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]

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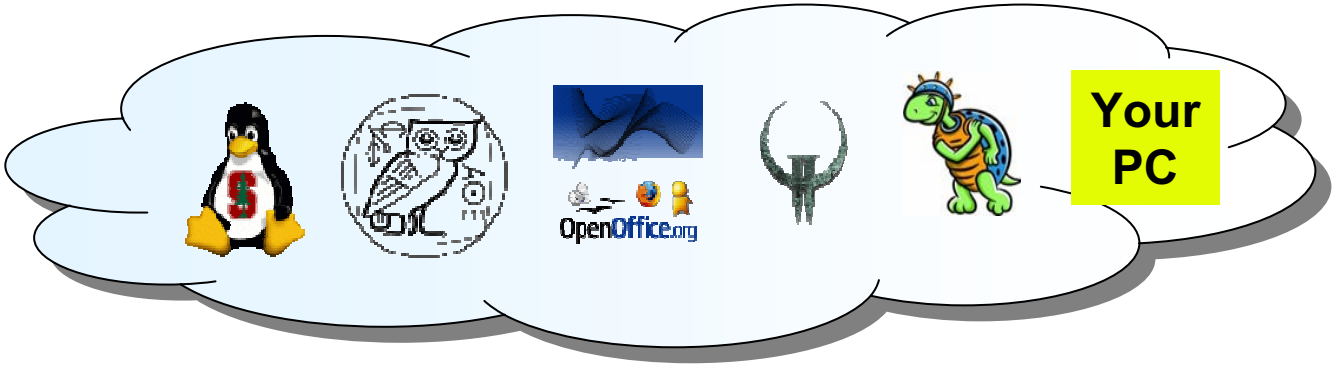
Closing Thoughts

- "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)

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9. All-in-one USB controller

- "Have controller, will play"
- 3D graphics virtualized
- Peripheral plugged into guest

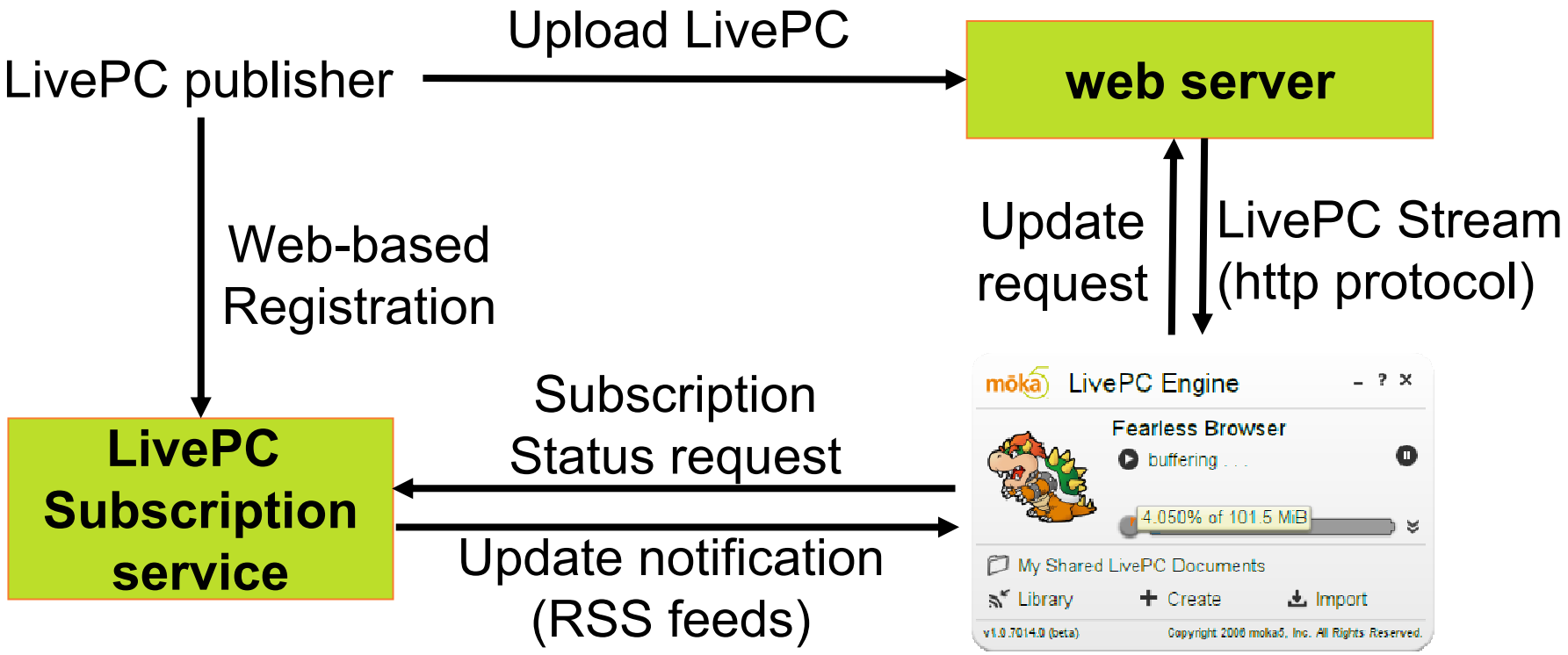
06

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

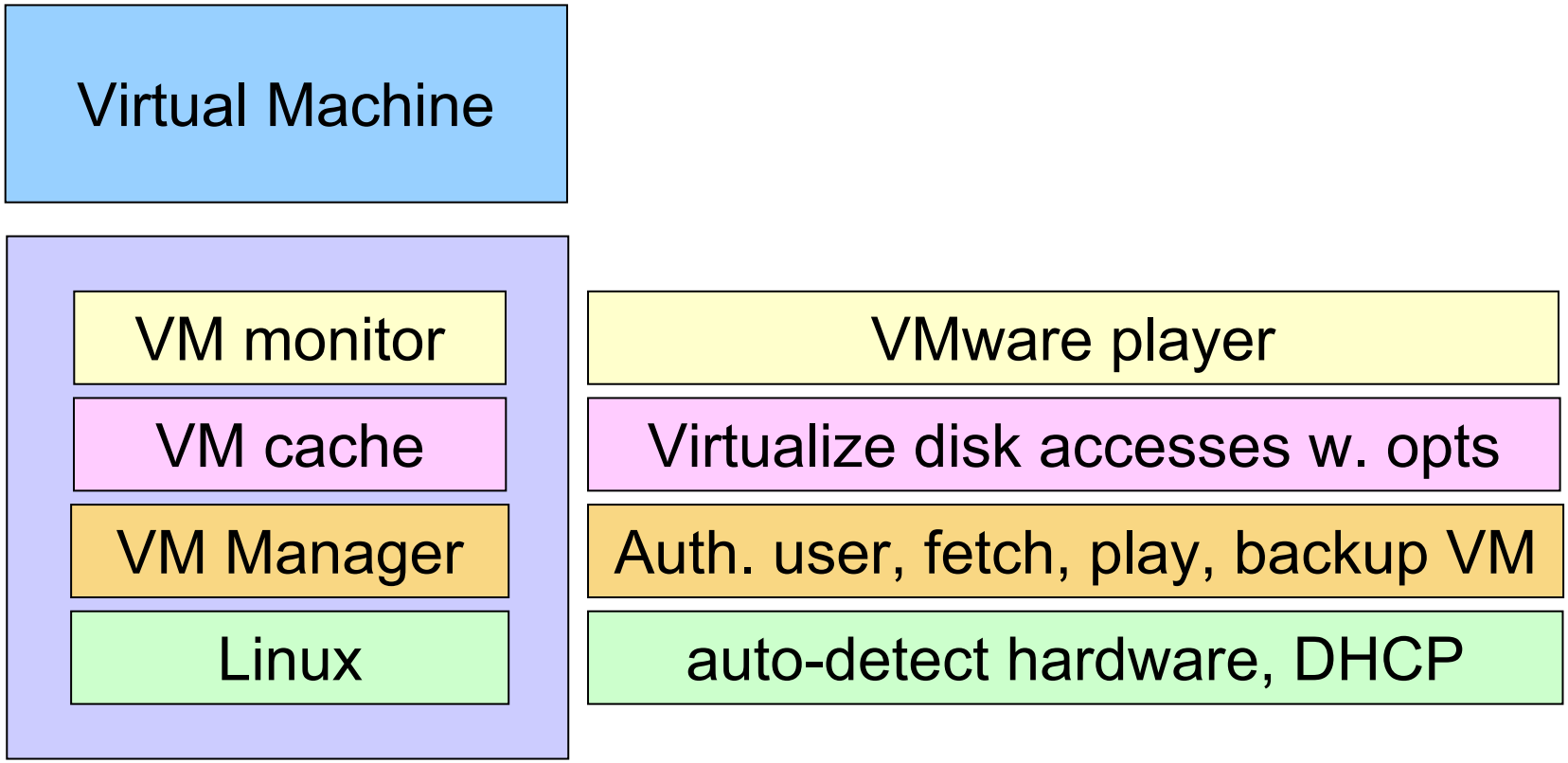
05

7. Community Portal: self service



[www.moka5.com]

LivePC Engine (Baremetal Ed.)



[The Collective: A Cache-Based System Management Architecture, Chandra, Zeldovich, Sapuntzakis, Lam, NSDI 05]

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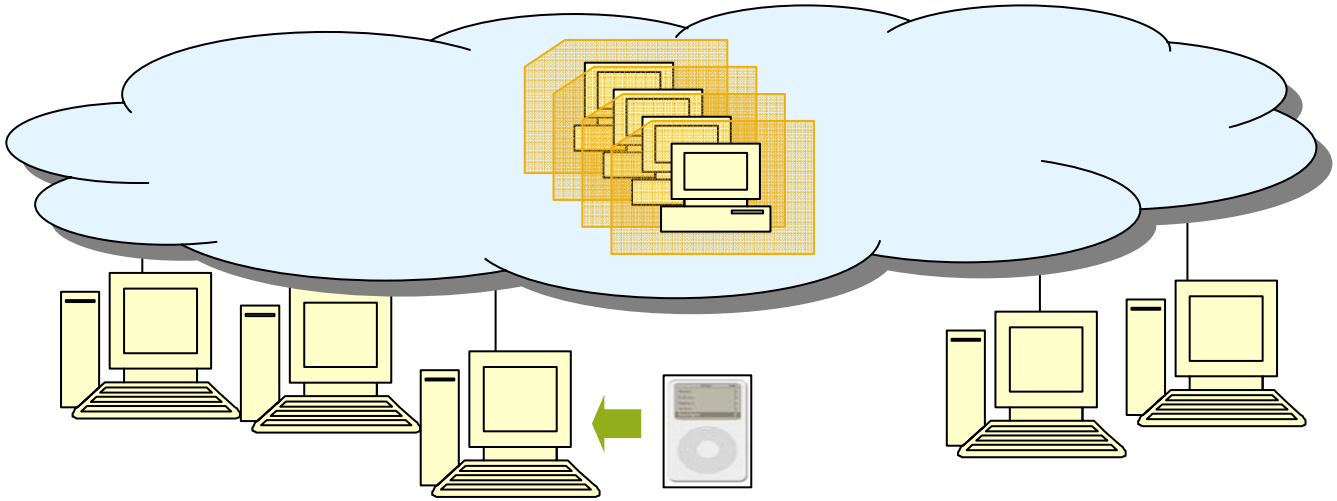
03

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**

[US Patent Application Number 11/007911]

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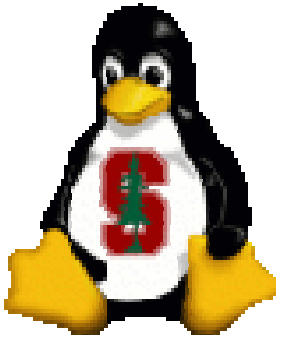
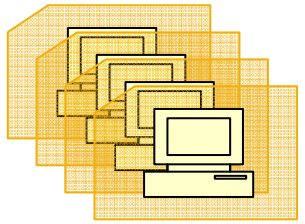
03

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]

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02

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]

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01

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]

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01

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]

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00

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 Ubiquitious Computing with Stateless Consoles and Computation Caches, Schmidt, Ph.D. Thesis, 2000]

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2. Virtualization of the OS level

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

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99

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

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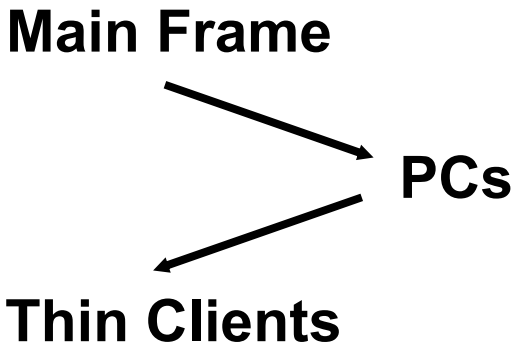
99 1. Sun Rays (Sun Labs)



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

[Interactive Performance of SLIM: A Stateless Thin-Client Architecture. Schmidt, Lam, Northcutt, SOSP, 99.]

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07

moka5 at Consumer Electronics Show

98
06

High-Level Milestones

1998	Sun Rays: Sun Labs
1999	
2000	
2001	Collective: NSF $3M grant to Stanford
2002	
2003	
2004	
2005	LivePCs: moka5, venture-backed
2006	

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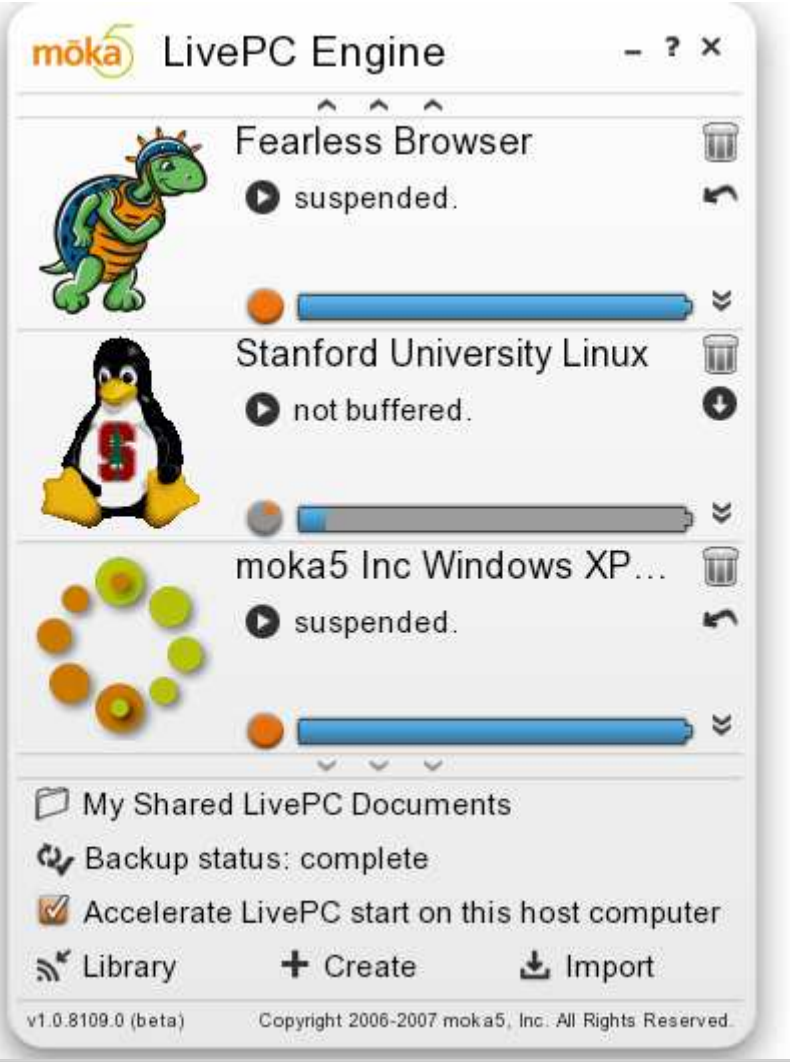
From Research To Product

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**

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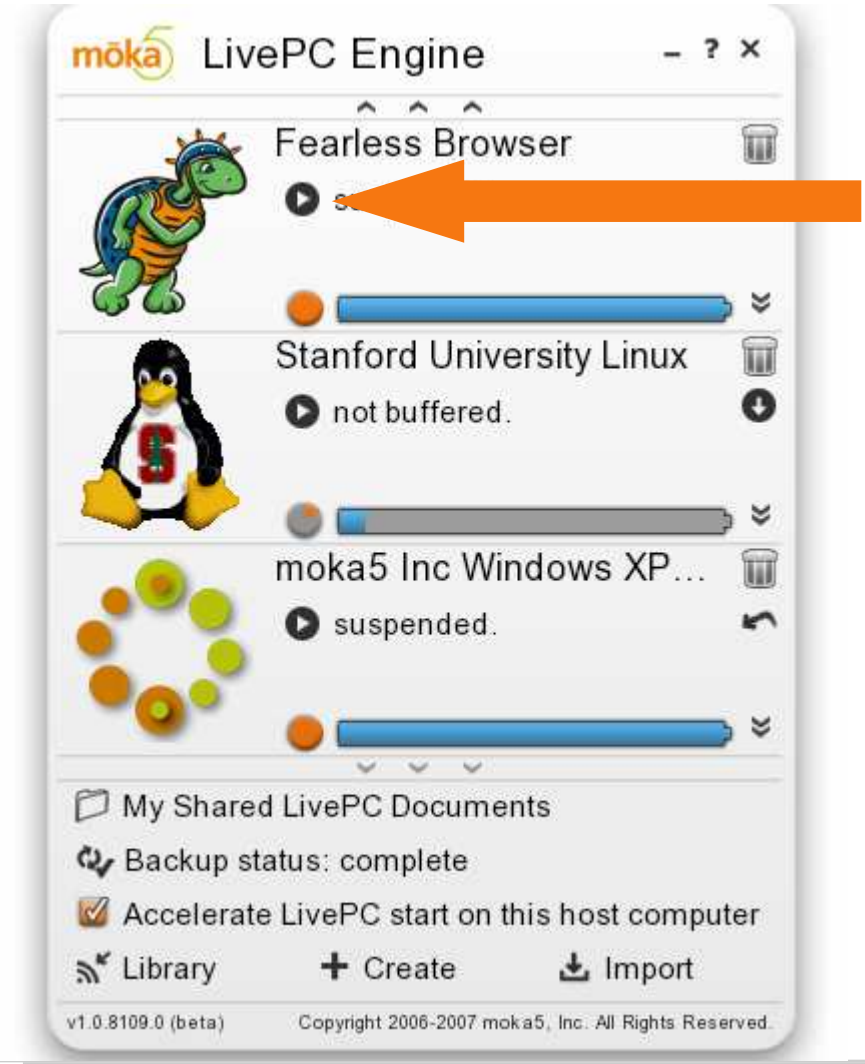
Play it on any Windows PC



Plug into Windows PC

Click "play"

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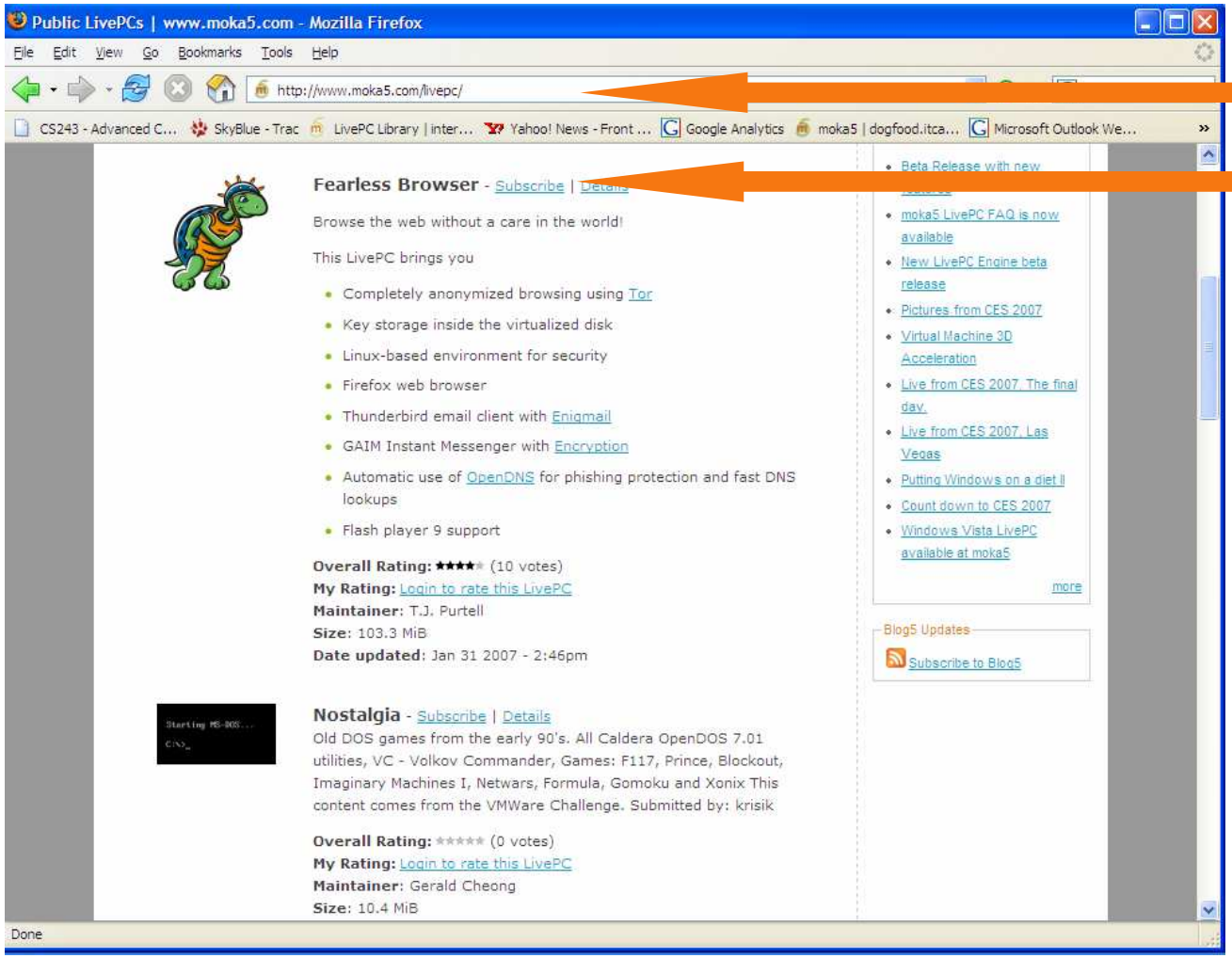
Like Watching TV: select your LivePC



www.moka5.com

Click "subscribe"

Choice of LivePCs:
OS + applications updated live

Peer sharing of LivePCs publicly or privately

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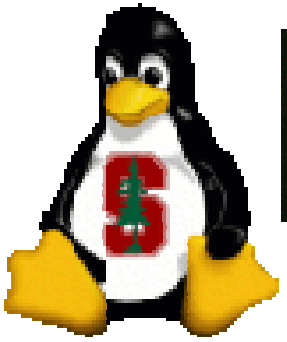
Demo

Part 2

Personal Digital Asset: Data + (Managed) x86 virtual machines



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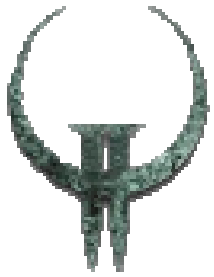

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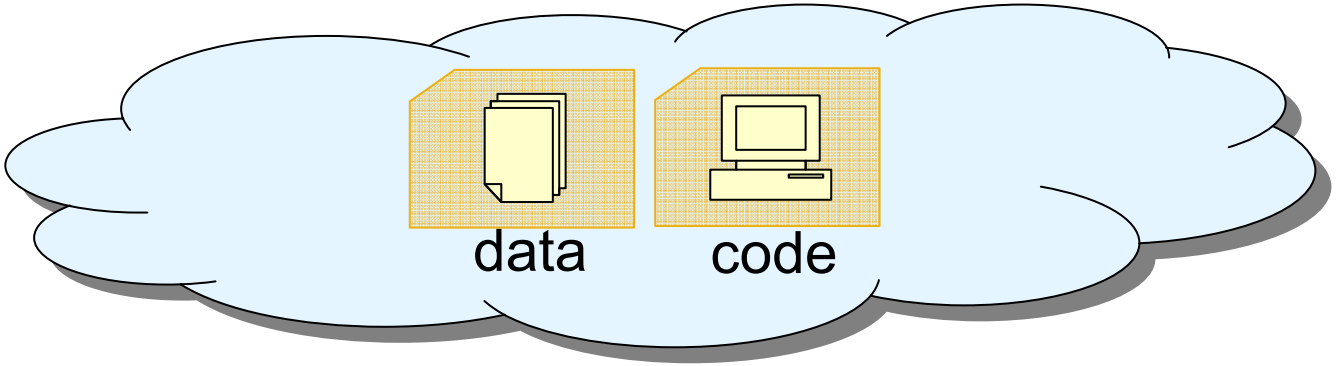
Digital Asset in the Cloud



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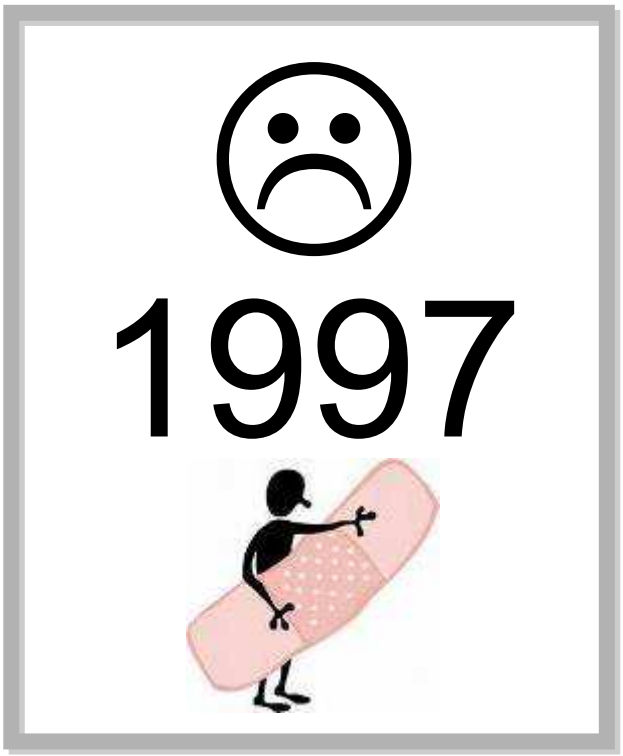
10-Year Research



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Company IT Nightmares

- Home computers infecting data centers
- Disasters
- Stolen data

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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

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Consumers ≠ System Admins

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

Need to commoditize system admin

PCs are unlike CEs

When a computer breaks,

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

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Part 1

Motivations

Consumerizing PCs

from research to product

Monica Lam
Stanford University
moka5, Inc.