



# 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](http://www.moka5.com)]

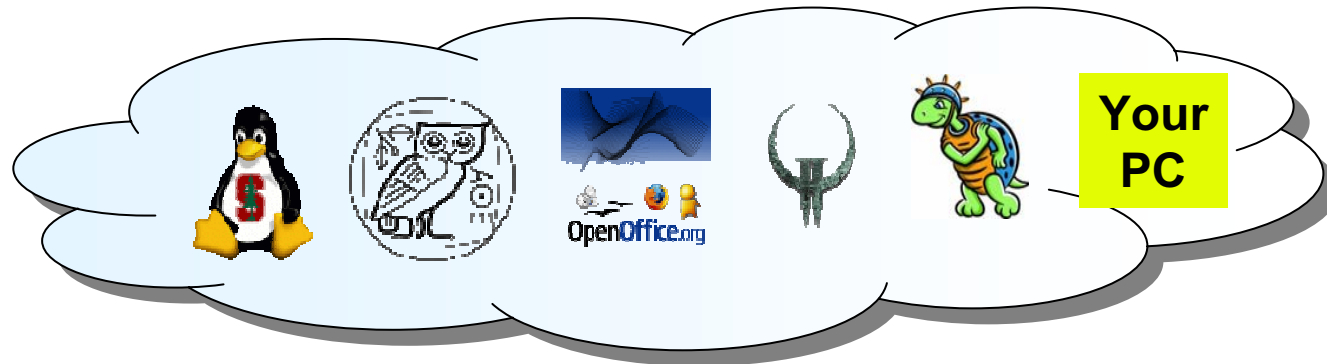




# Closing Thoughts

- “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)**

07

## 9. All-in-one USB controller

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

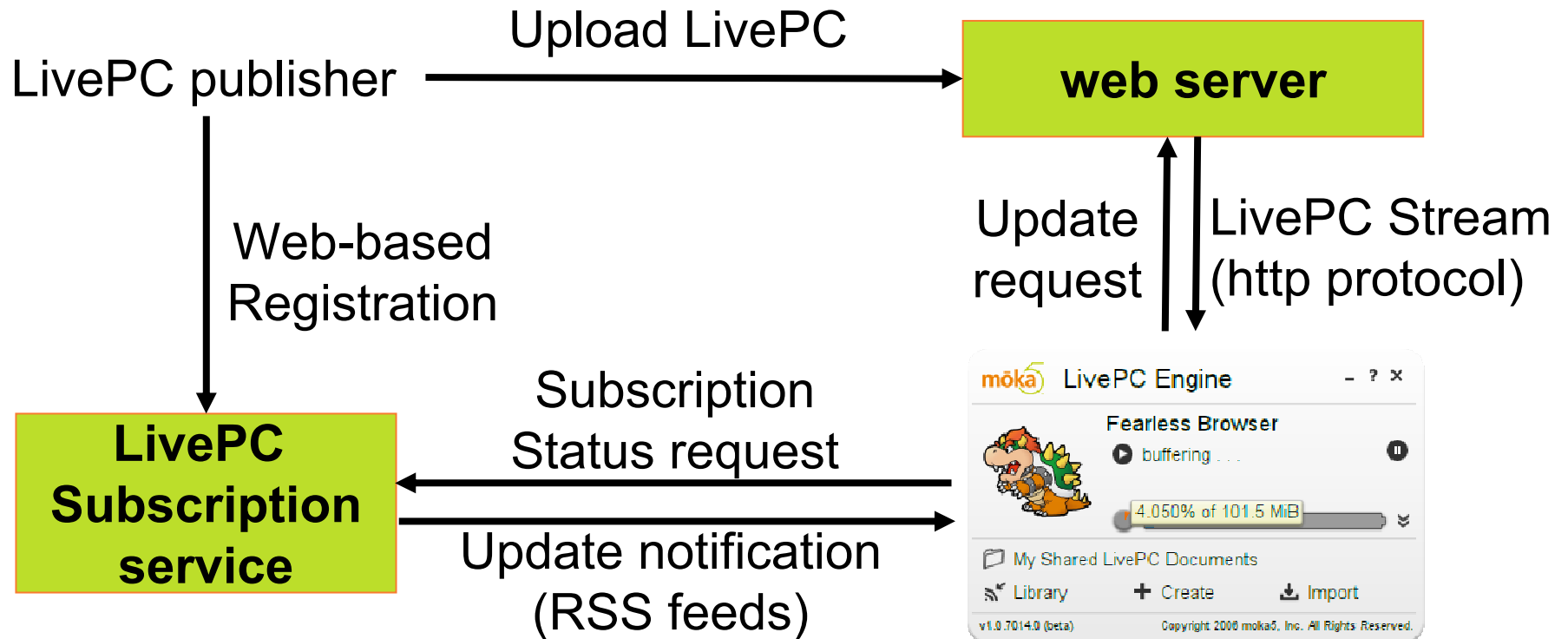


## 8. LivePC Engine: Windows app

- **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**

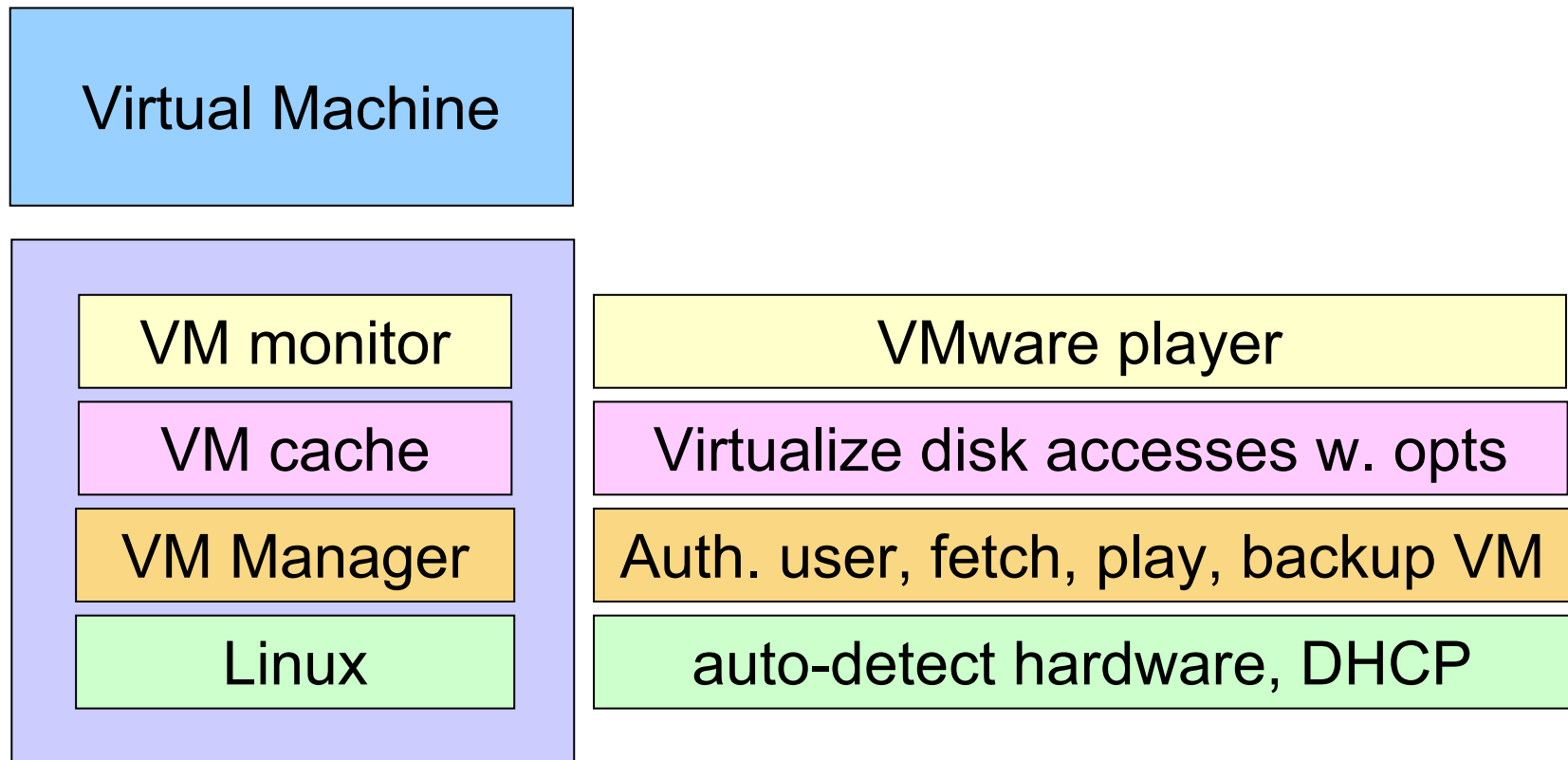
05

# 7. Community Portal: self service



[www.moka5.com]

# LivePC Engine (Baremetal Ed.)

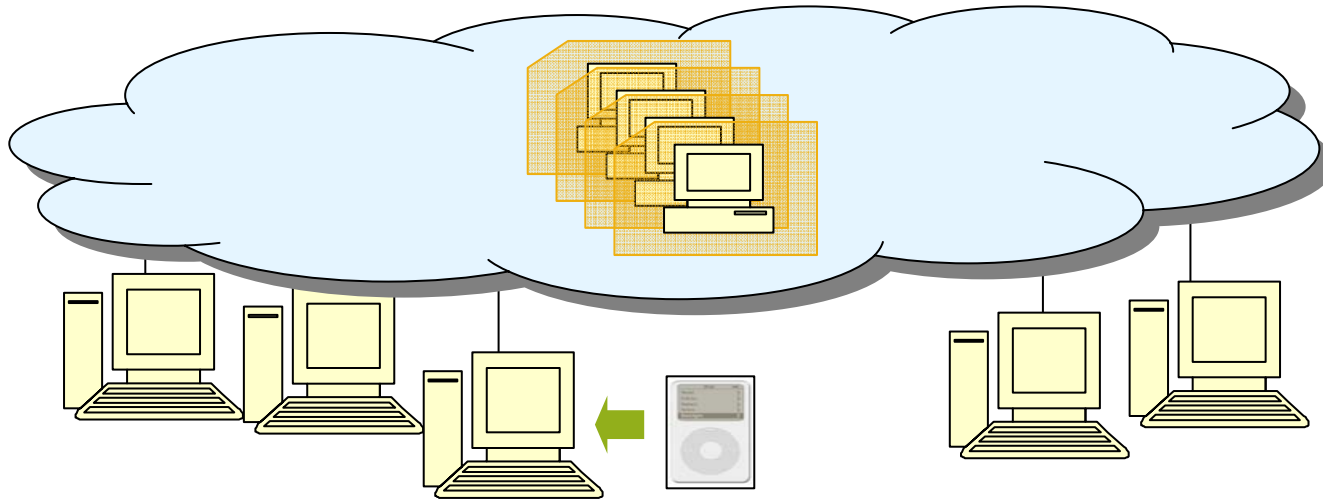


[The Collective: A Cache-Based System Management Architecture,  
Chandra, Zeldovich, Sapuntzakis, Lam, NSDI 05]

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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**

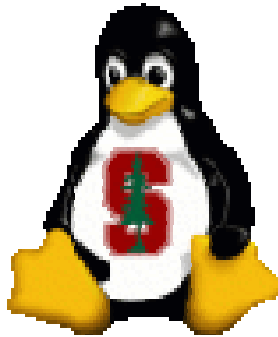
[US Patent Application Number 11/007911]

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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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## 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]

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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# 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]

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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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# Sun Rays (Sun Labs)

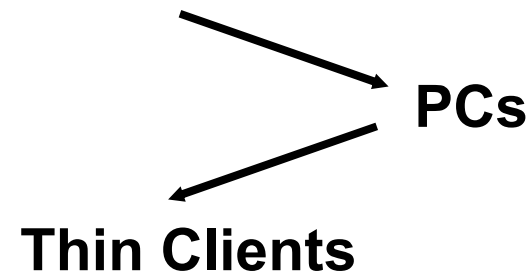
- ✓ **Central management, central execution**
- ✓ **Smart card enables instant access across Sun Rays**
- ✗ **Poor interactive performance over WAN**
- ✗ **No disconnected operation**
- ✗ **Single point of failure**
- ✗ **Data center: expensive, hard to scale**
- ✗ **Cost of thin-client similar to PCs**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

99

# 1. Sun Rays (Sun Labs)



Main Frame



- **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**

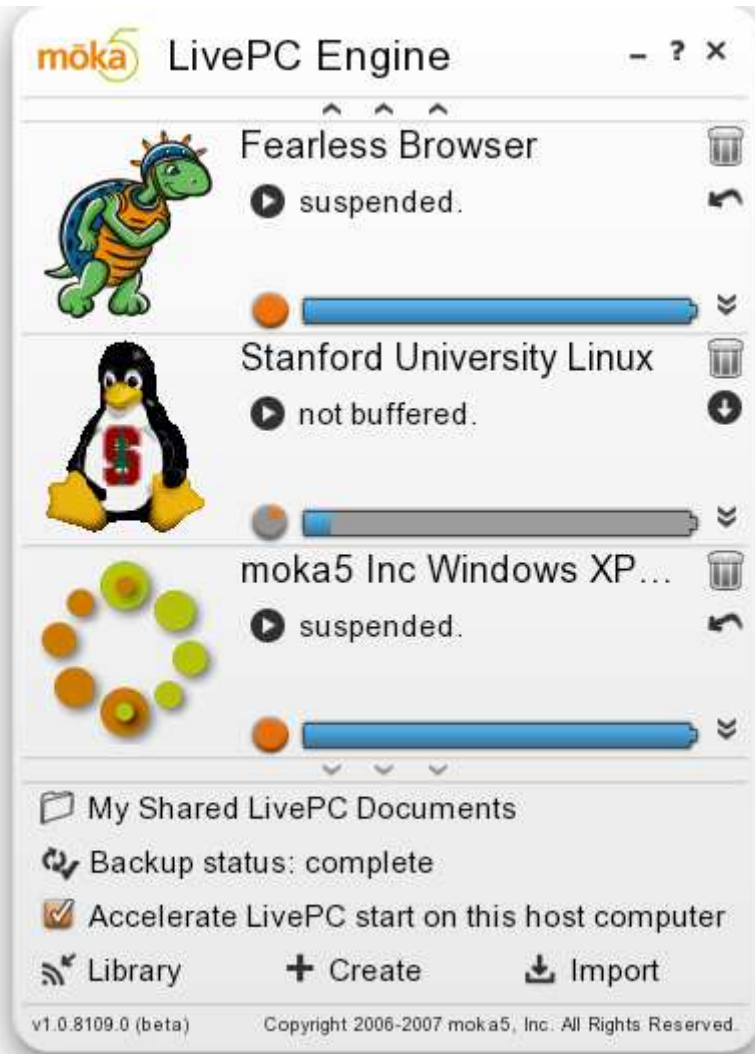
**2006**

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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

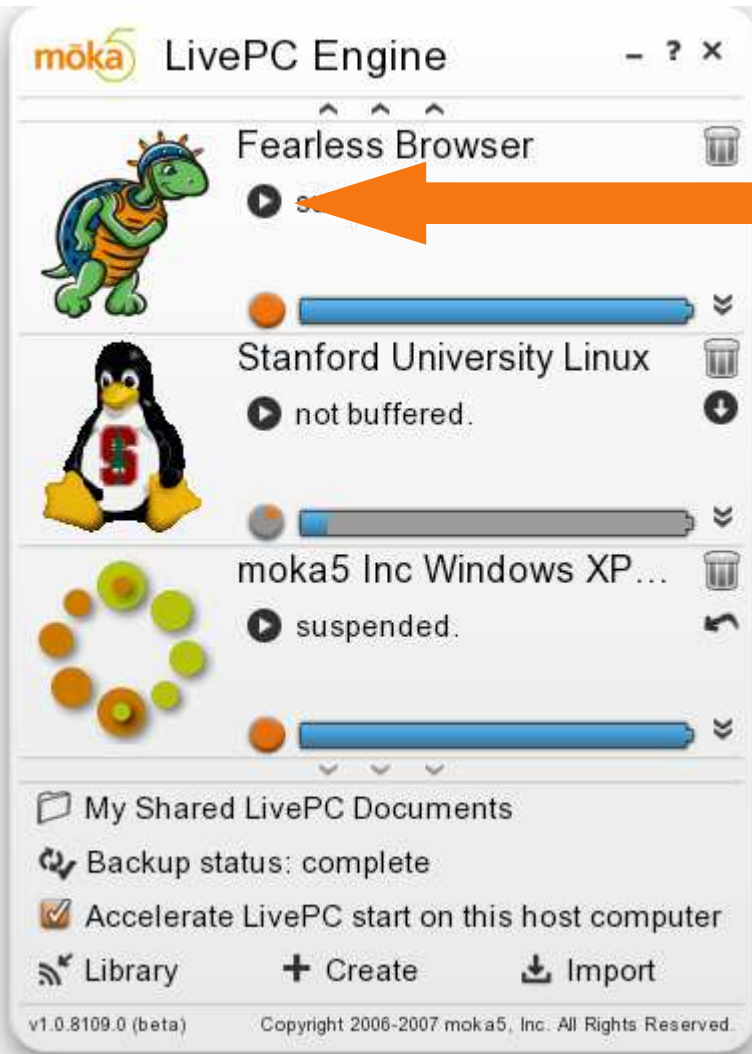
### Private:

Leaves nothing on the host

Takes nothing away

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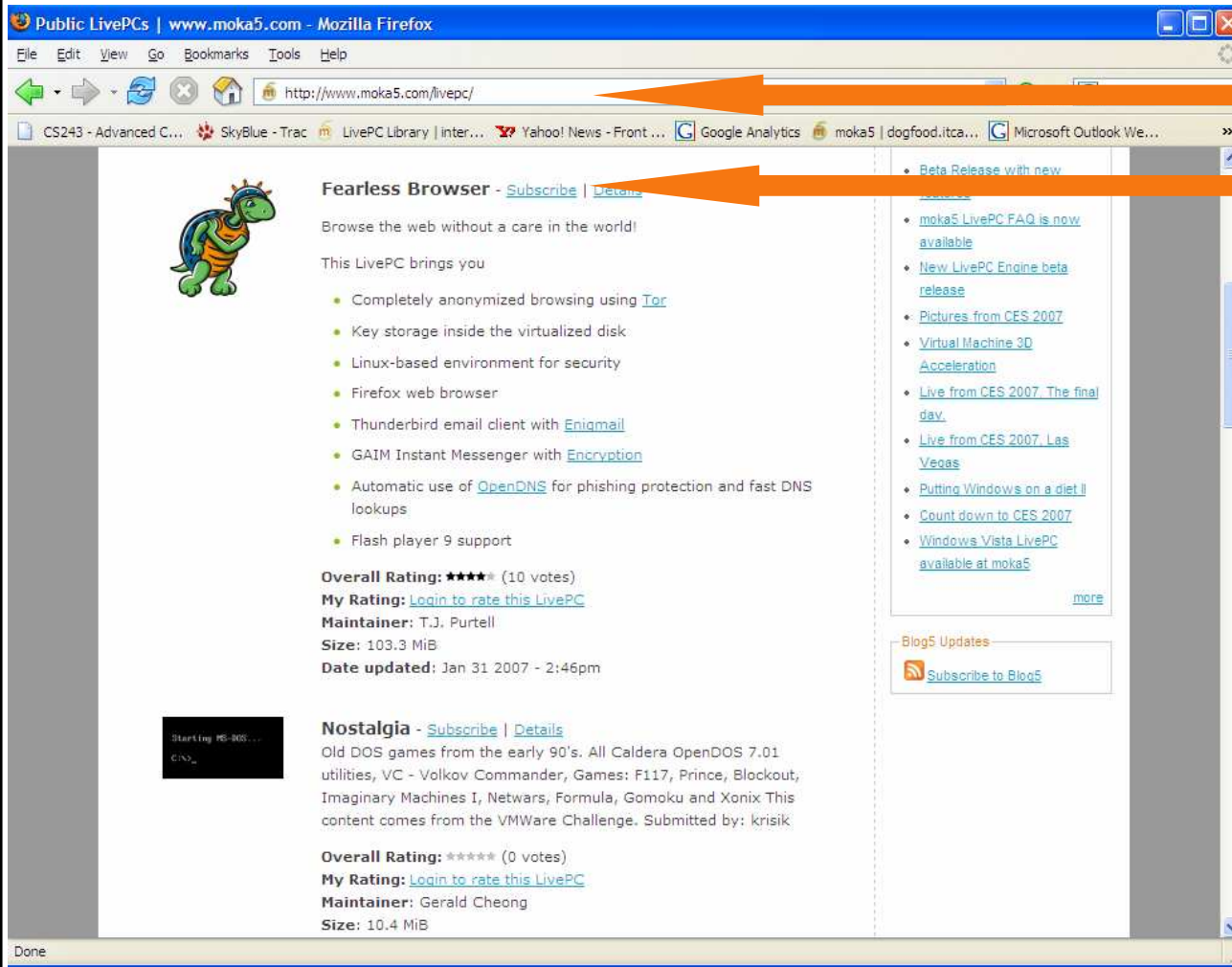
# Play it on any Windows PC



*Plug into Windows PC*  
*Click "play"*

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# Like Watching TV: select your LivePC



The screenshot shows a Mozilla Firefox browser window at the URL <http://www.moka5.com/livepc/>. The page displays two LivePC listings:

- Fearless Browser**: A LivePC for browsing the web without a care in the world. It features a completely anonymized browsing environment using Tor, key storage inside the virtualized disk, a Linux-based environment for security, Firefox web browser, Thunderbird email client with Enigmail, GAIM Instant Messenger with Encryption, automatic use of OpenDNS for phishing protection and fast DNS lookups, and Flash player 9 support. It has an overall rating of 4 stars (10 votes) and was updated on Jan 31 2007.
- Nostalgia**: A LivePC for playing old DOS games from the early 90's. It includes utilities, VC - Volkov Commander, and various games like F117, Prince, Blockout, Imaginary Machines I, Netwars, Formula, Gomoku, and Xonix. It has an overall rating of 5 stars (0 votes) and is 10.4 MiB in size.

Navigation arrows point to the address bar and the 'Subscribe' link for the Fearless Browser.

[www.moka5.com](http://www.moka5.com)

Click "subscribe"

Choice of LivePCs:  
OS + applications  
updated live

Peer sharing of LivePCs  
publicly or privately

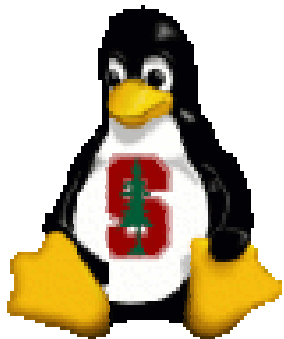
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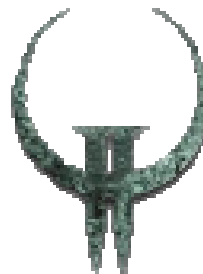
**Demo**

**Part 2**

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

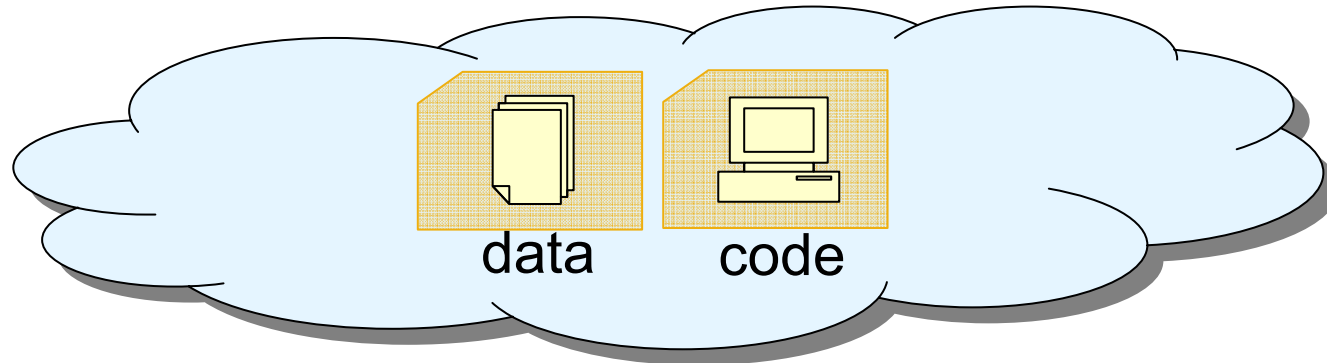


bd db db



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# Digital Asset in the Cloud



**Digital ID/cache  
unlocks asset  
in the cloud**



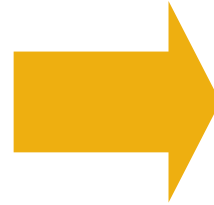
**Carry/access  
everywhere  
(network accelerator)**



**Borrow any PC  
(300M units)**

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# 10-Year Research





# 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 $\neq$ 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**



# PCs are unlike CEs

**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.

