Printing at Colleges and Universities

- Creating “Limits or rules” for printing is a top way schools can cut IT costs (Chronicle for Higher Education, 10/4/02*)

* http://chronicle.com/pm/weekly/v49/i06/06a03901.htm
Outline

• Why a printing system?
• Columbia’s model
• Initial System: Jake
• Improved System: NINJa
• NINJa: Example Case
• NINJa: Benefits
• Questions/Comments
Why do we need it?

• Develop a printing system to:
  – Reduce waste and abuse
  – Regulate printing cost
  – Provide reliable monitoring
  – Provide accurate statistics
Printing at Columbia University

- Academic Information Systems (AcIS) maintains printers for student computing facilities and libraries
- AcIS supports 80+ printers
- 16,000 unique users printed 8,000,000 pages 9/1/03-8/31/04
Model

- A release station kiosk atop each printer displays the printer’s queue
- User sends job to be printed
- User selects a job from the queue and authenticates
- User is authenticated and authorized to print
- Job is printed, printing account deducted
What does it look like?
Initial System: “Jake”

• Configuration
  – Thin-client release station and multiple Unix print servers
  – Central print servers used lpd to handle print jobs
  – Windows and Mac support enabled via Samba and Netatalk

• Key features
  – Used central unique user IDs for authentication and authorization
  – Page quota system
  – Simplex/duplex printing option at the kiosk
  – Secured jobs for authenticated clients
  – No licensing fees, locally written
  – Used 1991 thru 2002
Initial System (Jake): Limitations

- Groups of printers had single points of failure
- No true database model
- Diagnosing problems was overly complex
- System had problems printing from modern applications and operating systems

... Because of these limitations, the system did not scale efficiently
Goals of improved system

- Minimize points of failure
- Build a distributed model
- Database backend
- Easily maintained
- Design to be pluggable and use open standards
- Support credit card online transactions
- Scalable to 100+ printers
“NINJa” Printing System Design Goals

- Distributed model: each NINJa station is a print server in itself
- Uses PXE network boot technology -- downloads images from a server via tftp
- Uses a page control server for page accounting
- SQL database backend
- Open source, open standards
- Central Kerberos authentication and LDAP authorization
- Support credit card purchases via a secure web server
NINJa Printing System: Model

Anywhere

Public Lab or Cluster

Machine Room

User Station

Release Station

Printer

Authentication Server

Page Accounting Server

Database

Authorization Server

Sends Job

Releases Job

Deducts Account

Queries/Updates Account

Authorizes User (Kerberos)

Authorizes User

Authorizes User
NINJa: User Station

- Windows, Mac, Linux, Solaris
- Wired or Wireless network
- Campus run or personally owned
- All major applications
NINJa: Printer

- Hewlett-Packard 4000 and 8000 series
- Postscript
- HP JetDirect: network interface and security
- HP JetAdmin: administration
NINJa: Print Release Station/Server

- OS independent - written in Java
- Stripped down Remote Boot Linux station, with X-windows, LPRng, Kerberos, and Java
- Display is Customizable HTML
- Authenticates via Kerberos 5
- Communicates with separate page counting server (sends username and page request)
- Queues and releases print jobs to printer
NINJa: Page Accounting System

- Page quotas based on unique user ID authorization and printer types
- Weekly or semesterly quotas (flexible)
- Purchase of additional pages (which do not expire)
- Distinction between quota pages and purchased (non-expiring) pages
- Supports a pay-per-page model
NINJa: Page Accounting System (Cont’d)

• Pluggable authorization module via open standard identification system (e.g. LDAP)
• Page transactions for sales, refunds, credits, and queries
• Suite of tools for transactions, queries, and reporting
NINJa: Database

- Stores print usage
- Stores page sales transactions
- Data model that organizes printers, quotas, departments, pricing, and affiliations
- Portable SQL (Oracle)
- Seamless failover to backup
Deployment at Columbia

• 80+ printers maintained
• Minimum support (Besides supplies and repair)
• Usage for 9/1/03 to 8/31/04:
  – 16,000 users
  – 1,650,000 print jobs
  – 8,000,000 pages
  – $40,000 in sales
# Statistics Generation

## Printing Demographic Breakdown: 1/1/04 thru 5/31/04

<table>
<thead>
<tr>
<th>Primary University Affiliation</th>
<th>Unique Individuals Printing</th>
<th>Total Jobs</th>
<th>Total Pages Printed</th>
<th>Unique Individuals Who Bought Pages</th>
<th>Total Pages Sold</th>
<th>Gross Dollars Income*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Faculty</td>
<td>271</td>
<td>10,150</td>
<td>65,597</td>
<td>10</td>
<td>8,650</td>
<td>$865.00</td>
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<tr>
<td>Staff</td>
<td>454</td>
<td>13,130</td>
<td>63,974</td>
<td>17</td>
<td>4,340</td>
<td>$434.00</td>
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<tr>
<td>Grad Student</td>
<td>3,582</td>
<td>135,943</td>
<td>738,266</td>
<td>346</td>
<td>74,780</td>
<td>$7,478.00</td>
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<tr>
<td>Undergrad Student</td>
<td>8,495</td>
<td>589,546</td>
<td>2,913,251</td>
<td>338</td>
<td>53,246</td>
<td>$5,324.60</td>
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<tr>
<td>Professional Student</td>
<td>2,488</td>
<td>46,329</td>
<td>195,338</td>
<td>127</td>
<td>25,830</td>
<td>$2,583.00</td>
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<tr>
<td>Other Student</td>
<td>192</td>
<td>4,296</td>
<td>13,371</td>
<td>8</td>
<td>450</td>
<td>$45.00</td>
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<tr>
<td>Grace Period Student</td>
<td>122</td>
<td>3,776</td>
<td>14,424</td>
<td>24</td>
<td>8,100</td>
<td>$810.00</td>
</tr>
<tr>
<td>Alum</td>
<td>80</td>
<td>2,731</td>
<td>10,121</td>
<td>64</td>
<td>13,650</td>
<td>$1,365.00</td>
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<tr>
<td>Other</td>
<td>8</td>
<td>2,121</td>
<td>3,704</td>
<td>2</td>
<td>600</td>
<td>$80.00</td>
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<tr>
<td>No Match With Affil File</td>
<td>132</td>
<td>2,955</td>
<td>11,712</td>
<td>75</td>
<td>12,270</td>
<td>$1,227.00</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>15,804</strong></td>
<td><strong>810,977</strong></td>
<td><strong>4,029,753</strong></td>
<td><strong>1,011</strong></td>
<td><strong>202,116</strong></td>
<td><strong>$20,211.60</strong></td>
</tr>
</tbody>
</table>
Case study: Implementing NINJa in the Libraries

- Difference: 2.5 million pages @ $.02/page = $50,000
- Revenue ‘03-’04: $58,000 in page sales and account upgrades
- Costs lowered by $108,000

<table>
<thead>
<tr>
<th></th>
<th>‘02-’03</th>
<th>‘03-’04</th>
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<tbody>
<tr>
<td>AciS</td>
<td>4,000,000</td>
<td>6,000,000</td>
</tr>
<tr>
<td>Libraries</td>
<td>6,500,000</td>
<td>2,000,000</td>
</tr>
<tr>
<td>Total</td>
<td>10,500,000</td>
<td>8,000,000</td>
</tr>
</tbody>
</table>

(Pages Printed)
Benefits

- Regulates printing expenses
- Provides accurate statistics
- Provides reliable monitoring
- Reduces waste
- Utilizes central ID system
- Performance scaling and reliability via a distributed model
Recap

• Reasons for having a printing system
• Initial system and its limitations
• NINJa:
  – Goals
  – Design
  – Implementation example
  – Benefits
Thanks!

- Questions?