Evaluating Thin Clients & Alternative Compute Models

Spectrum of Compute Models

	Server-Side Compute & Centralized Data Storage	Client-Side Compute, Centralized Data Storage	Client-Side Compute & Centralized or Local Data Storage
Mobile Capable / **Off-Network Option**			Virtual Containers (emerging) · App Streaming/ Virtualization · Distributed, Rich Client
Network Connected Only	Web-Based Apps · Terminal Services · Virtual Hosted Desktop · 1:Many Blade PC	OS Streaming · 1:1 Blade PC	

Appropriate Architecture is a Balance of Many Inter-Related Factors

IT Requirements

Security
Image mgmt
License mgmt
Support structure
Disaster recovery

User Experience

Mobility
Responsiveness
Customization
"Ownership" & privacy
considerations

Available Infrastructure

Servers
Storage
Space, Power & Cooling
Network bandwidth
Budget priorities

Application Workloads

Compute & gfx load
Latency tolerance
(i.e. video, VOIP)
Peripherals & printing
Headroom

IT org structure

Budget

Politics

Other programs

User or business group influence

What Makes Sense to Centralize?

Administration ☑

Data Security ☑

Compute & Graphics **?**

Distributed Compute

- Mobility
- Application responsiveness
- Overcome limited or unreliable network connections
- Datacenter constrained by space, power, cooling, budget...

Centralized Compute

- Absolute smallest client attack profile required
- Users always on-network
- Workloads are compute and graphics lite
- Unconstrained datacenter
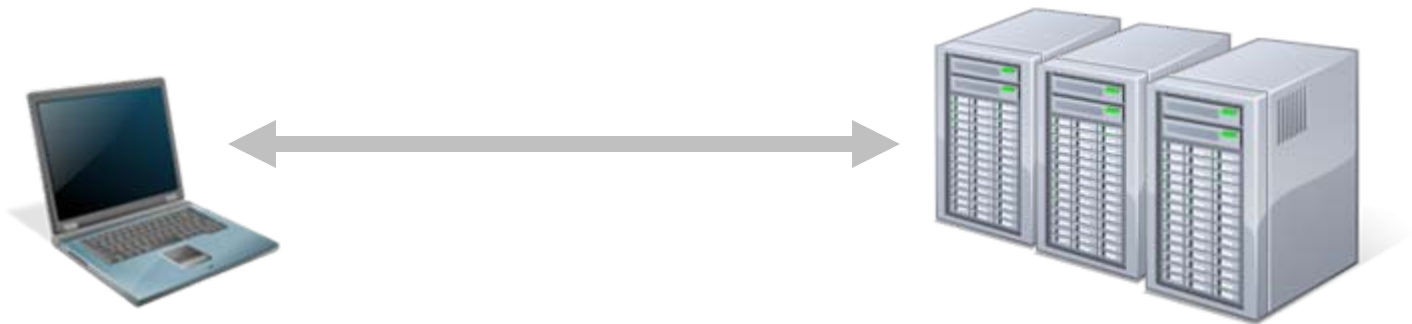
Datacenter & Network Requirements Must Be Accommodated in Infrastructure

	App Virtualization	OS Streaming	Virtual Hosted Desktop	Terminal Services
Datacenter Compute Requirement	Low	Low	High	Medium
Network Bandwidth Requirement	Medium (initial burst) Low (sustained)	High (initial burst) Low (sustained)	Medium (sustained)	Medium (sustained)

Mobility & Application Richness Shape Options

	Rich, Distributed Client	App Virtualization	OS Streaming	Blade PC	Virtual Hosted Desktop	Terminal Services
Fixed Location - Wired	■	■	■	■	○	○
"Work at Home" - Wired	■	■		○	○	○
On-Campus Roaming - Wireless	■	■		○	○	○
"Work at Starbuck's" - Wireless	■	■		○	○	○
Off-Network Mobile	■	■				

■=Rich applications supported   ○=Basic applications supported

No additional RDP acceleration

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Intel IT Benchmarking Results

Model	Percent Server Processor Utilization (20 Clients)	Network Utilization (20 Clients)	Single Server Scaling (Est. Max Clients)	Caveats
Virtual Hosted Desktop/ Embedded App	45	0.5 Mbps per client	35 Clients	No multimedia or compute-intensive
Virtual Hosted Desktop/ Streamed App	25	0.5 Mbps per client	55 Clients	No multimedia or compute-intensive
Stream OS/Embedded App	1	5 Mbps per client	150 Clients	Reboot Caution
Stream OS/Streamed App	1	0.8 Mbps per client	150+ Clients	Reboot Caution

Table 3: Summary of Study Results

- **User Segments**
  - Training rooms
  - Shared PCs in Fabs
  - Call centers

- **Requirements**
  - Fresh image for each user
  - Complete OS+App image centrally managed & updated
  - Office apps, motion graphics on web, streamed video
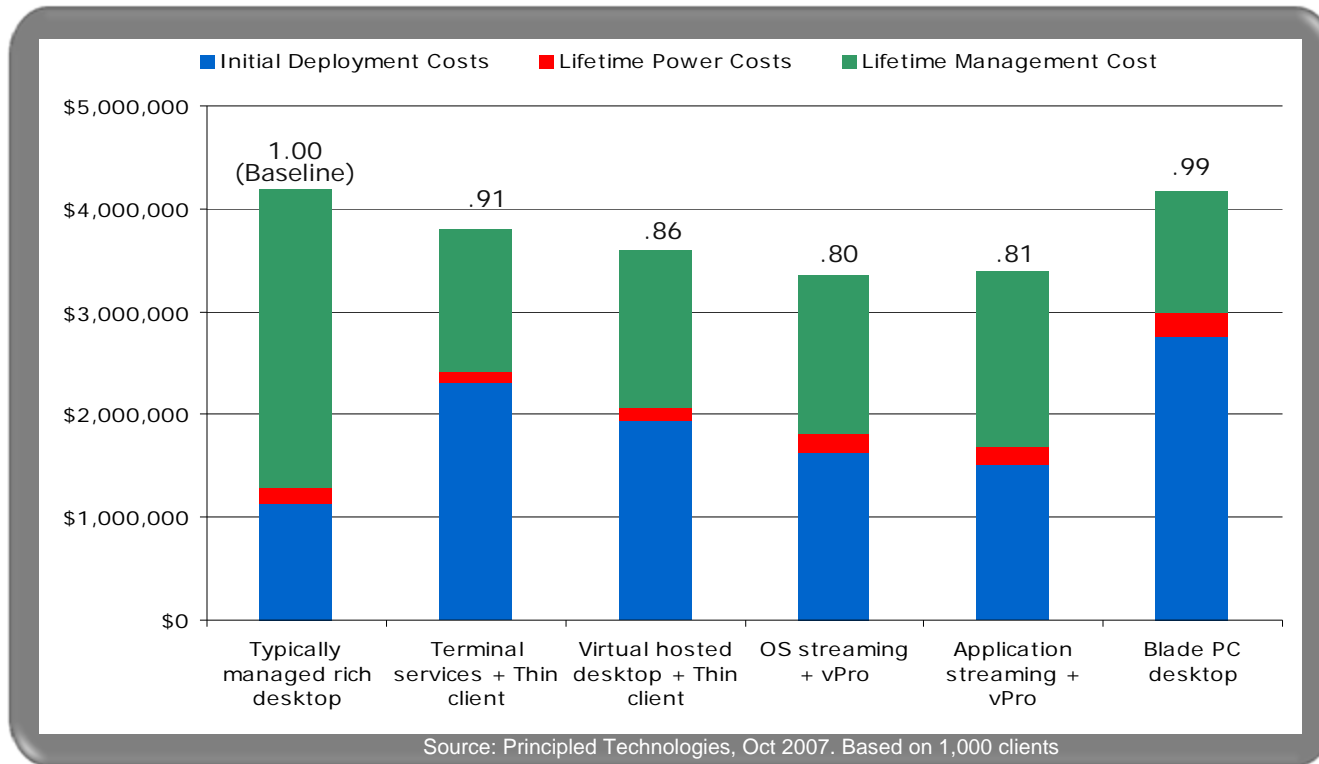 - No mobility

- **Solution Selected**
  - Deliver centrally managed OS via OS streaming
  - Deliver centrally managed apps on-demand via app virtualization
  - Desktop PCs with Intel vPro Technology

Complete study at: http://communities.intel.com/openport/docs/DOC-1333

Total Cost of Ownership Comparison

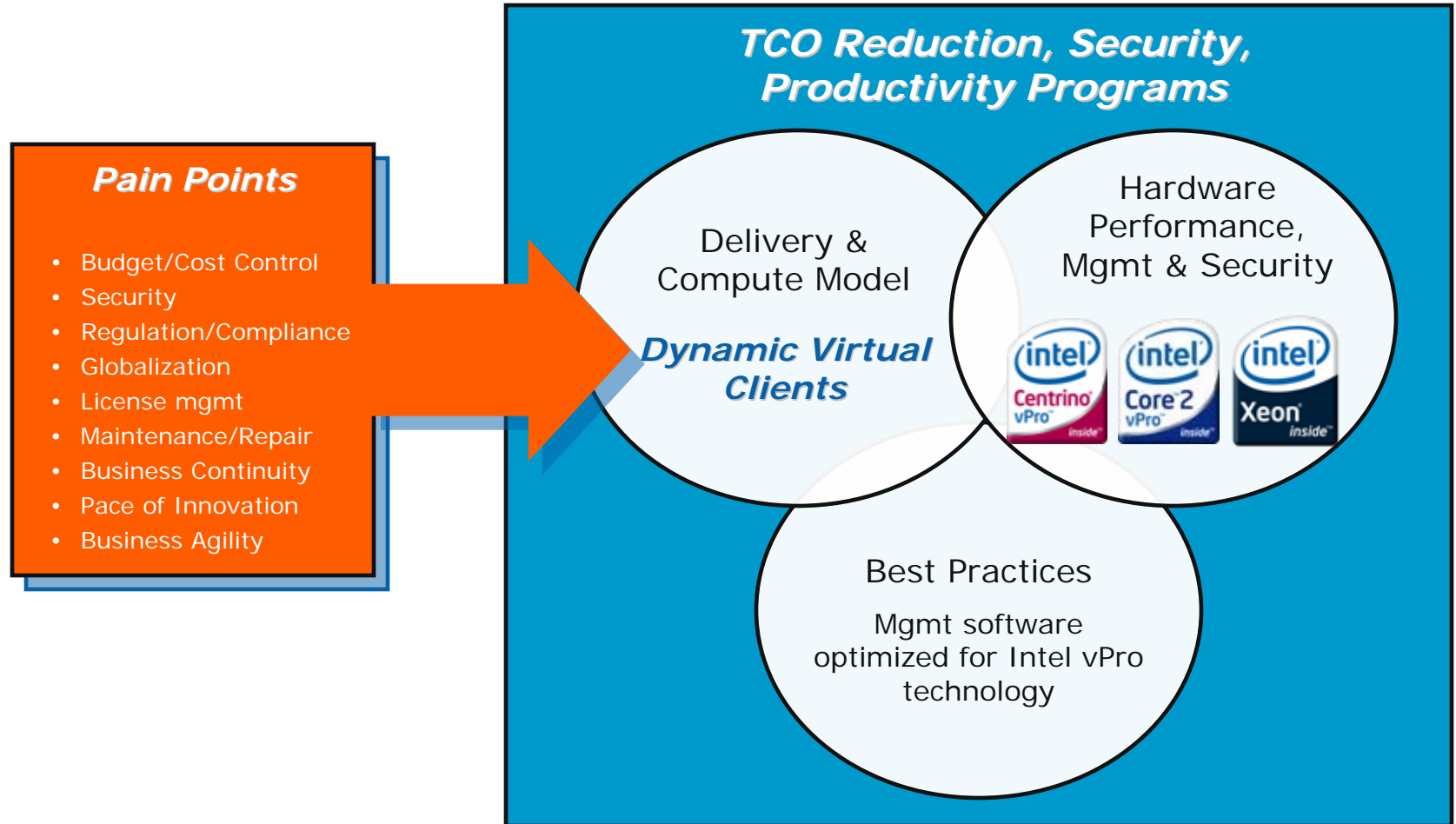Source: Principled Technologies, Oct 2007. Based on 1,000 clients

- All managed delivery models reduce TCO versus typical desktop
- Relatively minor differences may neutralize TCO in decision; Choice of models may be determined by other factors (e.g. mobility, app responsiveness, etc)
- TCO of server-side models impacted by higher infrastructure costs (servers, network, storage, facilities)
- Power is a minor TCO element (3-5%)

http://www.principledtechnologies.com/Clients/Reports/Intel/ComputeModelTCOCalc1107.xls

In the End, Solutions May Mix Models

- Diverse user and IT needs will likely result in hybrid models
  - Same user accesses application through multiple models

- 100% single-model deployments may be rare
  - Single model may make sense when security, management and workload requirements are unlikely to change over time

- Selected client devices should accommodate the most demanding requirements of target users
  - Desktop & laptop PCs provide most flexibility for all models
  - Thin terminals appropriate for 100% server-side deployments

Success will be the Sum of Delivery Model, Hardware & Practices

Pain Points

- Budget/Cost Control
- Security
- Regulation/Compliance
- Globalization
- License mgmt
- Maintenance/Repair
- Business Continuity
- Pace of Innovation
- Business Agility

TCO Reduction, Security, Productivity Programs

Delivery & Compute Model

Dynamic Virtual Clients

Hardware Performance, Mgmt & Security

intel Centrino vPro inside

intel Core 2 vPro inside

intel Xeon inside

Best Practices

Mgmt software optimized for Intel vPro technology

Summary

- Software delivery models have evolved and IT has more choices than ever

- The appropriate compute model for a user segment is a balance of many factors

- Optimization of IT and User needs will likely result in a mix of delivery models, even within a single user segment

- PCs with Intel® vPro™ and Centrino® Pro processor technology are the most manageable, secure PCs on which to deliver all compute models
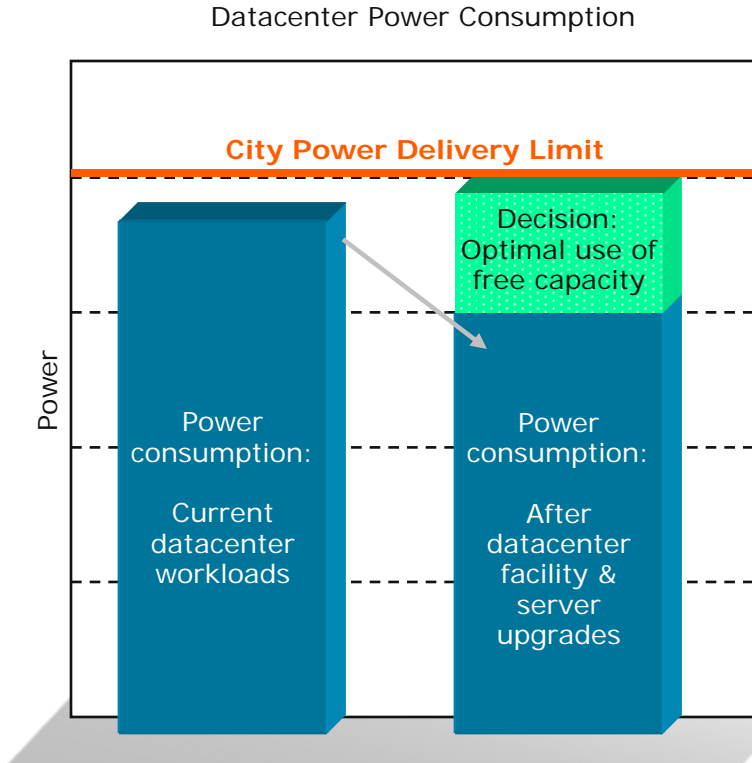
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Backup

Key Providers

Compute Model	Solution Providers*
Terminal Services	Citrix – XenApp (includes Presentation Server) Microsoft – Terminal Server
Virtual Hosted Desktop	Citrix – XenDesktop VMware – Virtual Desktop Infrastructure
Blade PC	ClearCube HP – Consolidated Client Infrastructure
OS Streaming	Citrix – XenDesktop, Provisioning Server Dell – On-Demand Streaming Solution
Application Streaming	AppStream (acquired by Symantec Q2'08) Citrix – XenApp Microsoft – Microsoft Application Virtualization (formerly SoftGrid) Symantec – Altiris Software Virtualization Solution VMware – Thinstall (acquired Q4'07)
Virtual Containers (Emerging)	Microsoft – Kidaro (acquired Q1'08) MokaFive VMware – Mobile VDI (concept demo Q1'08)

* Other names and brands may be claimed as the property of others.

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Customer Stories
- Constrained Datacenter

Datacenter Power Consumption

City Power Delivery Limit

Decision: Optimal use of free capacity

Power consumption:

Current datacenter workloads

Power consumption:

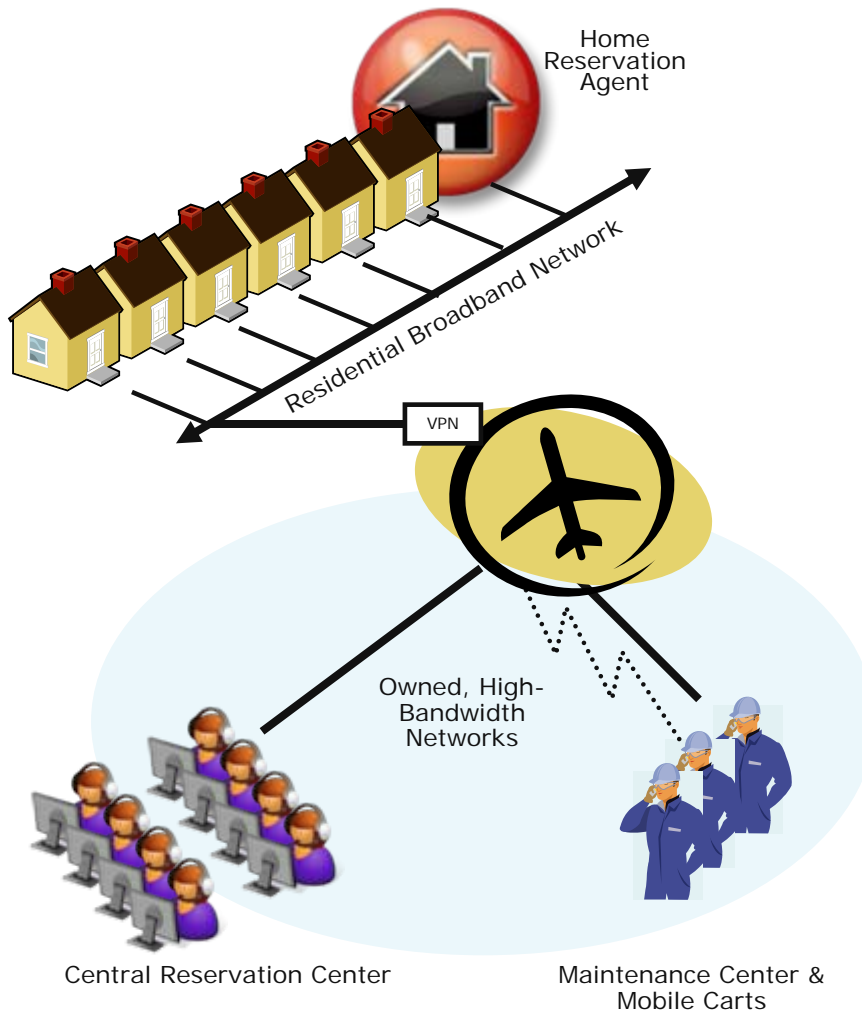After datacenter facility & server upgrades

Power

- ~8000 clients in compact, urban campus

- Most client workloads could be accommodated with VHD

- City cannot provide more power for datacenter at any price

- Chose Application Virtualization over VHD

  - "Why should we move 8000 computers from where I don't have a power and space problem to somewhere where I do?"

  - "If I free up room under the power cap, I can find better uses for the capacity than PowerPoint*"

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Customer Stories
- Uncontrolled Network Connections

Home Reservation Agent

Residential Broadband Network

VPN

Owned, High-Bandwidth Networks

Central Reservation Center

Maintenance Center & Mobile Carts

- ~200 work-at-home airline reservation agents

- ~800 airport or call-center workers

- Primary workload is database & reservation system access

- Residential broadband for home workers

- Chose Terminal Services for airport & call centers
  - Simple workloads, reliable network

- Chose Application Virtualization for home workers
  - "We're concerned about system responsiveness when all the neighbors get on the web at 7pm"
  - "Local execution means network traffic is only data, not screen shots"

Customer Stories
- Conflicting High Level Objectives

- CIO directive to "thin" the architecture for cost reduction & manageability

- Business units demand greater mobility

- Chose Application Virtualization for centralized mgmt & mobile support

  - "We were able to increase our control over app management and licensing, and still support the business units"

  - "We were already paying for SoftGrid through our Software Assurance contract and MDOP. Our start-up cost was minimal versus building a new thin client infrastructure"
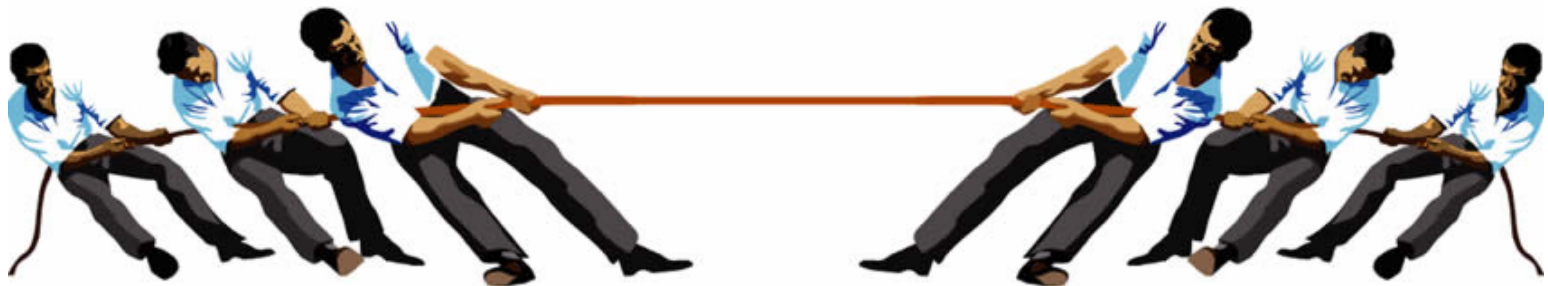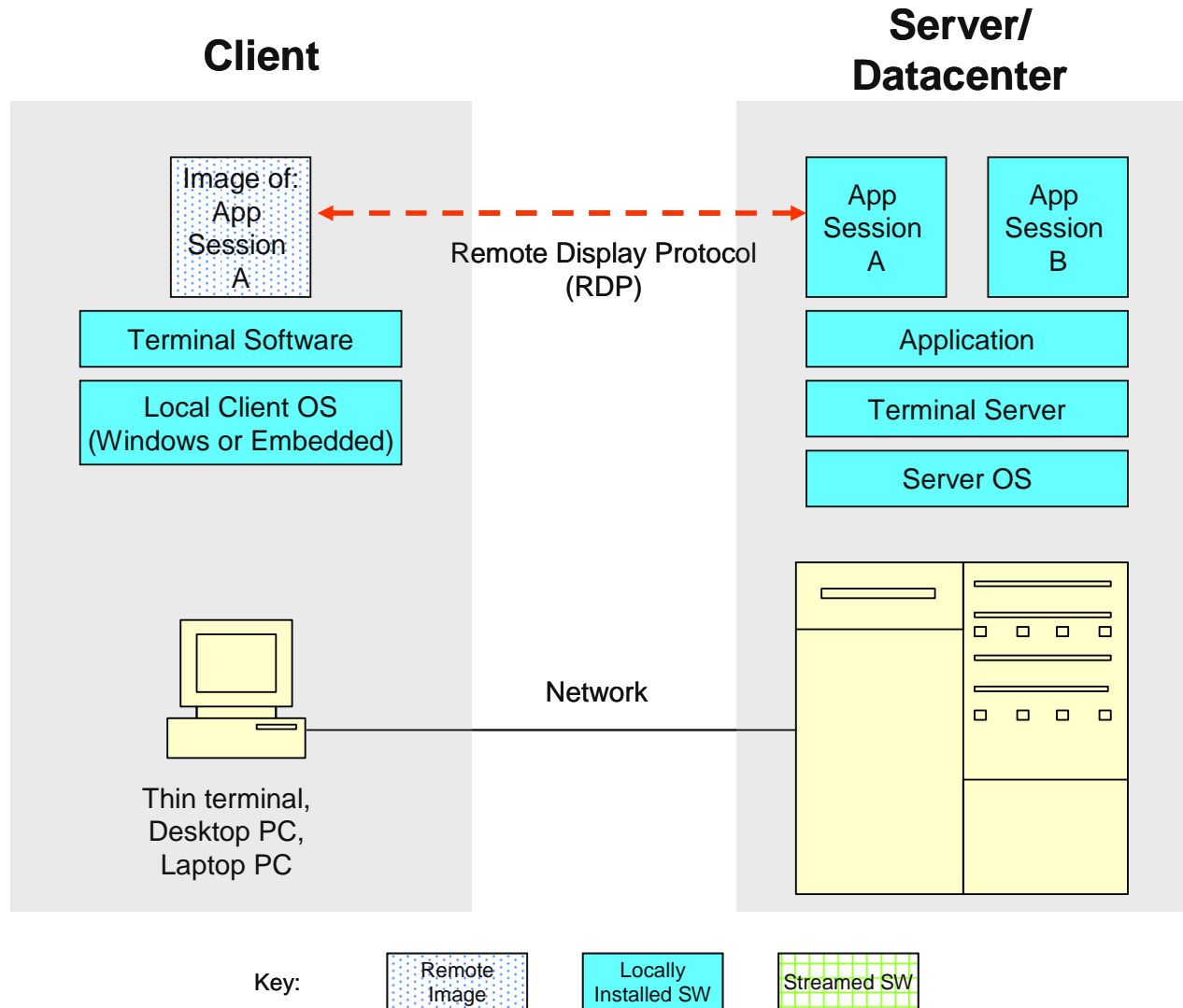
Compute Model Taxonomy

	Terminal Services (aka Session Virtualization)	Virtual Hosted Desktops (aka Virtual Desktop Infrastructure)	OS and Application Streaming	Application Streaming (aka Application Virtualization)	Virtual Containers (evolving model)	Rich, Distributed Computing (aka Rich Client, Fat Client)
Application Execution	Server	Server	Client	Client	Client	Client
Application Data Storage	Server, NAS or SAN	Server, NAS or SAN	Server, NAS or SAN	Client, Server, NAS or SAN	Client, Server, NAS or SAN	Client, Server, NAS or SAN
Mobility / Off-Network Operation	No	No	No	Yes, with local caching option	Yes	Yes
Local Device Connect & Synch (bar code readers, PDA, phone, etc.)	Limited	Limited	Yes	Yes	Limited	Yes
Acceptable Clients	Terminal, Desktop PC, Laptop PC	Terminal, Desktop PC, Laptop PC	Desktop PC, Laptop PC	Desktop PC, Laptop PC	Desktop PC, Laptop PC	Desktop PC, Laptop PC
Major Providers	Citrix, Microsoft	VMware, Citrix	Citrix	Microsoft, Citrix, Symantec, AppStream	Kidaro, VMware, Aternity, more developing sol'ns	Traditional PC software providers

NAS = Network Attached Storage
SAN = Storage Area Network

Terminal Services Model

Client

Server/Datacenter

Image of: App Session A

↔ Remote Display Protocol (RDP)

Terminal Software

Local Client OS (Windows or Embedded)

App Session A

App Session B

Application

Terminal Server

Server OS

Network

Thin terminal, Desktop PC, Laptop PC

Key:

Remote Image

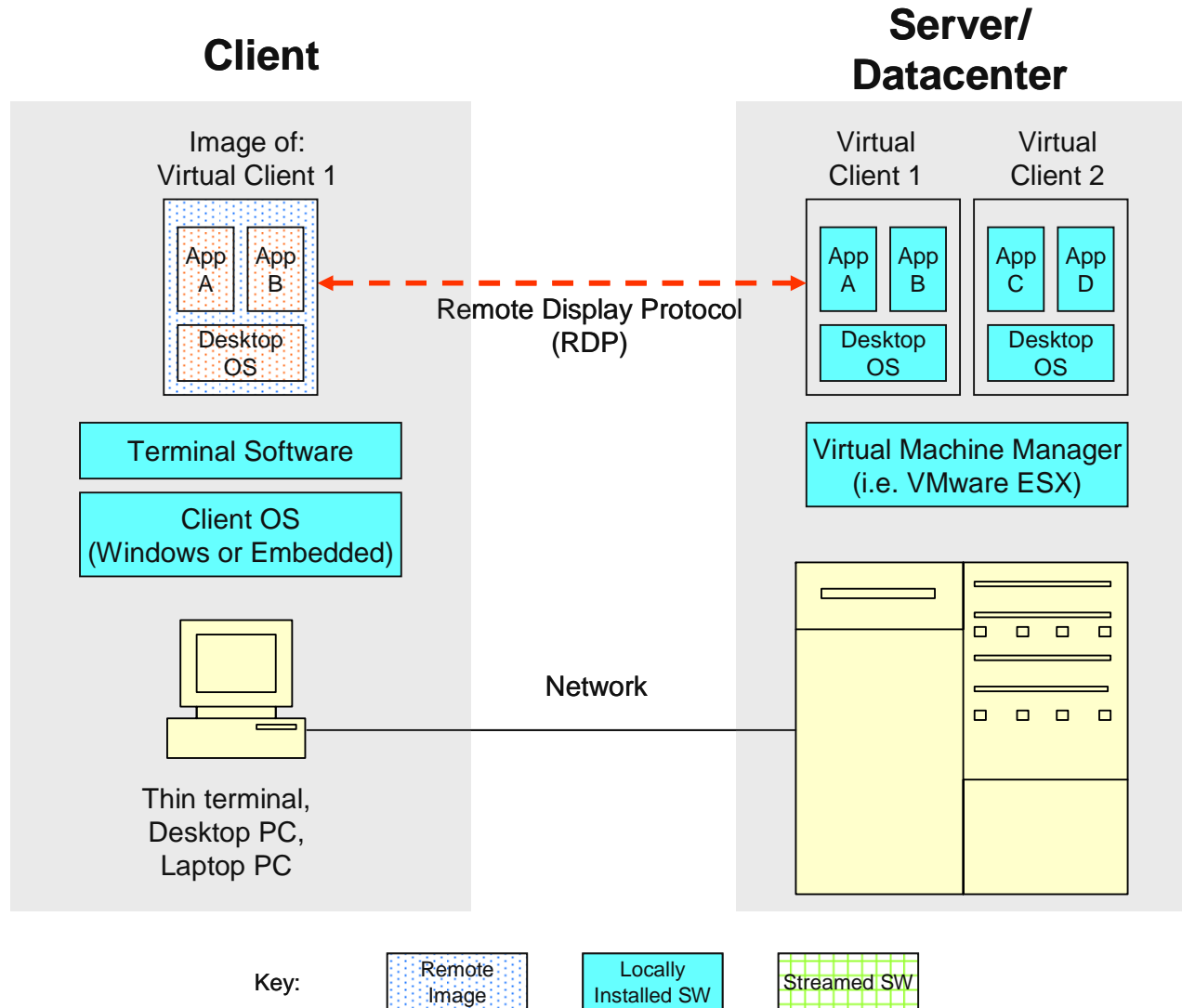Locally Installed SW

Streamed SW

Benefits

- Centralized mgmt & security
- Mature technology; Well-understood
- Potentially lower infrastructure requirements than other server-based models
- Access possible from any internet-connected PC
- "Stateless" client
- Disaster recovery

Limitations

- No off-network mobility
- Performance & responsiveness vary based on compute, graphics & physical distance
- Ill-suited to video, Flash, motion graphics, VOIP, & local device synch (i.e. PDA)
- Critical failure points in datacenter & network connection
- Potential costly datacenter, storage & network build-out
- User satisfaction issues

Virtual Hosted Desktop Model

Client

Image of: Virtual Client 1

App A	App B
Desktop OS	

◄ - - - - - Remote Display Protocol (RDP) - - - - - ►

Terminal Software

Client OS (Windows or Embedded)

Thin terminal, Desktop PC, Laptop PC

Server/ Datacenter

Virtual Client 1

App A	App B
Desktop OS	

Virtual Client 2

App C	App D
Desktop OS	

Virtual Machine Manager (i.e. VMware ESX)

Network

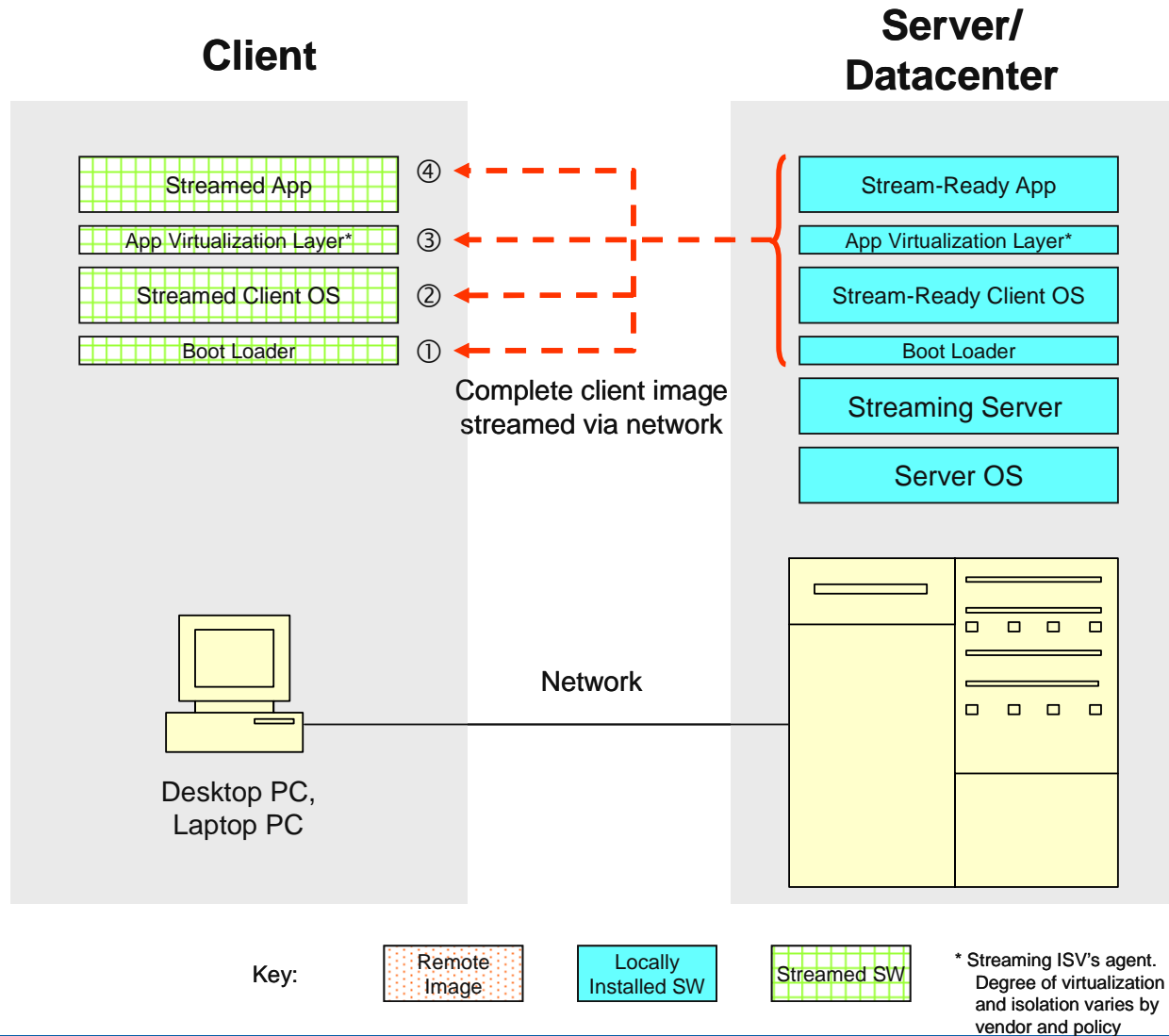**Key:** Remote Image | Locally Installed SW | Streamed SW

Benefits

- Centralized mgmt & security
- Familiar PC interface with user customization
- Access possible from any internet-connected PC
- "Stateless" client
- Disaster recovery

Limitations

- No off-network mobility
- Performance & responsiveness vary based on compute, graphics & physical distance
- Ill-suited to video, Flash, motion graphics, VOIP, & local device synch (i.e. PDA)
- Critical failure points in datacenter & network connection
- Potential costly datacenter, storage & network build-out
- Lower users/processor ratio than terminal services
- User satisfaction issues
- Immature deployment & management tools
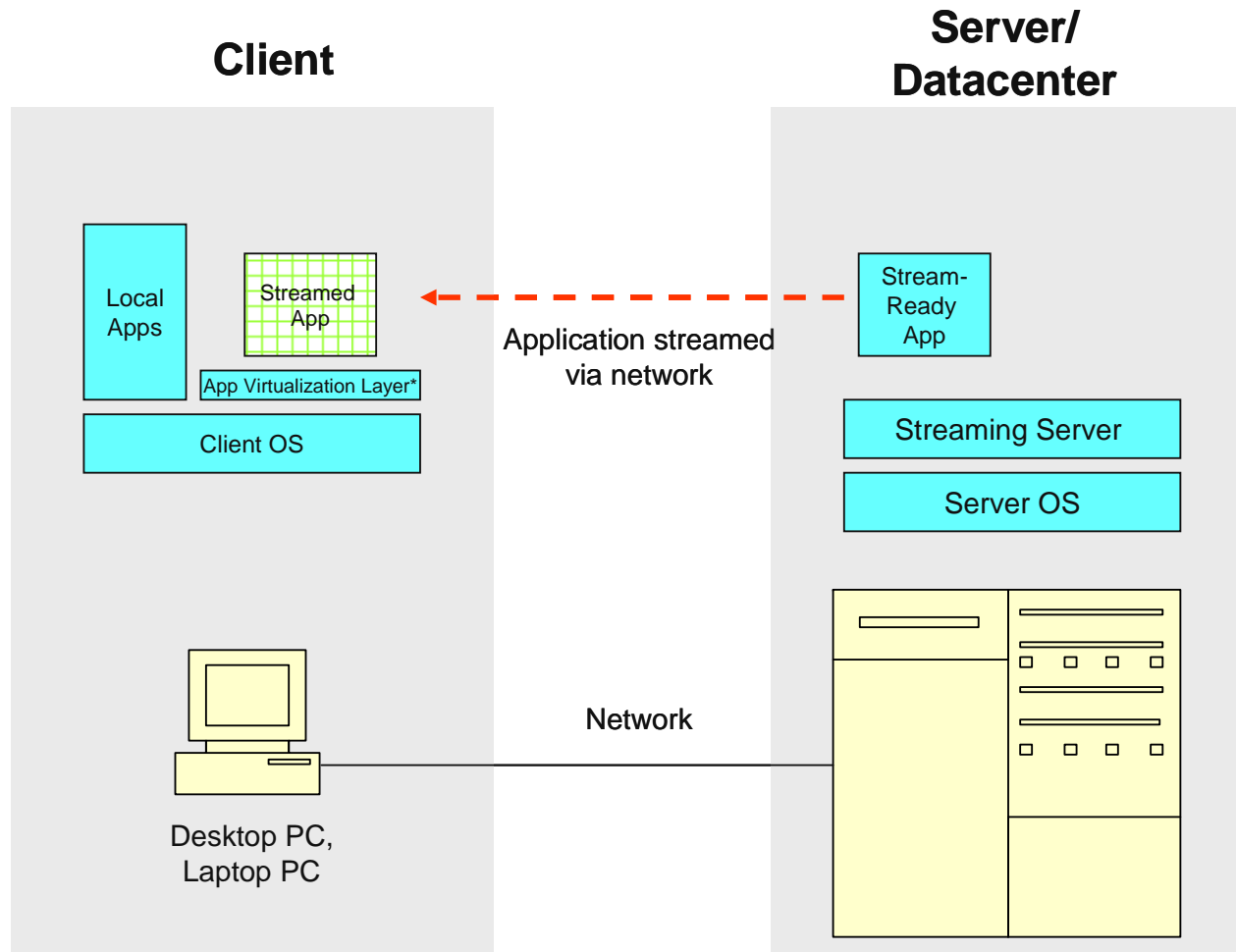
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OS and Application Streaming Model

Client

Streamed App	④
App Virtualization Layer*	③
Streamed Client OS	②
Boot Loader	①

Complete client image streamed via network

Desktop PC, Laptop PC

Network

Server/ Datacenter

| Stream-Ready App |
| App Virtualization Layer* |
| Stream-Ready Client OS |
| Boot Loader |
| Streaming Server |
| Server OS |

Key:
- Remote Image
- Locally Installed SW
- Streamed SW

* Streaming ISV's agent. Degree of virtualization and isolation varies by vendor and policy

Benefits

- Centralized mgmt & security
- Single OS & app image serves many clients (image mgmt, less storage)
- Responsive compute & graphics due to local execution
- Familiar PC interface with user customization
- App virtualization eases OS compatibility issues & increases security through isolation
- Lower datacenter & network requirements than server-side models
- "Stateless" client
- Disaster recovery

Limitations

- No local caching option among existing solutions (limited mobility)
- Streaming speeds vary based on simultaneous users & infrastructure
- Some application incompatibilities
- Application sequencing process & validation of virtualized apps can be labor-intensive

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Application Streaming Model

Client

Server/ Datacenter

Local Apps

Streamed App

App Virtualization Layer*

Client OS

Application streamed via network

Stream- Ready App

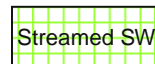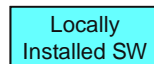Streaming Server

Server OS

Desktop PC, Laptop PC

Network

Benefits

- Centralized mgmt & security of applications & data
- Streamed apps can be latest versions with all patches
- Responsive compute & graphics due to local execution
- Familiar PC interface with user customization
- App virtualization eases OS compatibility issues & increases security through isolation
- Lower datacenter & network requirements than server-side models
- Disaster recovery with respect to applications & data
- Off-network mobility with local caching

Limitations

- Streaming speeds vary based on simultaneous users & infrastructure
- Some application incompatibilities
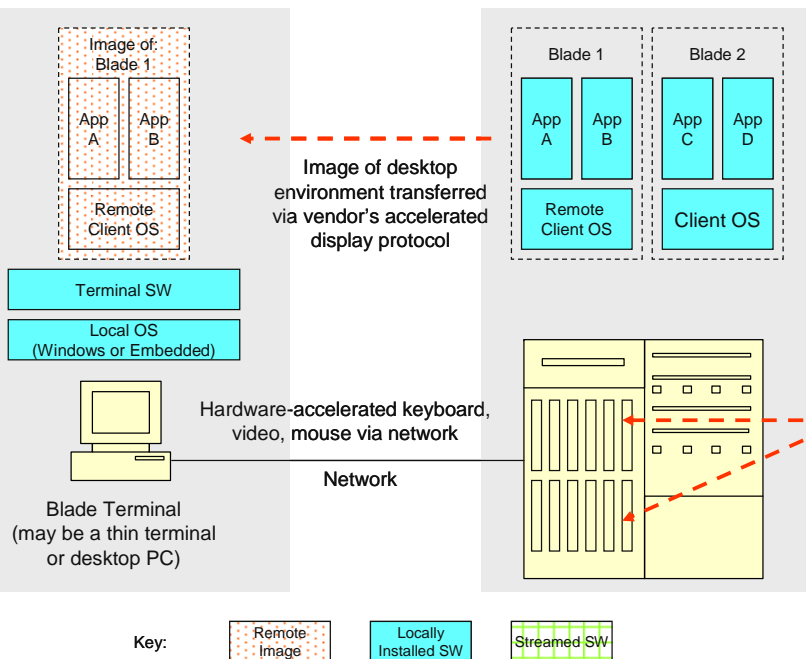- Application sequencing process & validation of virtualized apps can be labor-intensive

Key:

Remote Image

Locally Installed SW

Streamed SW

* Streaming ISV's agent. Degree of virtualization & isolation varies by vendor & policy. May be local or streamed

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Blade PC Model (1:1, 1:Many Ratio)

Limitations

- Vendor lock-in for hardware and management tools
- High acquisition & conversion costs
- No mobile option
- In 1:many configuration, responsiveness varies by number of users & workloads
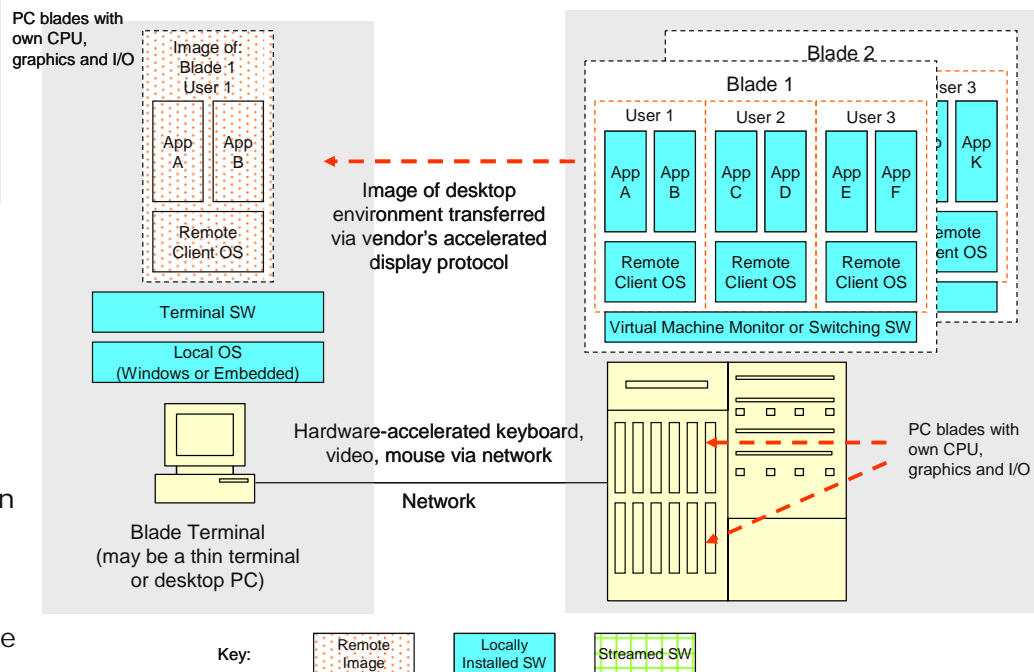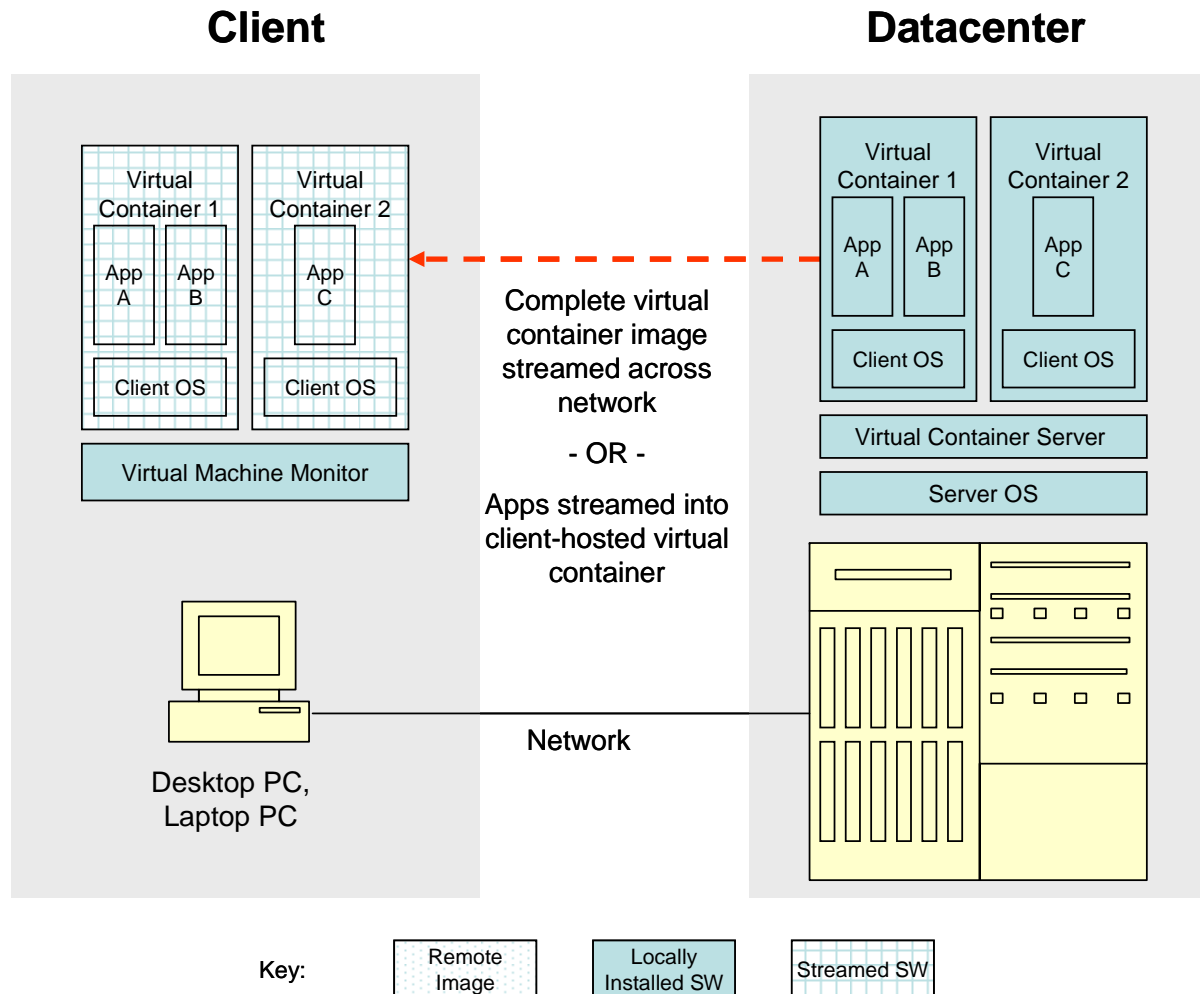- Critical failure points in blade server & network connection

Benefits

- Centralized mgmt & security
- Single hardware stack for image validation
- Users can be dynamically assigned to any blade
- Responsive compute & graphics due to "local" execution
- Familiar PC interface with user customization
- Disaster recovery
- Blade access from any internet-connected PC is possible

Virtual Containers Model (Evolving)

Client

Virtual Container 1
- App A
- App B
- Client OS

Virtual Container 2
- App C
- Client OS

Virtual Machine Monitor

Desktop PC, Laptop PC

Complete virtual container image streamed across network

- OR -

Apps streamed into client-hosted virtual container

Network

Datacenter

Virtual Container 1
- App A
- App B
- Client OS

Virtual Container 2
- App C
- Client OS

Virtual Container Server

Server OS

Benefits

- Centralized mgmt of complete desktop images
- Containers can be provisioned & managed for specific user groups
- Responsive compute & graphics due to local execution
- Platform virtualization eases HW configuration mgmt & validation
- Lower datacenter & network requirements than server-side models
- Disaster recovery with respect to applications & data
- Off-network mobility with local caching

Limitations

- Immature model at this time
- Full virtualization of graphics, peripheral drivers, docking stations remain industry challenges
- Risk of virtual machine sprawl

Key:
- Remote Image
- Locally Installed SW
- Streamed SW

Intel® vPro™ Technology Capabilities & Alternative Compute Models

Compute model➔ vPro capability⬇	Terminal Services	Virtual Hosted Desktop	OS + App Streaming	App Streaming (Local OS)	Rich Client or Mixed Model
Accurate count of clients (regardless of power or OS state)	X	X	X	X	X
Accurate HW inventory (regardless of power or OS state)	X	X	X	X	X
Accurate SW inventory (regardless of power or OS state)	X (inventory & update terminal SW)	X (inventory & update terminal SW)		X	X
Secure wake-&-update				X	X
Isolate an infected client			X	X	X
Monitor agent presence			X	X	X
Encrypt data on hard drive (Danbury Tech '08)				X	X

Major Companies Investing for Multiple Delivery Models

Microsoft

Current Products:

- Windows Server (terminal services)
- Hyper-V (VHD)
- SoftGrid (app. Virtualization)

Recent Acquisitions:

kidaro
(virtual containers)

calista TECHNOLOGIES
(graphics acceleration for terminal services or VHD)

CITRIX

Current Products:

- XenApp, formerly Presenation Server (terminal services, app. virtualization)

Recent Acquisitions:

Xen Source™
(VHD)

Ardence
(OS streaming)

vmware

Current Products:

- ESX (VHD)
- ACE (virtual containers)

Recent Acquisitions:

thinstall
(app. virtualization)