms (Unix, Mac, Windows)



Mail Transfer Agents (MTA)

Sendmail

- Long used on Unix (developed in 1982)
- Supports various protocols
- Many security holes
- Commercial version sold by Sendmail, Inc.

Postfix

- Interoperable with Sendmail
- Simple to configure

qmail

- Fast, robust
 - No security holes discovered
- Simple to configure
- Not OSS, strictly speaking (distribution of modified versions is restricted)



Database Management Systems (DBMS)

- PostgreSQL
 - Based on POSTGRES (previously Ingres) developed at UC Berkeley
 - Pioneering object-relational database
- MySQL
 - Developed by Swedish company MySQL AB
 - Dual license (GPL and commercial license)Streamlined features and fast performance
- Firebird
 - Open Source version of InterBase from Borland; released in 2000
 - Name clashed with Mozilla Firebird, prompting Mozilla to rename it Firefox
- PostgreSQL top in Japan; MySQL top worldwide

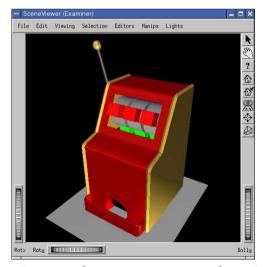


Computer Graphics (CG)

- POV-Ray
 - Ray tracing program for CG creation
- blender
 - Program for 3D CG creation
 - Released as OSS after development company went bankrupt
 - Can be used with YafRay (Yet Another Free Raytracer) for ray tracing
- Open Inventor
 - VRML rendering library
 - SGI software released as OSS



CG rendering using POV-Ray



Sample program in Open Inventor



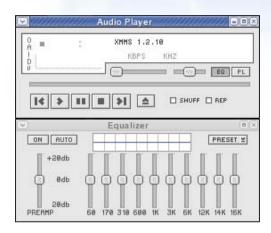
Video

- xanime, mtv, plaympeg
 - First wave of video players
- MPlayer, Xine
 - Support many video formats
 - MPEG, AVI, ASF, WMA, QT, MOV, etc.
 - Continued development in danger due to software patent issue
- XawTV, tvtime
 - TV viewing software relying on TV capture device
- Kino, Coriander
 - Saves video from FireWire (IEEE 1394) cameras
- Other tools: FFmpeg (video format converter),
 Ogle (DVD player), etc.



Audio, Music

- XMMS (X Multimedia System)
 - Audio file and CD player
- LAME (Lame Ain't an MP3 Encoder)
 - MP3 encoder
- Ogg Vorbis
 - Free music compression format
 - Designed to replace other compression formats having many rights issues
- RoseGarden
 - Desktop music creation tool
- Timidity
 - oftware MIDI synthesizer



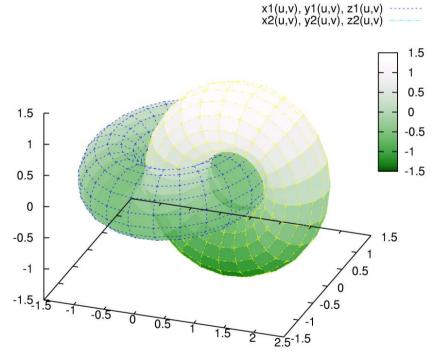
XMMS



Computation, Science and Technology

- R
 - Statistical computing package
 - Compatible with S language
- SciLab, Octave
 - Science and technology computing software
 - Compatible with MATLAB
- Maxima
 - Formula manipulation software
 - Comparable to Mathematica
 - Capable of high quality formula display when used with TeXMacs

- gnuplot
 - Plotting software



Graph drawn in gnuplot



Developing Languages

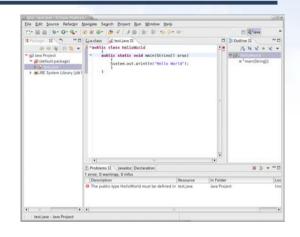
- gcc (GNU Compiler Collection)
 - Collection of compilers for C, C++, Fortran, Java, etc.
 - Standard compiler for development on Unix
- Perl
 - Strong text processing
 - Flexibility to use various syntax for same process
 - TMTOWTDI: There's More Than One Way To Do It.
 - Frequently used for system management and CGIs

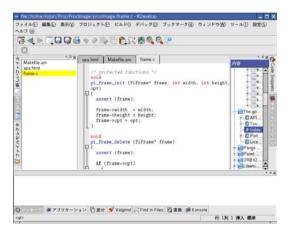
- PHP
 - HTML-embedded, server-side scripting language
 - Main language for Java and Web system development
 - LAMP/LAPP
- Python
 - Features block designation using indentation
- Ruby
 - Developed by Yukihiro Matsumoto
- Python and Ruby are rival languages
 - Python is an object-oriented version of Perl



Integrated Development Environments (IDE)

- Eclipse
 - Development environment implemented in Java
 - Supports languages other than Java
 - Plug-ins for C/C++ development
 - C/C++ Development Toolkit (CDT)
- IDE for various desktop environments
 - Kdevelop for Qt/KDE
 - Anjuta for GTK+/GNOME
- Other IDE
 - WideStudio
 - For creating GUI applications using C/C++







Major Linux Distributions

- About distributions
 - Collection of software
- RedHat / Fedora
 - Top share for enterprise
 - Full of leading-edge functions
- Turbolinux
 - Focuses on desktop use

- SUSE LINUX
 - Distribution from Europa
 - The second largest share of Linux market
- Vine Linux
 - Well-tailored Japanese environment
- Debian GNU/Linux
 - Many developers in the world
- KNOPPIX
 - Bootable from CD



Turbolinux

- Developed and marketed by Japanese company Turbolinux, Inc.
 - Japan: No. 2 in Linux server OS market share (2003 survey) *1
 - China: No. 1 in Linux server OS market share (2003 survey) *2
 - Released Chinese version of Linux
 - Joined UnitedLinux industry consortium in 2002
 - Purpose: Establish standard distribution for Linux
- Focus on desktop Linux OS
 - Releases: Turbolinux 10 Desktop, etc.
 - Enhanced with Windows-like GUI
 - Comes with player supporting Windows Media video files

^{*1} IDC, "China Linux 2004—2008 Forecast and Analysis," July. 2004

^{*2} IDC Japan, "Operating System Market in Japan: Linux Market Analysis and Forecast 2003—2007" (In Japanese)



(4) Philosophy and History of Open Source Software

History of OSS

 Looking round the evolutionary process of OSS from "Birth of Hackers" to current situations where OSS is widely spread in enterprise market

Definition of OSS

 Use the term OSS correctly by knowing strict definition of "Open Source Software"

OSS Licenses

 To understand meanings of software licenses and categories of licenses



History of OSS

- Birth of hackers
 - Basis of emerging free software
- Free software movement and FSF
 - Free software as freedom of software
- Copyleft
 - Fundamental structure to keep freedom of software
- Spread of the Internet
 - Free software played an important role

- Birth of Linux
 - A pioneer of "Bazaar model development"
- Growth of OSS, and Launch of OSI
 - Market share of OSS has enhanced for business use
- Penetrating the enterprise market
 - Many major computer vendors join the OSS enterprise market



Birth of Hackers (1950s to Present)

- "Hacker" began to be used at MIT to describe a person who writes good programs or new algorithms
 - Individuals who attack systems are "crackers"
- Hacker culture is a type of gifting culture
 - "Hacker" title bestowedby others
- Unix conceived in 1971

- "Hack" (definition from thefreedictionary.com)
 - Originally, a quick job that produces what is needed, but not well.
 - An incredibly good, and perhaps very time-consuming, piece of work that produces exactly what is needed.
 - To bear emotionally or physically.
 - To work something (typically a program).
 - To pull a prank on.
 - To interact with a computer in a playful and exploratory rather than goal-directed way.



Free Software Movement and FSF (1980s)

- Aim: World where citizens can live with Free Software alone
- GNU Manifesto (1983)
 - Author: Richard Stallman
- Launch of GNU Project (1984)
 - Develop Unix-compatible OS from scratch
 - Developed main Unix functions through 1990
- Free Software Foundation (FSF) (1984)
 - Founder: Richard Stallman
 - Organization for managing copyleft software
 - GNU General Public License (GPL) Version 1 released (1989)
 - GPL Version 2 released (1991)
 - "Free" stands for "freedom," not free of charge



Copyleft

- Copyleft
 - Stipulates freedom of program and freedom of modified or extended versions
- Protects freedom of software from copyright
 - Does not abandon copyright
 - Manages copyright and ensures freedom of license
 - Right of copyright holder cannot be abandoned under Japanese law, preventing notion of public domain software





Spread of the Internet

- ARPANET launched by US Department of Defense (1969)
- NSFNET branched off from ARPANET (1986)
 - Network for research community
 - Linked computers at research institutes worldwide
- Free Software drives growth of Internet
 - E-mail (Sendmail), DNS (Bind), newsgroups (INN), etc.
- Internet opened to commercial interests (1991)
- NCSA Mosaic Web browser conceived (1993)
 - Impetus for Internet boom
 - Growth of online e-commerce (since late 1990s)



Birth of Linux (Early 1990s)

- Linux released by Linus Torvalds in October 1991
 - Student at Helsinki University in Finland
- Licensed under GPL
 - Free Software success story
- Pioneered bazaar-style development model
 - Frequent beta releases in mid-development
 - Many developers send bug reports and patches
- Driving factor in emergence of Open Source
 - Business success of Linux drew attention to effectiveness of bazaar-style development and its software, but Free Software movement was too radical for companies



Growth of Open Source; Launch of Open Source Initiative (Late 1990s)

- OSI (Open Source Initiative)
 - Founded by Eric Raymond and Bruce Perens
 - Strategic initiative to promote adoption by business
 - Release of Netscape source code impetus for founding OSI
- 「The Open Source」
 - Proper noun focusing on software development model
 - Prescribed under the Open Source Definition
 - Increased recognition has led to greater misuse and misunderstanding
 - New terms being considered
 - FOSS : Free / Open Source Software
 - FLOSS : Free / Libre / Open Source Softrware



Definition of OSS

- The software whose source code is published, does NOT equal to OSS
 - Insufficient, if ONLY publishing its source code
- GNU's definition
 - "Free Software"
- OSI's definition
 - "Open Source Software"



Definition by Open Source Initiative

- Prescribed by the Open Source Definition (OSD)
 - Wider recognition leads to greater misuse of term
 - Criteria for OSS licenses
 - Over 50 licenses approved
- Based on Debian Free Software Guidelines (DFSG)
 - OSD places greater emphasis on distribution criteria
- Free Software complies with Open Source definition

- Free Redistribution
- Source Code
- Derived Works
- Integrity of The Author's Source Code
- No Discrimination Against Persons or Groups
- No Discrimination Against Fields of Endeavor
- Distribution of License
- License Must Not Be Specific to a Product
- License Must Not Restrict Other Software
- License Must Be Technology-Neutral



OSS Application Fields

- Network servers
 - Of any field, network applications were the quickest to adopt OSS
- Internet business and enterprise systems
 - Became popular from B2B to enterprise systems
- Embedded systems
 - OSS is widely used in embedded environment
- EWS (Engineering Work Station)
 - Descended from Unix workstation
- Desktops
 - Usability is improved to satisfy average users



Network Servers

- Very high affinity between OSS and network services
 - Evident from origins of OSS
- Internet Service Providers (ISPs)
 - OSS used for mail servers and name servers
 - Portal sites, Web servers
 - Load balancer also critical for large-scale ISPs
- Small-scale network servers
 - In-house intranet systems
 - Mail servers, file servers
 - Groupware
 - Wiki for information sharing



Internet Business and Enterprise Systems

- Evolved from network servers
- Factors driving OSS use for Internet business
 - OSS servers used as platforms
 - Emerging IT companies and Internet venture firms
 - Desire to maximize return by reducing system investment costs
 - Popularity of e-commerce
- Making inroads into enterprise sector
 - OSS gradually making inroads into business applications
 - E-learning, ERP, CRM
 - Business package software for specific applications



Embedded Systems

- OSS penetration in embedded environments
 - Linux, NetBSD and other OSS operating systems support many CPU architectures
 - Various embedded platforms are supported
 - Motivation for porting often evolves out of developer interest
- Embedded equipment manufacturers look to OSS
 - EMBLIX (since 2000), CE Linux Forum (since 2003)
 - Main equipment applications
 - Portable information devices
 - PDAs, mobile phones, car navigation systems
 - Information appliances
 - Hard disk recorders, media servers, multimedia equipment
 - Various home electric appliances, as their features become more sophisticated
 - Refrigerators, air-conditioners, microwave ovens, etc.



Engineering Workstations (EWS)

- From Unix to PC-Unix (Linux, *BSD)
 - Same system operation and user interface
 - Same applications are used
 - Or many comparable OSS can be used
 - Can reduce hardware costs
 - Switching from Unix machines to IBM PC-compatible machines leads to significant cost savings
- OSS development supported by EWS users
 - Continue to uphold the principle of "user as developer"



Desktops

- Desktop use by general users
- Last stronghold of proprietary software?
 - Many users only familiar with Windows or Mac OS
 - Ease of use nearly the same for all desktop environments
- Application fields
 - Used in schools
 - Used by teaching staff in their offices
 - Used by children in PC labs
 - Used in routine task applications
 - Telephone operator terminals, counter terminals
 - Medical data terminals
 - Office terminals (private sector and government)



Deploying OSS

- Deploying a new OSS environment
 - Dual booting
 - CD booting
 - Using a Virtual Machine
- Using OSS under Windows
 - The first step is trying to use OSS applications under Windows
- Cygwin
 - The package to use GNU software under Windows



Dual Booting

- Install multiple operating systems on one system
 - Switch between OS'es at bootup
 - Possible to share data by setting up shared drive partition accessible to multiple OS'es
- Advantages
 - Operation is same as single boot environment
 - Runs on one machine; affordable way to try new OS
- Drawbacks
 - Multiple OS'es cannot be used concurrently
 - Slightly bothersome to partition hard drive and configure boot loader



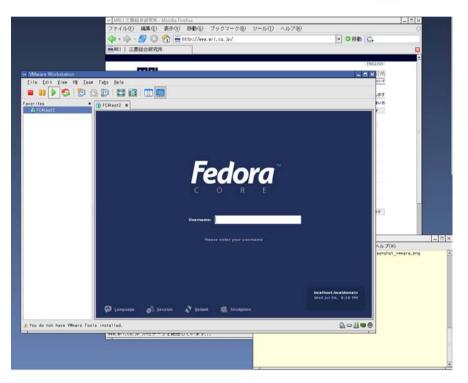
CD Booting

- OS boots directly from CD-ROM
 - Leading example: Knoppix
- Can run on diskless system
 - User data stored in USB memory, etc.
 - Some OS'es save data to CD-R at shutdown
 - Temporary files operate on RAM disk
- Advantages
 - Easy to try new environment
 - CD-ROM based, so minimal risk of harming system
- Disadvantages
 - System cannot be extended
 - Cannot apply security patches, etc.



Using a Virtual Machine

- Run one OS on top of another
 - Ex: Windows on Linux
- Leading examples
 - VMware
 - coLinux
- Advantages
 - Easy to try new OS
- Drawbacks
 - Slower performance due to inevitable overhead



Linux running inside of Linux



(10) Issues with OSS

- Lack of applications, human resources and guarantees
 - Factors lacking in order to utilize OSS the most effectively
- Legal risks
 - Who secures legal risks in using OSS?
- OSS deployment on desktops
 - Desktop use is backward in comparison with server use
- Diversity
 - What makes the issue of software complex?
- Standardization trends and localization
 - Standardization to eliminate diversities
 - Localization to use domestically in each nations