Consumerizing PCs
from research to product

Monica Lam
Stanford University
moka5, Inc.
When a computer breaks,

- it is not my fault
- “I cannot just buy a new one”
Consumers ≠ System Admins

- System admins = CS students on vacation
- Even Ajax may not run on all browsers
- Manual tasks: disk defragmentation
- Data are not backed up
- Ultimate resort: re-install the OS
- Consumers have no aptitude, interest, time

Need to commoditize system admin
Security Measures: Arms Race

- Spyware, malware targeted at children
- 1/3 of children ages 10-17 are exposed to unwanted porn
- Viruses, spam, spyware, phishing, bots
- Zero-day vulnerability
Company IT Nightmares

- Home computers infecting data centers
- Disasters
- Stolen data
10-Year Research

1997

=>

2007
Happy, digital me.
Digital Asset in the Cloud

- Digital ID/cache unlocks asset in the cloud
- Carry/access everywhere (network accelerator)
- Borrow any PC (300M units)
Personal Digital Asset: Data + (Managed) x86 virtual machines
Like Watching TV: select your LivePC

www.moka5.com
Click “subscribe”

Choice of LivePCs:
- OS + applications updated live
- Peer sharing of LivePCs publicly or privately
Play it on any Windows PC

Plug into Windows PC
Click “play”
Secure and safe, no hassles

Choice of LivePCs
Safe and secure:
“Firebreak” between LivePCs & host
Always up-to-date
Spyware vanishes with each reboot
Private:
Leaves nothing on the host
Takes nothing away
<table>
<thead>
<tr>
<th>Year</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>1998</td>
<td>Sun Rays: Sun Labs</td>
</tr>
<tr>
<td>1999</td>
<td></td>
</tr>
<tr>
<td>2000</td>
<td></td>
</tr>
<tr>
<td>2001</td>
<td>Collective: NSF $3M grant to Stanford</td>
</tr>
<tr>
<td>2002</td>
<td></td>
</tr>
<tr>
<td>2003</td>
<td></td>
</tr>
<tr>
<td>2004</td>
<td></td>
</tr>
<tr>
<td>2005</td>
<td>LivePCs: moka5, venture-backed</td>
</tr>
<tr>
<td>2006</td>
<td></td>
</tr>
</tbody>
</table>
moka5 at Consumer Electronics Show
1. Sun Rays (Sun Labs)

- Stateless protocol: frame buffer protocol + opts
- Smart card: instant access to personal state

Sun Rays (Sun Labs)

- Central management, central execution
- Smart card enables instant access across Sun Rays
- Poor interactive performance over WAN
- No disconnected operation
- Single point of failure
- Data center: expensive, hard to scale
- Cost of thin-client similar to PCs
- Solaris
- Management centralized but not solved
2. Virtualization of the OS level

10,000 students log in, but they don’t log out!
Virtualization of the OS level

✓ Virtualized user processes in Solaris suspended & resumed independently

✗ Quick to demo, hard to be complete
   Requires re-design at the OS level

✗ Operating-system specific

Inspired:

▪ Solaris Zones [’04]
▪ Linux Zap [’02]

[Supporting Ubiquitous Computing
   with Stateless Consoles and Computation Caches,
   Schmidt, Ph.D. Thesis, 2000]
3. Virtual Desktop Infrastructure

- A compute utility model
- X86 virtual machines in the data center
  - Windows, Vista, Linux, MacOS X
  - x86 virtual machine monitor
- Remote display on clients’ desks

[NSF Research Grant #0121481, Lam, 2001]
Virtual Desktop Infrastructure

✓ User virtual machines can be suspended independently
✓ Runs all legacy software
✗ Expensive data-center operation
  ✗ Enterprises but not universities and consumers
  ✗ Miss out on “killer micro” advantage

[VDI, VMware Product 2005]
4. Distributed Virtual Desktops

- Distribute virtual machines to end users
- Optimized virtual machine transfers
  - caching
  - for user mobility and management
  - incremental update, sharing between variations
  - streaming, prefetching with trace optimization
- “Is this research?”
  - Management was not an academic topic in ‘02
  - An NSF research initiative in ‘07

[Optimizing the Migration of Virtual Computers, Sapuntzakis, Chandra, Pfaff, Chow, Lam and Rosenblum, OSDI 2002]
5. Virtual Appliances

- Soft special-function machines
- Manage by shipping new diffs
- Spyware vanishes upon reboot

[Virtual Appliances in the Collective: A Road to Hassle-Free Computing, Sapuntzakis and Lam, HotOS 2003]

[Virtual Appliances for Deploying and Maintaining Software, Sapuntzakis, Brumley, Chandra, Zeldovich, Chow, Lam, Rosenblum, LISA, 2003]
6. Collective System Architecture

- LivePCs: managed x86 virtual machines in the cloud
- PC = LivePC Engine (Linux boot)
  - Download, boot, upload, cache LivePCs
- 20GB 1.8 inch drive = portable LivePC Engine

LivePC Engine (Baremetal Ed.)

Virtual Machine
- VM monitor
- VM cache
- VM Manager
- Linux

VMware player
- Virtualize disk accesses w. opts
- Auth. user, fetch, play, backup VM
- auto-detect hardware, DHCP

[The Collective: A Cache-Based System Management Architecture, Chandra, Zeldovich, Sapuntzakis, Lam, NSDI 05]
7. Community Portal: self service

LivePC publisher → Upload LivePC → web server

- Web-based Registration
- LivePC Subscription service

- Subscription Status request
- Update notification (RSS feeds)

- Update request
- LivePC Stream (http protocol)

[www.moka5.com]
8. LivePC Engine: Windows app

- Linux does not work for all hardware
- Hard to get network connection upon bootup
- Borrow not just hardware, but also Windows device drivers + network connection
- Dynamic install of Windows application
- Less secure, more portable
9. All-in-one USB controller

- “Have controller, will play”
- 3D graphics virtualized
- Peripheral plugged into guest
Final Architecture

Digital ID/cache unlocks asset in the cloud

Carry/access everywhere (network accelerator)

Borrow any PC (300M units)
Closing Thoughts

- “Feel the force” (Moore’s Law)
- Think outside the box – first in a category
  - there are no rules
  - It’s fun, hair-raising, requires confidence
- Follow your passion:
  especially when starting a company
- Research                   Product
  - way out there              bite-sized steps
  - right architecture    perfection, best in class
- The key: people – mentors, students, team
- Startup:
  good ideas→good people→good people→good ideas
Computer Revolution

32
Computer Revolution

mainframe

mini

workstation

PC

laptop

finger tip

Every person will carry his digital assets on a fingertip drive!

[Software freely available at www.moka5.com]