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FREEDOM COMPUTING™

Beyond VDI: Why Thin-Client Computing and Virtual Desktop Infrastructures Aren't Cutting it

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Desktop Virtualization: Road to Discovery

DATE	INSTITUTION	CONCEPTS
1999	**w. Sun Labs**	**Sun Rays**
2000		
2001	**Stanford**	**Collective Computing Utility (VDI)** ($3M, NSF)
2002		
2003		**Virtual Appliances for Deploying & Managing Software** (LISA 2003)
2004		
2005	**MokaFive**	**LivePCs: (**$3M, Vinod Khosla)
2006	**MokaFive**	**LivePC Lab:** ($15M, Highland Capital, Khosla)
2007		
2008	**MokaFive**	**DaaS Desktop-as-a-Service Platform**
	Stanford	**POMI 2020: Programmable Open Mobile Internet** ($10M from NSF)

1999: Central Management & Mobility with Sun Rays

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

2000: OS Virtualization

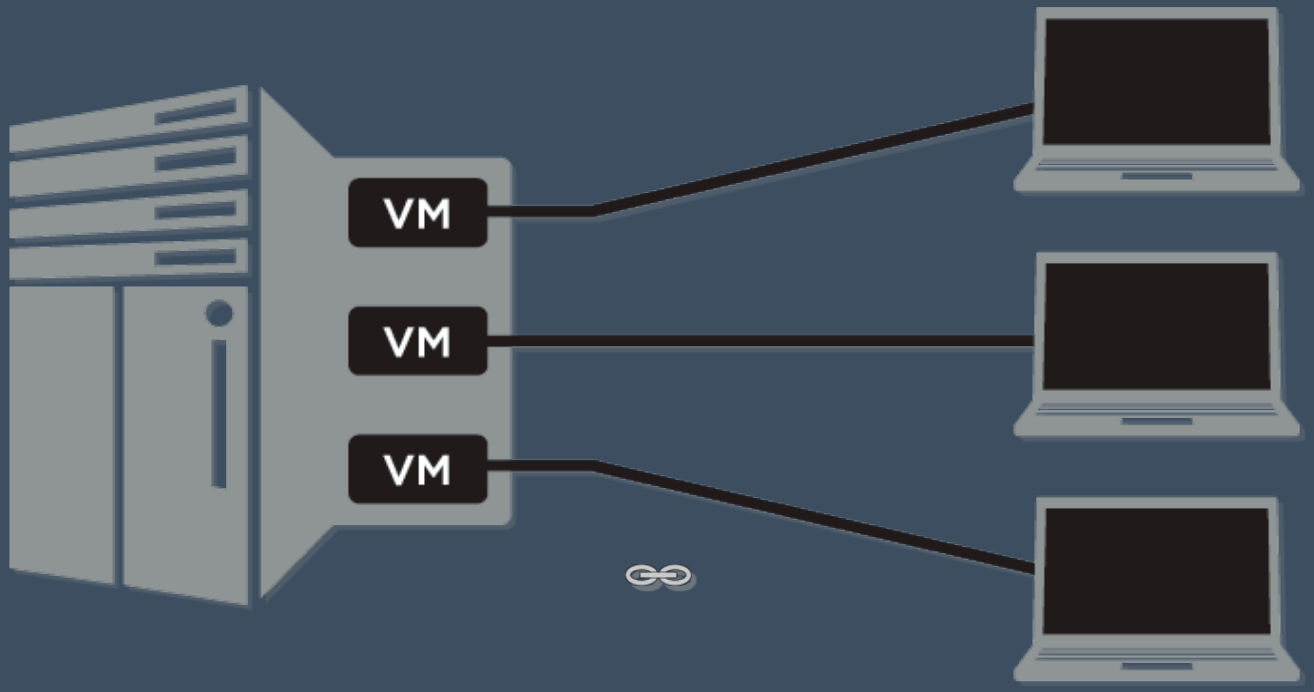
Inspired:

- Linux Zap ['02]
- Solaris Zones ['04]

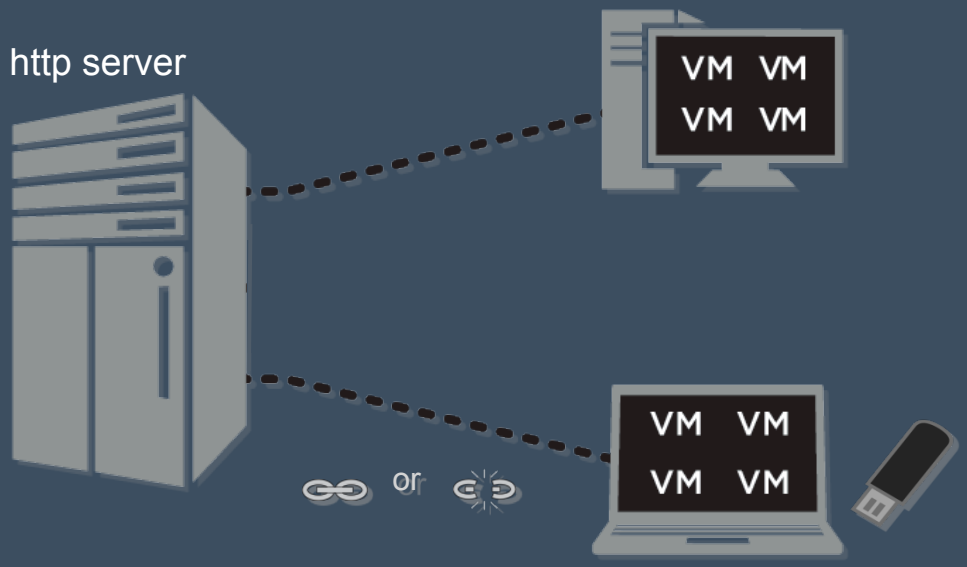
Microsoft Windows in the future?

Supporting Ubiquitous Computing with Stateless Consoles & Computation Caches. Schmidt, Stanford Ph.D. Thesis, 2000

2001: Virtual Desktop Infrastructure



2003: LivePCs

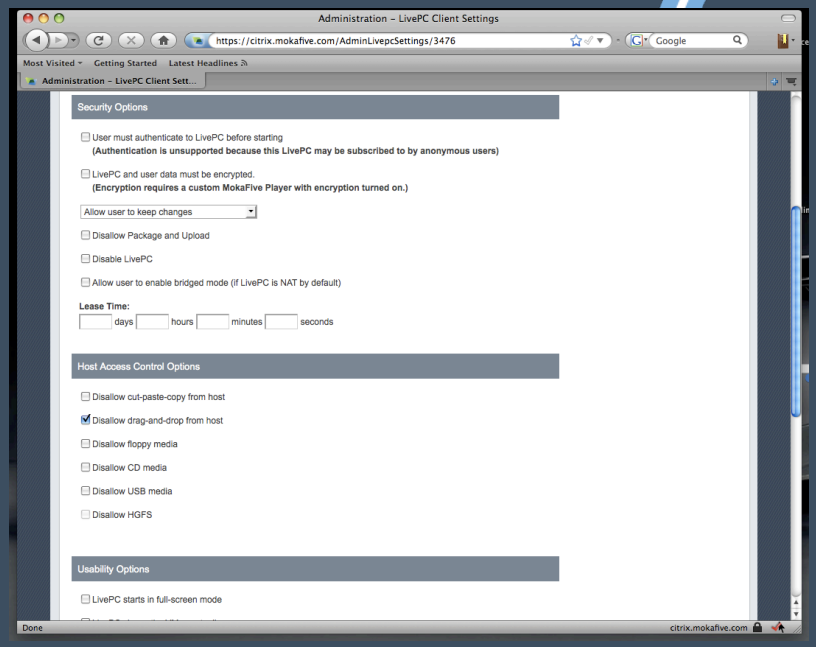


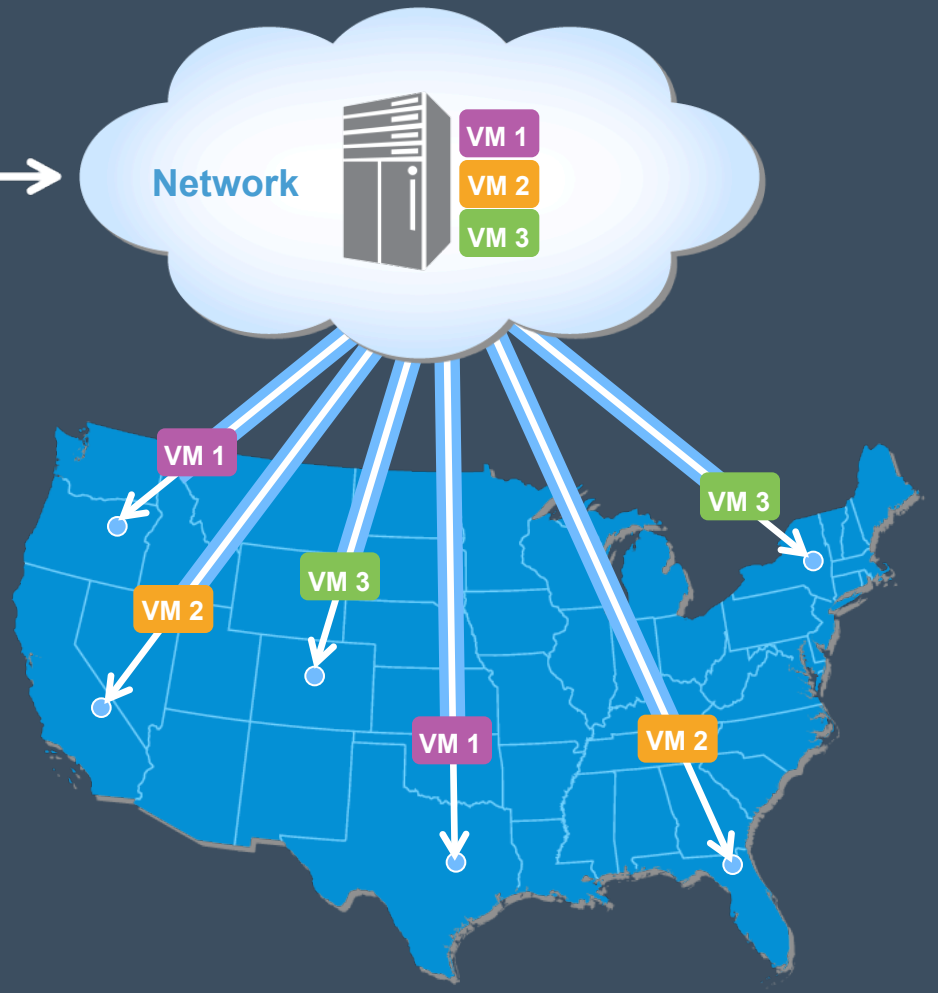
- LivePCs = Secure, managed VM images in the cloud
- PCs (Windows, Linux, Mac PC) are generic platforms
- USB flash: personalized cache as a network accelerator
  - Supports disconnected operation

The Collective: A Cache-Based System Management Architecture,
US Patent, Lam et al, 2003 & NSDI, 2005

LivePC Creator/Player

MokaFive Professional DaaS





Top Three Myths Around VDI

3. Thin-client computing reduces the hardware cost

Cost of End-Point Hardware

- Thin-client hardware: $300 + $60 a year (no monitor)
- PC: $499 (no monitor)
  - Intel Pentium Dual Core 1.86 GHz, 2GB M, 160 GB SATA drive
- Consumerization of PCs: $0
  - Let the employees use their own computers

Moving desktops to data centers?

- Server virtualization in data centers:
  - Consolidation reduces cost and energy
- Desktop virtualization in data centers?
  - Additional cost: data center operation
  - Servers: 4-10 users per processor (Terminal services: 40 users per OS)
  - Storage: 5GB per user
  - Energy; rent; labor

Cost of Server Operation

- The “Superbowl” effect
  - Must provision for the “important moment”
  - Superbowl for TV networks, final projects at school
  - 9 to 5 for companies?
- Redundancy to guard against a single-point of failure
  - Google docs (July 8, 2008: 45 minutes)
  - Amazon EC2 (July 20, 2008: 8 hours)
- Resource allocation and management among clusters

LivePCs: an http server can support thousands of users

Top Three Myths Around VDI

3. Thin-client computing reduces the hardware cost

2. Central management => centralized execution

Security and Management, commtouch, May 2008

- Number of active zombies per day: 10-15 millions
- Typical number of zombies in a single botnet: 10,000 – 200,000
- New zombies that come ‘alive’ every 24 hours: 200,000-500,000
- Typical Zombies Activities: Spam, phishing, malware, command & control, data theft, click fraud, DDoS
- Spam activity on the Internet accounted for by zombies:120 billion messages daily

Stealthy security breaches are harmful!

System Admin with Virtual Machines

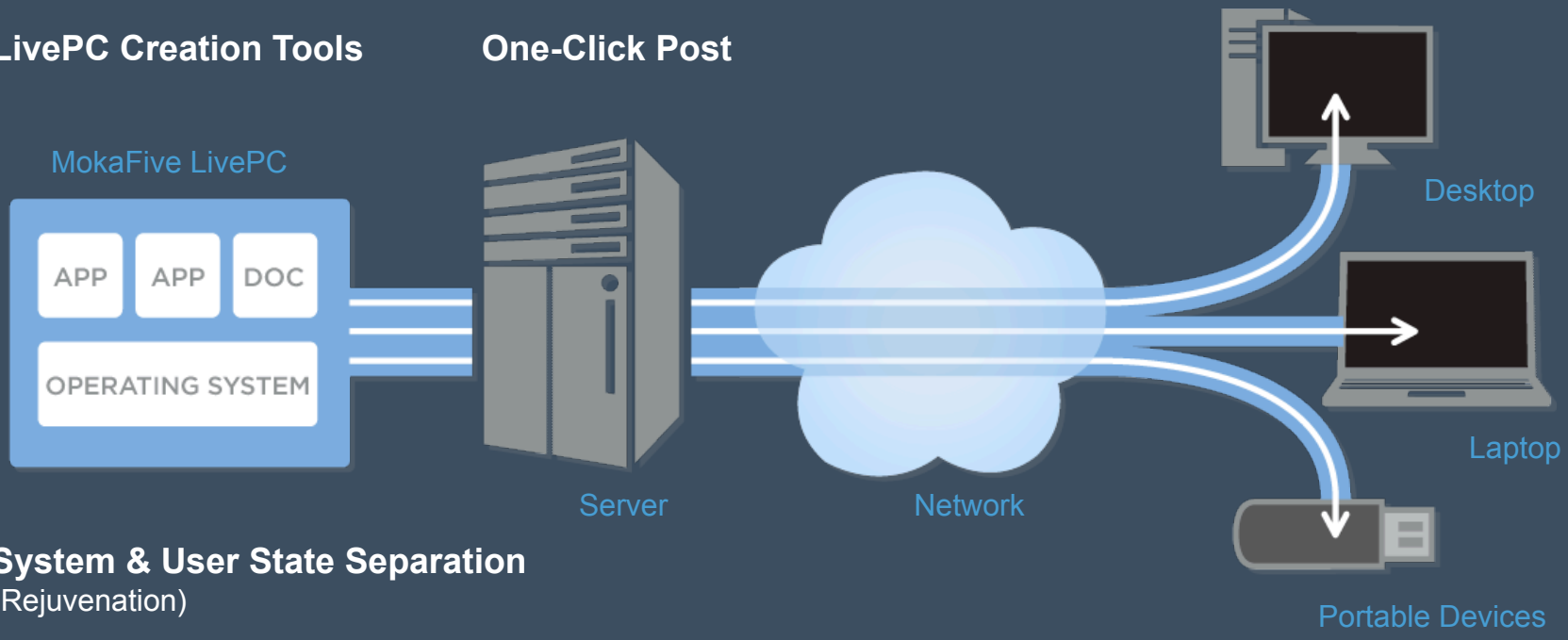
- VMs by themselves do not improve management
- VMs: complete machines “on a platter”
  - Virtual machines → holistic management
  - Virtual machines → outside-the-box security control
- Central management ≠> centralized execution
  - Physical security ≠ security

Administration Work Flow

Multi-Platform Support
Online and Offline Use (Cache-On-Go)
Faster Launch (Streaming & Predictive Fetch)

LivePC Creation Tools

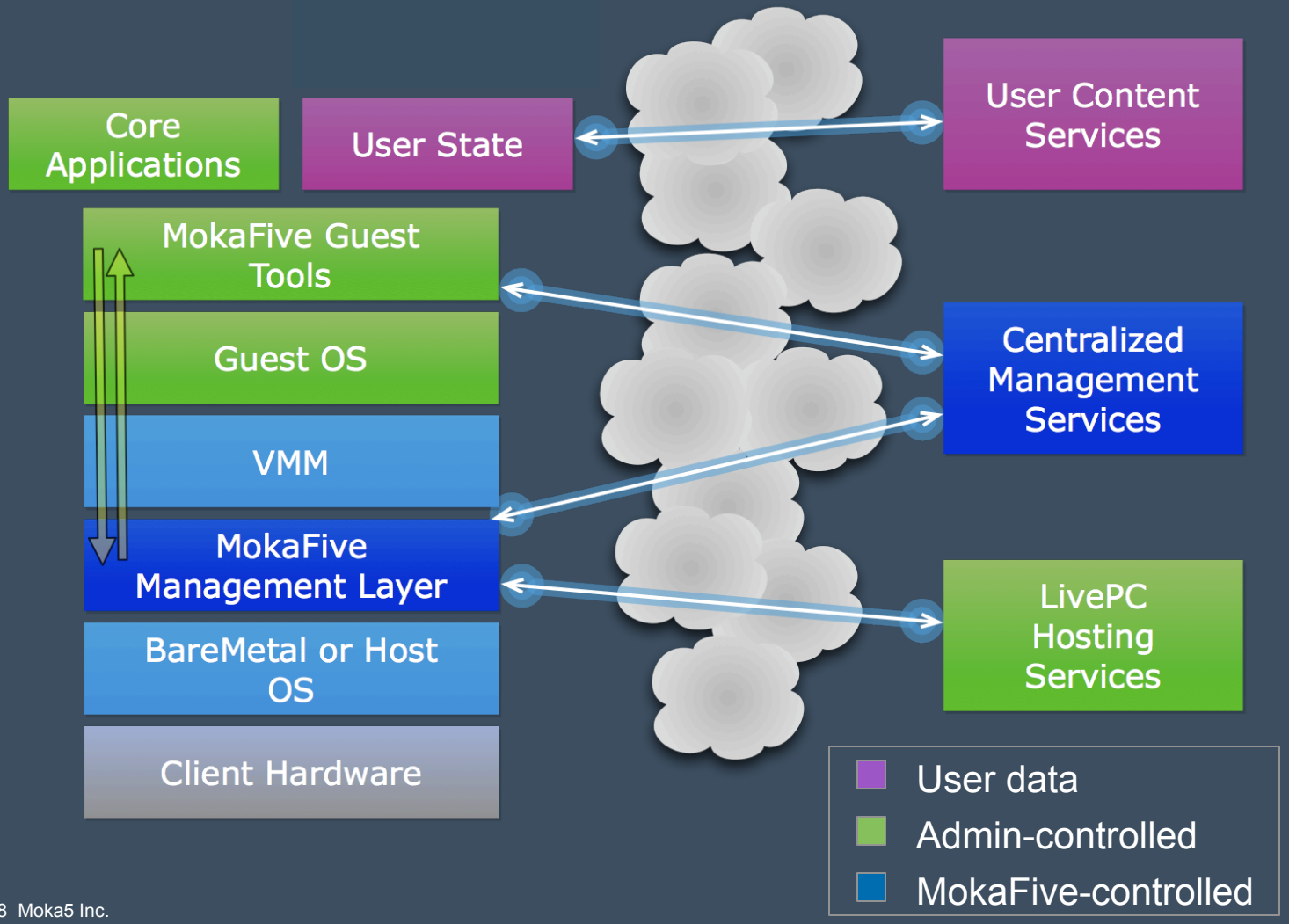
One-Click Post



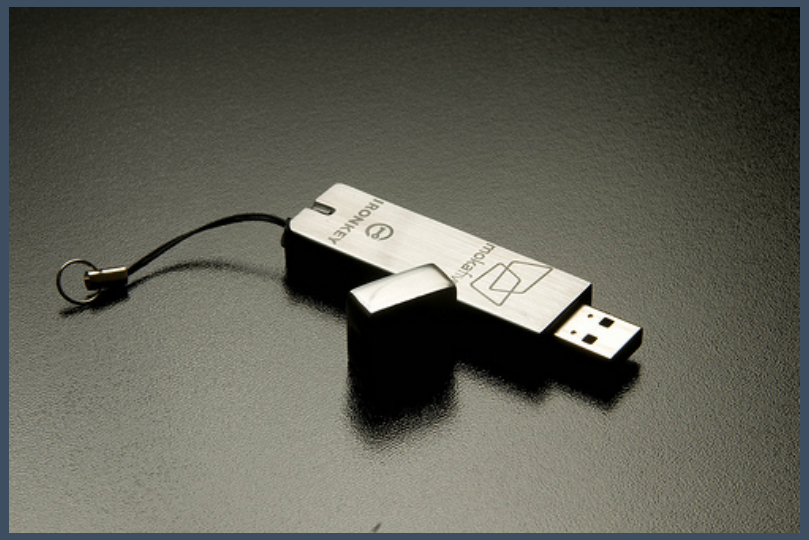
System & User State Separation
(Rejuvenation)

Automatic & Incremental Updates via RSS
(Slim Transfer & Auto Subscription)

MokaFive System Architecture



Securing the End Points with Encrypted Keys



- Hardware / software:
  - Encryption
  - Revocation
  - Self-destructs after 10 incorrect password guesses
- Hardware only:
  - Self-destructs if physically tampered

Holistic Management

Delivering a mirror of a golden image

Rejuvenate system disk by default

Incremental updates

- Image provisioning
- Software deployment
- Software updates
- Software rollback
- Lockdown
- New services (e.g. encryption)
- Revocation

Minimizing Virtual Image Sprawl

- A single virtual image for employees in the same dept
  - Running on different hardware
  - Different user states

Separation of System and User State

- User state customization:
  - a separate virtual disk for user state
- Machine customization
  - Domain join
  - Active Directory with group policy
  - Cached credentials
- Local environment customization
  - USB and network printer pass through

Outside-the-Box Security

- Quick patching
  - Only touched blocks that need to be fetched
  - Can recall patches easily if necessary
- Recover from zero-day vulnerabilities
  - Automatic rejuvenation
  - Viruses in the user state:
    Defense-in-depth; clean with new anti-virus/OS
- Only way to get rid of all root kit attacks
- Baremetal version – eliminates keylogging

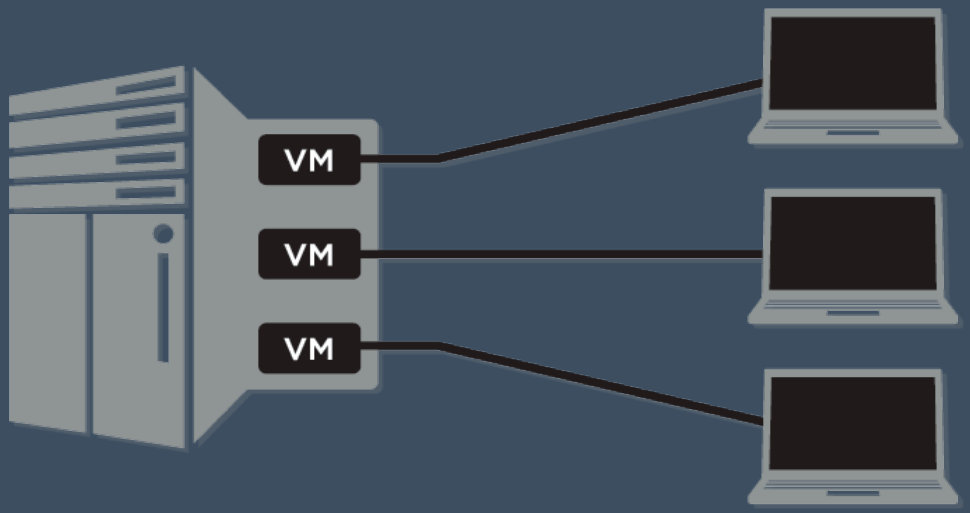
Top Three Myths Around VDI

3. Thin-client computing reduces the hardware cost

2. Central management => centralized execution

1. Central management => bad user experience

Overheads of Virtual Desktop Infrastructure



- VM
- Multiplexed VM
- Remote display

Main Frame to PC/Laptop Revolution

VDI is a Throw Back to Main Frame Days

- Allows occasional disconnection from the network
- Fast and cheap hardware
- Interactive applications
- 3D graphics: Google earth
- USB peripherals
- Personal Computer -- personal control: hw, applications

Question: Why Not?

MokaFive: “Eat your cake and have it too”

New Frontier: Security + Quality of Life

Security

Information leakage

- Data breach disclosure 12000 lost laptops per week in airports
- Encryption statutes
- SOX
- HIPPA
- IP

Foreign travel

Quality of Life

Portability

Platform of choice

- Macs, EEEPC

Personalization

Performance

Green initiative

- Work from home

Corporate LivePCs on Consumer PCs

Use Cases

- Business: HR staff's home access to employee data
  Disaster recovery: a backup PC in your pocket
- HMO: Patient data access in clinics, hospitals, homes
- Law firm: Proprietary client info &software access
- University: Labs for running different courses
- ISV: Demos on customers' machines

Future Use Cases

- Hotels
- Internet cafes
- Consumers

Stanford POMI 2020 Project: Programmable Open Mobile Internet

10x cheaper, 10x more users

Technological Trends

Convergence of broadband, wifi, cellular, wimax

Convergence of PC, CE, phones

Three-Tier Architecture

SERVERS

PC/TVs

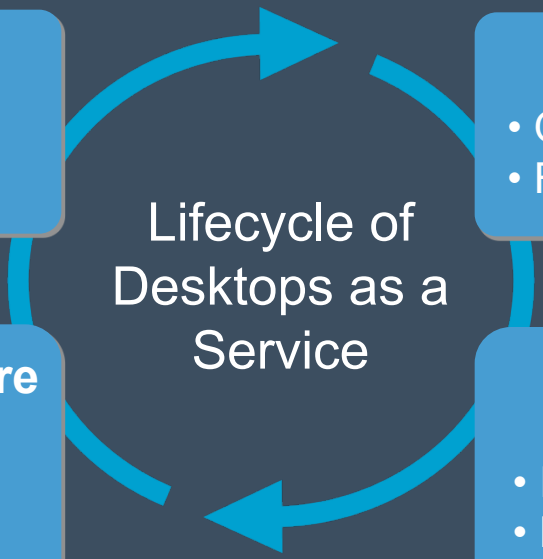
Personalize the generic PC,
Borrow the power, display, keyboard, memory, …

PHONES

My key, cache, window into my
digital ID, digital personality, digital assets,
and the internet

Conclusion: Virtual Desktop as a Service

Pioneered Virtual Desktops
- Optimized for DaaS
- "The Collective"
- 15 patents pending



Create
- Creator Wizard

Deliver
- One click post and subscribe
- Faster launch

Users free to work anywhere
- Online & offline
- X-platform
- Isolation (Secure and Confidential)

Maintain & Control
- Incremental update
- Rejuvenation
- Revocation, AAA & Encryption
- BareMetal™