Mobile & Secure End-Point Computing with Managed Virtual Machines

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Pressing Problems

Consumerization of IT: Using home computers

- Viruses on home computers attacking the data center
  - May test for existence of virus scanners
  - How to test if virus scanners are disabled?
  - How to test for absence of malware?
- Difficulty in managing home computers
- Choice of PCs: Windows, Macs

Other Pressing Problems

Road Warriors: data leakage

- Stolen laptops with unencrypted data
- Reading email at kiosks and leaving a footprint

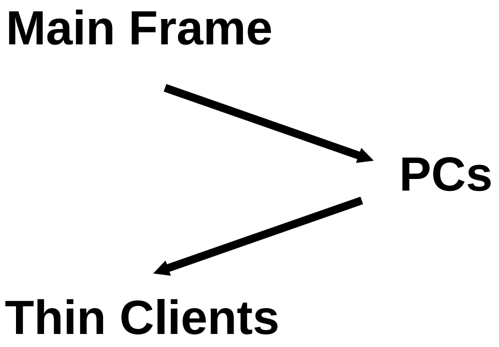
Disaster recovery

- Failed laptops on the road
- New office set ups after man-made/natural disasters

Zero-day vulnerabilities

- Detecting and recovering from rootkit attacks

Central Management: Sun Rays



- 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.]

Sun Ray: Advantages and Disadvantages

- ✓ **Central management**
- ✓ **Mobility: Smart cards enable instant access**

- ✗ **Dependence on the network**
  - ✗ Poor interactive performance over WAN
  - ✗ No offline operation
- ✗ **Does not leverage PCs: TCO, user experience**
  - ✗ Cost of thin clients similar to PCs
  - ✗ Data center: expensive, hard to scale
  - ✗ Single point of failure
  - ✗ Unwillingness to give up on the flexibility of PCs
- ✗ **No peripherals**
- ✗ **Management centralized but not solved**
- ✗ **Solaris → Citrix terminal server, not all Windows apps**

Virtual Desktop Infrastructure (VDI)

Run X86 virtual machines in the data center

- Windows, Vista, Linux
- VMware virtual machine monitor

Remote display on clients' desks

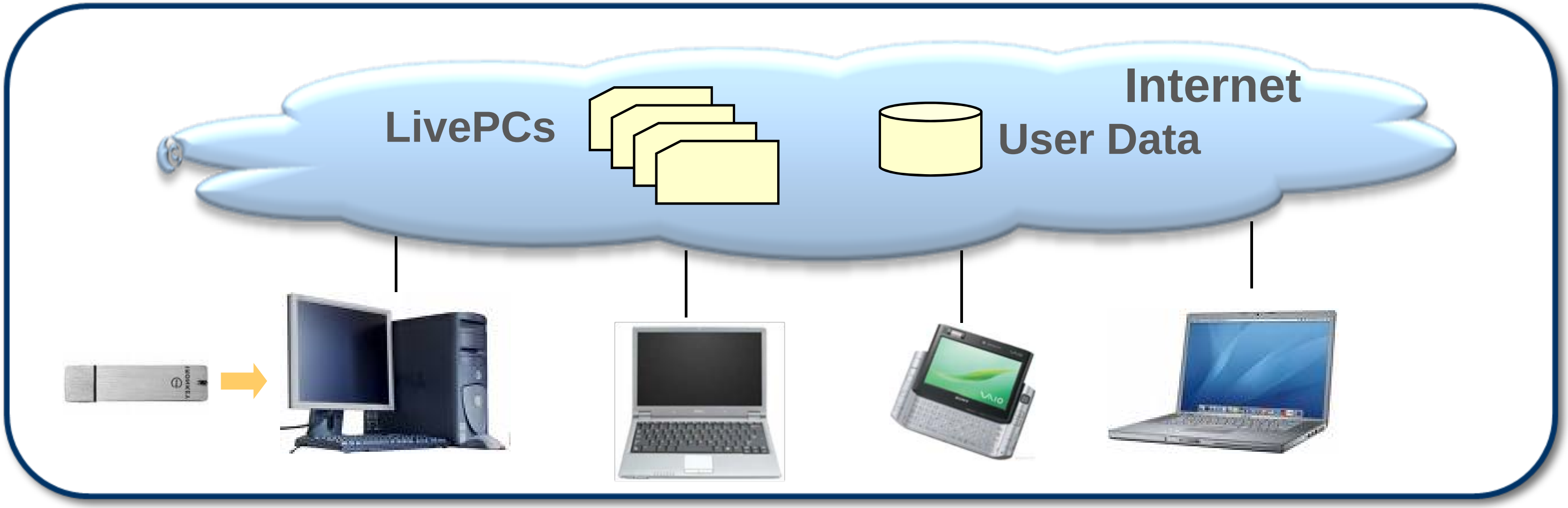
[NSF Research Grant #0121481, Lam, Rosenblum, Boneh 2001]

VDI Advantages and Disadvantages

✓Runs all legacy software

✗ Disadvantages of centralized computation
  - ✗ Higher total cost of ownership: 8 users to a server?
  - ✗ Miss out on “killer micro” advantage
  - ✗ Overhead of both virtualization and remote display
  - ✗ Management of many virtual machines

The Stanford Collective Project → Moka5 LivePCs



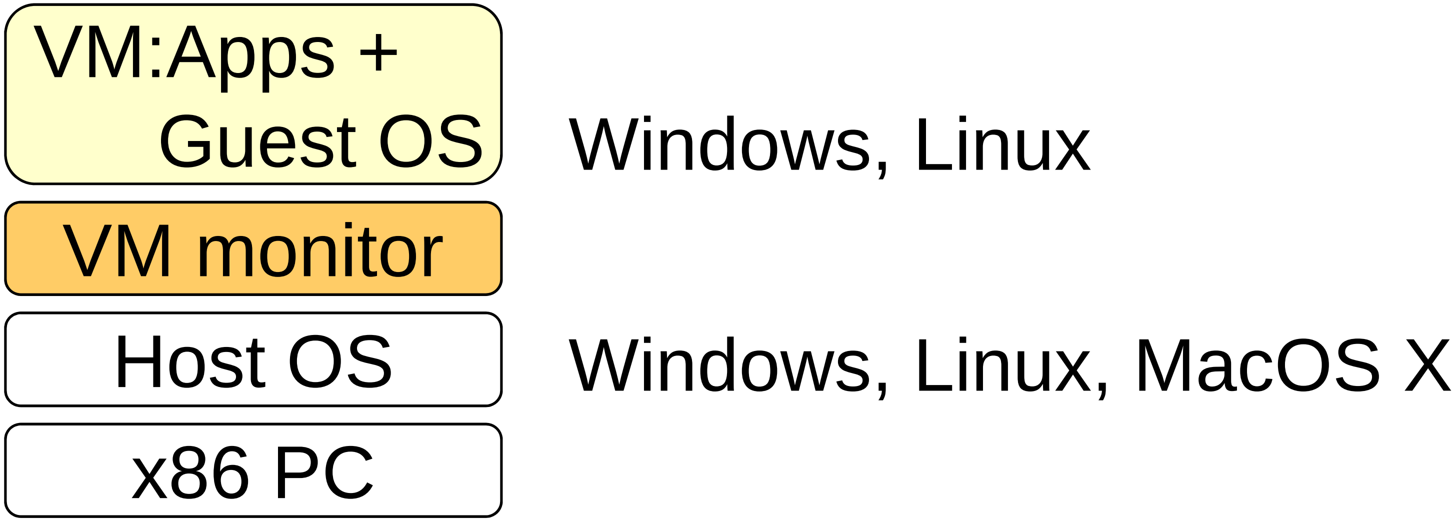
LivePCs: Managed virtual machines in the cloud

PCs (Windows, Linux, Mac PC) become generic platforms

Portable flash: personalized cache as a network accelerator

- Supports disconnected operation

X86 Machine Virtualization



VM:Apps + Guest OS

Windows, Linux

VM monitor

Host OS

Windows, Linux, MacOS X

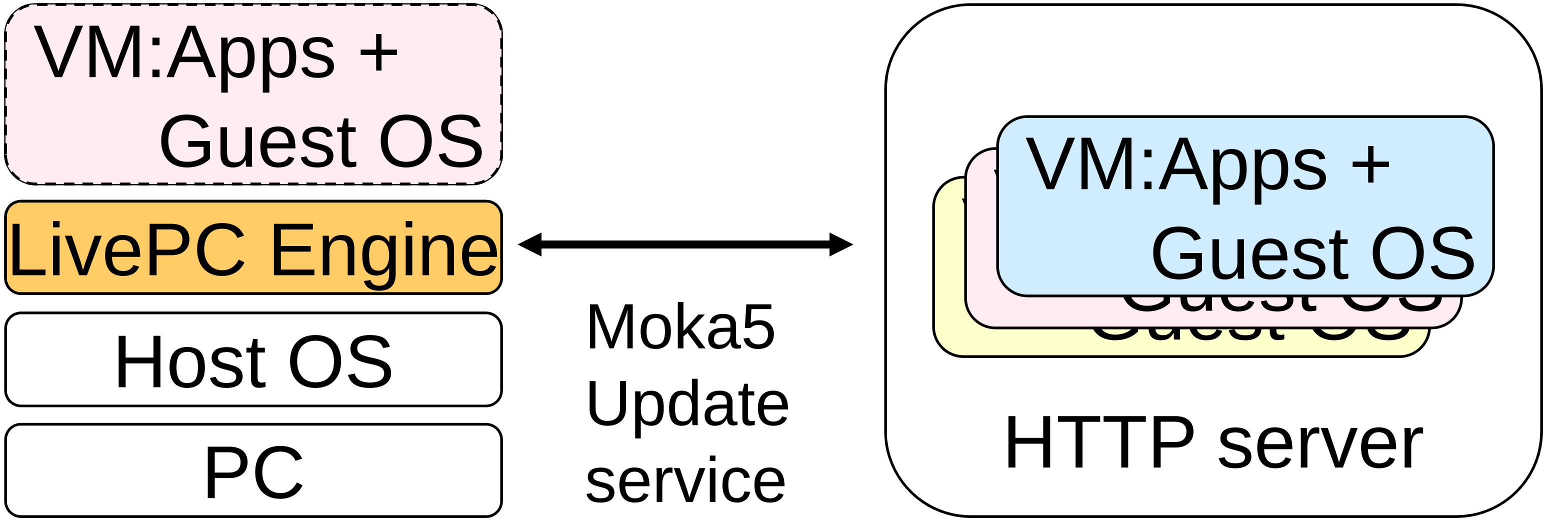
x86 PC

VM Monitor

A guest OS can run on a host OS like an app

Runs all x86 software w/o modification

LivePC Engine



LivePC: Managed virtual machines

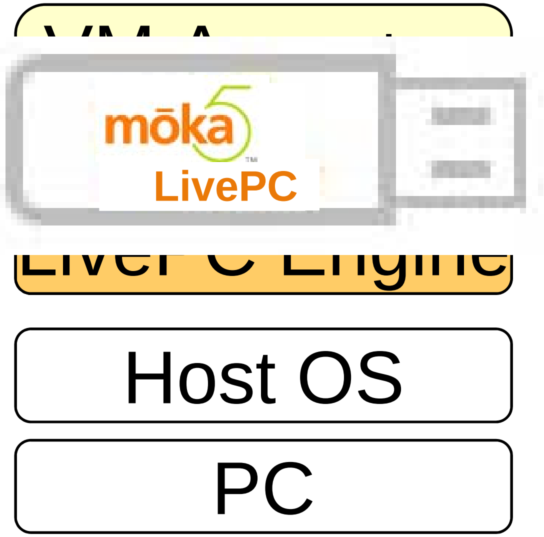
LivePC Engine:

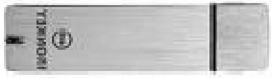
- Runs latest VM image on local machine
- Streams, caches, prefetches incremental changes on server

Network connectivity needed just for deployment/updates

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

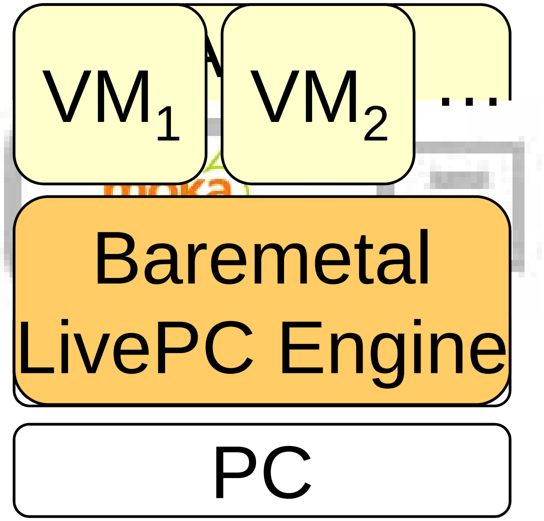
Portable LivePC Engine





Flash memory:
$1/GB in 4 years

Baremetal LivePC Engine (+ Portability)



Baremetal LivePC Engine

- Closed custom Linux build
- LivePC Engine

Runs choice of VM on demand

Streams LivePCs dynamically

Not subjected to keyloggers

More secure

Demo

3 Scenarios

- Remote administration on unmanaged machines
- Mobility with a USB drive
- Managing (distributed) computer facilities

1. Unmanaged Machines: Management

LivePCs: Quick & easy deployment & management

- Imaging
  - Virtual image works across devices (including Macs)
  - One-click publish/subscribe
- Automatic updates
  - Easy to roll out/roll back software and security patches
- Scalable, deterministic: 1000s of users per server
  - Example: SP2 update
- Works on Windows and Macs

[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]

1. Unmanaged Machines: Security

Isolation and control

- Home computer viruses isolated
- Guaranteed configuration
- Baremetal eliminates the possibility of keylogging

Rejuvenation: outside-the-box solution

- Only solution that guarantees to remove all rootkits
- Rejuvenation incurs no additional delay.

2. Mobility

Auto-install on Windows

- Administration privilege needed for first execution
- Same USB works on Windows and Macs
  (Macs need fusion)

Data protection

- Leaves no personal data behind
- Takes nothing away
- Hardware-provided security
  - Ironkey: hardware encryption
  - Biometric USB drives

One-click recovery on a new drive

Baremetal avoids keyloggers

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

3. Managing Facilities

Supports dynamic provisioning across machines

- Hoteling: training, call centers, classroom labs, conference computers
- Distributed branch offices

Isolated user-supplied environments

- Isolation between user and host platform
- Kiosks, hotel business centers, guest rooms

Summary

LivePCs: a new platform that supports

- Management
- Security
- Mobility

www.moka5.com:

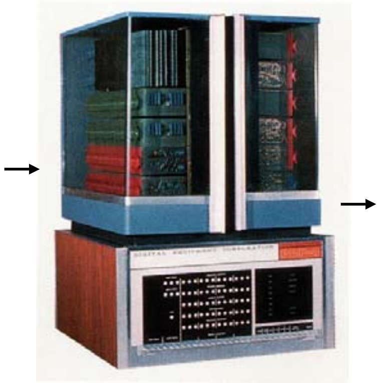
- A library of community contributed LivePCs

Computer Revolution

mainframe

→

mini



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workstation

→

PC

→

laptop

→

phone