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

[Software freely available at www.moka5.com]
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
Final Architecture

Digital ID/cache unlocks asset in the cloud

Carry/access everywhere (network accelerator)

Borrow any PC (300M units)
9. All-in-one USB controller

- “Have controller, will play”
- 3D graphics virtualized
- Peripheral plugged into guest
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
7. Community Portal: self service

LivePC publisher -> Upload LivePC -> web server

- Web-based Registration
- LivePC Stream (http protocol)
- Update request
- Subscription Status request
- Update notification (RSS feeds)

LivePC Subscription service

[www.moka5.com]
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]
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

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]
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]
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]
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]
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]

2. Virtualization of the OS level

10,000 students log in, but they don’t log out!

Stanford
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
1. Sun Rays (Sun Labs)

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

moka5 at Consumer Electronics Show
<table>
<thead>
<tr>
<th>Year</th>
<th>Event</th>
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<tbody>
<tr>
<td>1998</td>
<td>Sun Rays: Sun Labs</td>
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<tr>
<td>1999</td>
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<tr>
<td>2000</td>
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<tr>
<td>2001</td>
<td>Collective: NSF $3M grant to Stanford</td>
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<td>2002</td>
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<tr>
<td>2005</td>
<td>LivePCs: moka5, venture-backed</td>
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<tr>
<td>2006</td>
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From Research To Product

Part 3
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
Plug into Windows PC
Click “play”
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
Personal Digital Asset: Data + (Managed) x86 virtual machines
Digital Asset in the Cloud

Digital ID/cache unlocks asset in the cloud

Carry/access everywhere (network accelerator)

Borrow any PC (300M units)
10-Year Research

1997

Happy, digital me.

2007
Company IT Nightmares

- Home computers infecting data centers
- Disasters
- Stolen data
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
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
When a computer breaks,

- it is not my fault
- “I cannot just buy a new one”
Motivations

Part 1
Consumerizing PCs from research to product

Monica Lam
Stanford University
moka5, Inc.