Prof. Ying-Dar Lin 林盈達
Department of Computer and Information Science
National Chiao Tung University
Hsinchu, Taiwan
ydlin@cis.nctu.edu.tw
www.cis.nctu.edu.tw/~ydlin
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Agenda

✦ Open Source Resources
  • Taxonomy of over 10,000 packages
  • Business models
  • Why open source solutions?

✦ Product Lines
  • General categories: client, networking, server
  • Networking devices: access, core, service

✦ Live Examples from My Lab at NCTU
  • Policy-based bandwidth manager
  • Security gateway with VPN, firewall, IDS
  • Mail server clustering for enterprise outsourcing services
For an up-to-date review of the development, licensing, and business models of open source, see “Ming-Wei Wu and Yind-Dar Lin, An Overview of Open Source Development, IEEE Computer, June 2001”.
## Hierarchy of

**[Console/GNOME/KDE/X11]**

<table>
<thead>
<tr>
<th>68</th>
<th>Console/ GNOME/KDE/X11</th>
</tr>
</thead>
<tbody>
<tr>
<td>[019] AfterStep applets</td>
<td>[023] FTP Clients</td>
</tr>
<tr>
<td>[119] Applications</td>
<td>[052] Filesystems</td>
</tr>
<tr>
<td>[048] Backup</td>
<td>[051] Financial</td>
</tr>
<tr>
<td>[008] Browser Addons</td>
<td>[179] Firewall and Security</td>
</tr>
<tr>
<td>[023] CAE</td>
<td>[026] Fonts and Utilities</td>
</tr>
<tr>
<td>[034] CD Writing Software</td>
<td>[593] Games</td>
</tr>
<tr>
<td>[030] Compression</td>
<td>[008] Home Automation</td>
</tr>
<tr>
<td>[009] Core</td>
<td>[103] IRC</td>
</tr>
<tr>
<td>[130] Database</td>
<td>[053] Java</td>
</tr>
<tr>
<td>[063] Desktop</td>
<td>[074] Log Analyzers</td>
</tr>
<tr>
<td>[027] Development</td>
<td>[208] MP3</td>
</tr>
<tr>
<td>[055] Documentation</td>
<td>[051] Mini Distributions</td>
</tr>
<tr>
<td>[088] Editors</td>
<td>[351] Misc</td>
</tr>
<tr>
<td>[165] eMail</td>
<td>[007] Modem gettys</td>
</tr>
<tr>
<td>[008] Embedded</td>
<td>[184] Monitoring</td>
</tr>
<tr>
<td>[088] Emulators</td>
<td>[003] Motif</td>
</tr>
<tr>
<td>[068] Encryption</td>
<td></td>
</tr>
<tr>
<td></td>
<td>[032] Multimedia</td>
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<tr>
<td></td>
<td>[480] Networking</td>
</tr>
<tr>
<td></td>
<td>[048] News</td>
</tr>
<tr>
<td></td>
<td>[053] OS</td>
</tr>
<tr>
<td></td>
<td>[048] Office Applications</td>
</tr>
<tr>
<td></td>
<td>[042] Packaging</td>
</tr>
<tr>
<td></td>
<td>[053] Printing</td>
</tr>
<tr>
<td></td>
<td>[189] Scientific Applications</td>
</tr>
<tr>
<td></td>
<td>[007] Screensavers</td>
</tr>
<tr>
<td></td>
<td>[031] Shells</td>
</tr>
<tr>
<td></td>
<td>[265] Sound</td>
</tr>
<tr>
<td></td>
<td>[136] System</td>
</tr>
<tr>
<td></td>
<td>[041] TV and Video</td>
</tr>
<tr>
<td></td>
<td>[011] Terminals</td>
</tr>
<tr>
<td></td>
<td>[190] Text Utilities</td>
</tr>
<tr>
<td></td>
<td>[665] Utilities</td>
</tr>
<tr>
<td></td>
<td>[004] VRML</td>
</tr>
<tr>
<td></td>
<td>[033] Video</td>
</tr>
<tr>
<td></td>
<td>[038] Viewers</td>
</tr>
<tr>
<td></td>
<td>[684] Web Applications</td>
</tr>
<tr>
<td></td>
<td>[038] Web Browsers</td>
</tr>
<tr>
<td></td>
<td>[121] Window Maker Applets</td>
</tr>
<tr>
<td></td>
<td>[039] Window Managers</td>
</tr>
</tbody>
</table>
Hierarchy of [Daemons]

Daemons

- [007] Anti-Virus
- [005] Batch Processing
- [030] BBS
- [010] Chat
- [032] Database
- [026] DNS
- [015] Filesharing
- [009] Finger
- [022] FTP
- [006] Hardware
- [097] HTTP
- [013] Ident
- [013] IMAP
- [050] IRC
- [015] Mailinglist Managers
- [231] Misc
- [027] MUD
- [009] Network
- Directory Service
- [013] NNTP
- [023] POP3
- [071] Proxy
- [031] SMTP
- [005] SNMP
- [002] Time

Development

- [010] Bug Tracking
- [068] Compilers
- [014] CORBA
- [073] Database
- [038] Debugging
- [084] Environments
- [028] Game SDK
- [048] Interfaces
- [173] Java Packages
- [028] Kernel
- [001] Kernel Patches
- [121] Languages
- [485] Libraries
- [100] Perl Modules
- [008] PHP Classes
- [001] Pike Modules
- [057] Python Modules
- [031] Revision Control
- [019] Tcl extensions
- [017] Test Suites
- [558] Tools
- [178] Web
- [055] Widget Sets
Business Models (1/2) with Open Source Solutions

Case 1 Software (desktop clients/servers)
- Free core
- Non free accessories
  e.g. Sendmail Inc.

Case 2 Services
- Free software
- Charged service
  e.g. RedHat

Case 3 ASP
- Appz
  e.g. lots of portals, ASP, and …
  MSN hotmail !!

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Business Models (2/2)
with Open Source Solutions

Case 4 **Embedded clients/servers/networking**

Case 5 **User Feedback**

Case 6 **Add-on values**

- e.g. Cobalt (Sun), VA Linus, Juniper, Packeteer, F5, Sitara, and a lot more….
- e.g. RedHat
  - Roller coaster!! $151 ~ 1

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Why Open Source Solutions?

- Abundant open source resources
  - Over 10,000 packages
- Cost of development and ownership
  - No license fee, royalty
- Better code quality and higher availability
  - Worldwide contributors, fast patches
- Time to market
## Commercial Embedded OSs

### VxWorks, QNX, ChorusOS, pSOS, WinCE

<table>
<thead>
<tr>
<th></th>
<th>VxWorks</th>
<th>QNX</th>
<th>ChorusOS</th>
<th>pSOS</th>
<th>Windows CE</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sales</strong></td>
<td>$130M</td>
<td>$20M</td>
<td>$20M</td>
<td>$105M</td>
<td>$3M royalty (FY99)</td>
</tr>
<tr>
<td></td>
<td>($20M royalty)</td>
<td></td>
<td></td>
<td>($15M royalty)</td>
<td>$2M Tools</td>
</tr>
<tr>
<td><strong>Profit Margin %</strong></td>
<td>8.7% (SEC filling)</td>
<td>Unknown. &lt;10%</td>
<td>Unknown</td>
<td>9% (SEC filling)</td>
<td></td>
</tr>
<tr>
<td><strong>Direct Sales Force</strong></td>
<td>Approx 250 (Worldwide)</td>
<td>Approx 40</td>
<td>Original sales force, around 20 + Sun</td>
<td>Approx 200 (Worldwide)</td>
<td>Approx 12 (Worldwide)</td>
</tr>
<tr>
<td><strong>Market Share</strong></td>
<td>15%</td>
<td>2%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Tools Price (per seat)</strong></td>
<td>$7,500 - $10,000 (Based on a 10 seats license)</td>
<td>$2,995 per seat (3rd party tools)</td>
<td>$23,000 initial seat, $4,000 for the following seats</td>
<td>$4,995 by seat Depends on the options</td>
<td>$995</td>
</tr>
<tr>
<td><strong>Royalty</strong></td>
<td>$1-$35</td>
<td>Component-based pricing $3-$80</td>
<td>Low-end $15 Mid-Range $58 High-End $109</td>
<td>Range from $1 up to $30</td>
<td>Range from $5 up to $30+</td>
</tr>
<tr>
<td><strong>Distribution Model</strong></td>
<td>Direct; 3 distributors in Japan</td>
<td>Mixed – direct for large market; 40 distributors for smaller market</td>
<td>Direct only</td>
<td>Direct; 16 distributors</td>
<td>Direct (&gt;25,000 units) Distributors</td>
</tr>
<tr>
<td><strong>Focus</strong></td>
<td>Digital imaging, telecom/datacom, CE, automotive</td>
<td>Industrial automation, medical systems, CE, telecom/datacom</td>
<td>Telecommunications</td>
<td>Automobile industry, some CE (interactive television)</td>
<td>Higher-end applications: ADCU has focused on Manufacturing, Retail, Healthcare</td>
</tr>
</tbody>
</table>
| **Strengths**    | *Most complete integrated environment*  
*Largest coverage of CPU and hosts* | *True micro-kernel architecture*  
*Complete POSIX compliant*  
*Most scalable* | *Exceptional reliability and high availability*  
*Optimized for telecommunications*  
*Ying-Dar Lin* | *Integrated development environment*  
*Optimized for Motorola processors and DSPs* | *Win32*  
*NT Connectivity*  
*Robust graphics/UI* |

*Ying-Dar Lin*
Product Line: Size Matters

Ying-Dar Lin
## Components for Embedded Systems

### Processor (CPU)
- 2 bit CISC/RISC architecture
- Performance (MIPS)
- Power Consumption

### Memory
- 128MB DRAM (SDRAM/EDO)
- 16 MB Flash Memory
- Various size for different applications

### Storage
- DE HDD (large capacity)
- MLC Drive
- Flash Memory (PCMCIA/DOC/Compact)
- Dedicated media for various applications

### Communication Module
- Analog modem/Cable/ADSL/Ethernet/ISDN
- Wireless (RF/Bluetooth/IrDA)

### Input/Output
- Keyboard
- Mouse
- RS-232
- Parallel PCMCIA Smartcard

### Multimedia Function
- Video
  - SVGA Monitor
  - TV Output (STN/TFT) LCD
  - Touch Panel
  - MPEG 2
  - VCD/DVD
- Audio
  - SB Audio
  - MP3 Audio
  - MPEG 2
  - AC3
  - Dolby
  - VCD/DVD

### Processor (CPU)
- X86
- PowerPC
- MIPS
- StrongARM
- SH Series

### Memory
- SRAM
- EDO
- SDRAM
- Flash (DOC)

### Input/Output
- Keyboard
- Mouse
- RS-232
- Parallel PCMCIA Smartcard

### Operating System (OS)
- WinCE
- Java
- Linux
- RTOS (VxWorks,...)
- Native Chinese OS

### Storage
- IDE HDD
- Mini Drive
- Flash Memory (PCMCIA/DOC/Compact)
- DOC Flash Memory

### Communication Module
- Analog Modem
- Cable Modem
- ADSL Modem
- 1/10/100 Ethernet
- ISDN/G.Lite
- RF
- Bluetooth
- IrDA
- SVGA Monitor
- TV Output (STN/TFT) LCD
- Touch Panel
- MPEG 2
- VCD/DVD
- Touch Panel
- MPEG 2
- VCD/DVD
- Touch Panel
- MPEG 2
- VCD/DVD

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### Summary
- The document provides an overview of various components and their specifications for embedded systems, including processors, memories, storage devices, communication modules, and multimedia functions. Each component is detailed with specific features and specifications, allowing for a comprehensive understanding of the embedded system's capabilities.
Product Lines: Client-Side

- Analog Modem
- Cable Modem
- ISDN Modem
- XDSL Modem
- G Lite
- ATM

Set up Box

Thin Client & Windows-based Terminal

Home Entertainment

Web Phone

Internet Box

Point of Sales

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Product Lines: Network-Wide
Hot Products

- **Client:**
  - STB, Web TV, Web phone, Web terminal, PDA, WAP handset, MP3 player, etc.

- **Server:**
  - All-in-one intranet server, mail server, FAX server, message server, proxy server, cache server, storage server, directory server, streaming server, etc.

- **Network:**
  - Security gateway, home gateway, bandwidth manager, Web switch, etc.
Live Examples in My Lab at NCTU

- Policy-based bandwidth manager
- Security gateway with VPN, firewall, IDS
- Mail server clustering for enterprise outsourcing services

.... to be released by the end of 2001!!
Policy-based Bandwidth Manager
for TCP Rate Control at edge gateway

Objective:
Enforcing per-class/per-flow bandwidth management policy at edge routers, using new techniques (PostAck, PreAck) for low buffer requirement and stable TCP rate control
Security Gateway
Integrating VPN, Firewall, NAT, Routing, IDS

Objectives:
(1) Integrating IPsec-based VPN, firewall, routing into Linux kernel
(2) Creating a common platform for future QoS and security features
## Packages used in Security Gateway

<table>
<thead>
<tr>
<th>Package Name</th>
<th>User-space Program</th>
<th>Kernel-space Program</th>
<th>Function</th>
<th>Package Size</th>
<th>Version</th>
</tr>
</thead>
<tbody>
<tr>
<td>ipchains</td>
<td>Management tool</td>
<td>Kernel build in</td>
<td>Packet filtering firewall, and IP masquerade (MASQ)</td>
<td>63KB</td>
<td>1.3.9</td>
</tr>
<tr>
<td>Squid</td>
<td>Daemon</td>
<td>No</td>
<td>Cache server, transparent proxy, and URL filter</td>
<td>1104KB</td>
<td>2.3</td>
</tr>
<tr>
<td>TIS</td>
<td>Daemon</td>
<td>No</td>
<td>Application proxies, and web content filter</td>
<td>476KB</td>
<td>2.1</td>
</tr>
<tr>
<td>FreeS/WAN</td>
<td>Pluto Daemon</td>
<td>KLIPS kernel patch</td>
<td>IPSec with encryption, authentication, and Internet key exchange (IKE)</td>
<td>1252KB</td>
<td>1.5</td>
</tr>
<tr>
<td>Snort</td>
<td>Daemon</td>
<td>No</td>
<td>Intrusion detection</td>
<td>644KB</td>
<td>1.7</td>
</tr>
</tbody>
</table>
## Mail Server Clustering for Enterprise Outsourcing Services

<table>
<thead>
<tr>
<th>Service provider</th>
<th>Web access</th>
<th>POP3 access</th>
<th>IMAP4 access</th>
<th>Anti-virus</th>
<th>Anti-spam</th>
<th>SSL support</th>
<th>Domain hosting</th>
<th>Account migration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yahoo!mail [5]</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Web access</td>
<td>Yes (for individuals)</td>
<td>No</td>
</tr>
<tr>
<td>Hotmail.com [6]</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Web access</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Critical Path [4]</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Web/POP3/IMAP4 access</td>
<td>Yes (for enterprises)</td>
<td>No</td>
</tr>
<tr>
<td>USA.net [7]</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Web/POP3/IMAP4 access</td>
<td>Yes (for enterprises)</td>
<td>Yes</td>
</tr>
<tr>
<td>Our system</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Web/POP3/IMAP4 access</td>
<td>Yes (for enterprises)</td>
<td>Yes</td>
</tr>
</tbody>
</table>
Architecture for Mail Server Clustering
SMTP, POP3, IMAP4, LDAP, NFS Servers

End users
External mail system

POP3/IMAP4 request

SMTP servers
SMTP request
forward outbound messages
query LDAP
forward anti-virus messages

LDAP servers
query LDAP
transfer inbound messages, via NFS

mail data server

anti-virus servers
transfer inbound messages, via NFS

External mail system

Fetch user's messages, via NFS

Relay servers

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Final Remarks

- Abundant resources in open source communities
- Penetration of open source solutions
  - Server > networking > client
- Technical barrier of utilizing open source resources
  (domain knowledge + hands-on skills)
  - Networking > client > server
- 10% of your codes, leveraged by 90% of existing codes
- Be an open source user, administrator, and … contributor/programmer!!