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Citrix HDX 3D Virtualization:

Six Years of Remoting 3D Apps

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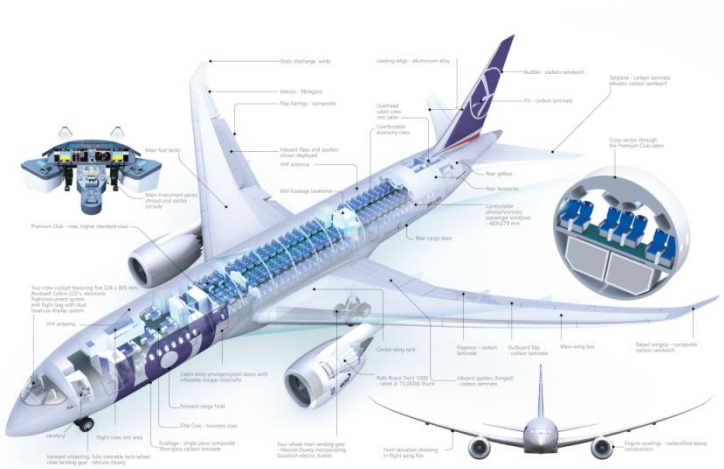
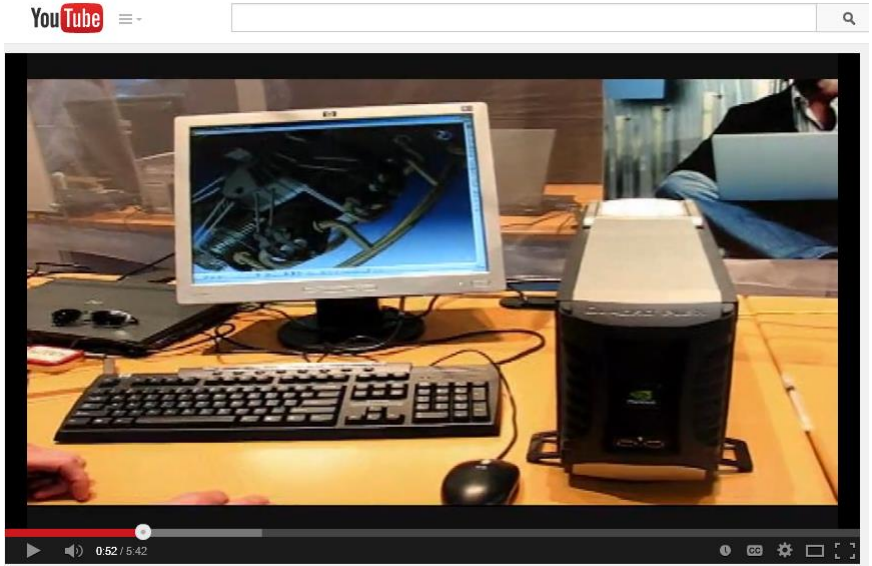
It started with Boeing…

- Back in 2006…
- Dreamliner design involved a global team
- Files transfers would have taken hours and put the company's IP at risk
- Project K2: ICA protocol enhancements and NVIDIA GPU acceleration of OpenGL in a private release just for Boeing



A false start with “API Intercept”

- Project Pictor
- API capture driver approach
- What we learned
- Why we leap-frogged over Pictor to XenDesktop HDX 3D Pro (introduced in 2009)



2010: Early success stories

BOMBARDIER
the evolution of mobility

Vestas®

Power and productivity for a better world™ ABB

VOLVO

- Great traction at the high end of the market!
- But… **cost was a barrier** to many organizations
- The market needed a more scalable solution…

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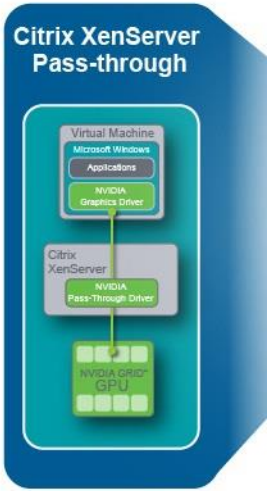
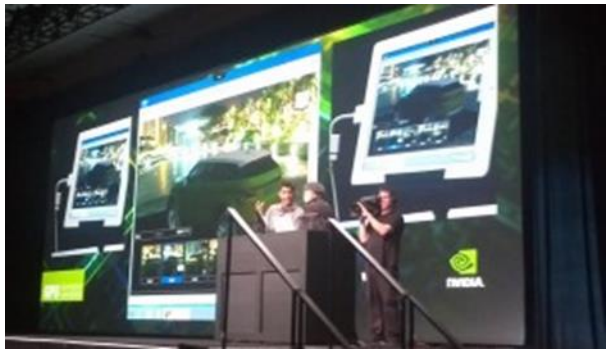
2011: Multiple GPUs per host

- XenServer 6.0 introduced direct GPU Passthrough ☺
- Huge increase in user density → lower cost per user
- Now a single host could support [typically] 4 concurrent HDX 3D Pro users



2012: Performance! Performance! Performance!

- XenDesktop 5.6 Feature Pack 1
- Citrix was first vendor to support NVIDIA's **"Monterey VGX" API (now "GRID")**
  - Direct frame buffer access
  - Higher frame rate



GTC 2012 Keynote

- **H.264-based Adaptive Deep Compression**
  - Great bandwidth efficiency
  - Automatic adjustment of frame rate and image quality based on the network connection

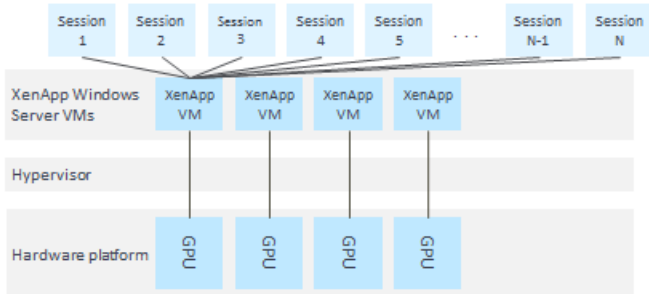
Citrix Synergy 2013

Jensen Huang, NVIDIA Co-Founder and CEO, was featured in Mark Templeton's Citrix Synergy Keynote

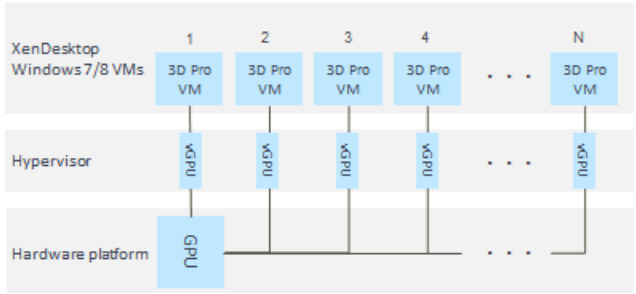
2013: High Performance GPU Sharing / “vGPU”

- For cost-effective Windows Server RDS “XenApp” workloads
  - No API Intercept
  - High performance; latest DirectX/OpenGL versions
- For highly-customizable Windows desktop OS “XenDesktop VDI” workloads
  - XenServer first to deliver NVIDIA GRID vGPU

GPU Sharing with RDS workloads



GPU Virtualization for VDI workloads



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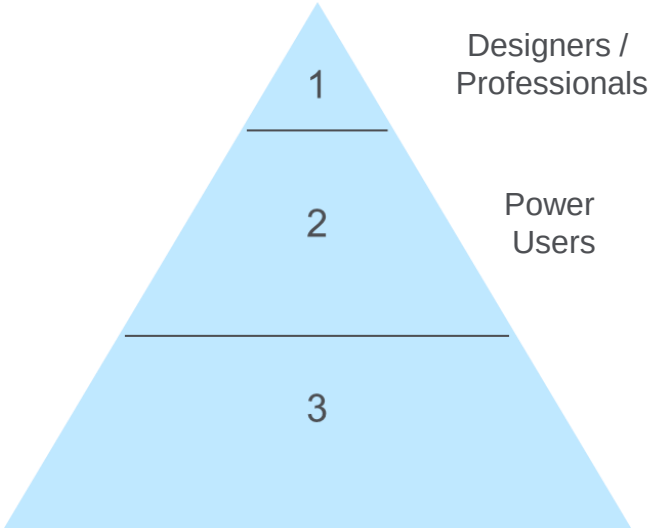
2013: High Performance GPU Sharing / “vGPU”

- For cost-effective Windows Server RDS “XenApp” workloads
  - No API Intercept
  - High performance; latest DirectX/OpenGL versions
- For highly-customizable Windows desktop OS “XenDesktop VDI” workloads
  - XenServer first to deliver NVIDIA GRID vGPU
- GPU-accelerated 3D remoting now became available to a **huge second tier of end users**



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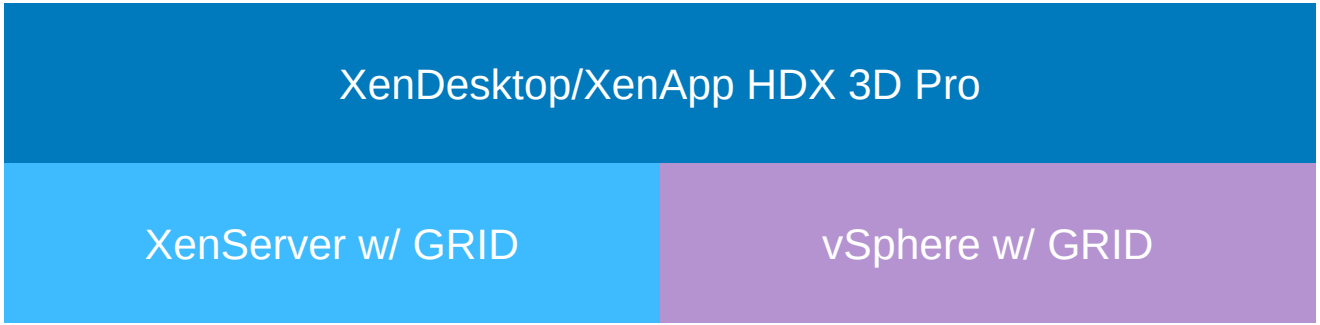
2014: Polishing the diamond

- **Reference architectures** from Cisco, Dell, HP, IBM
- ISV “Citrix Ready” **certification** program and white papers
- **PVS** (in addition to MCS) for vGPU provisioning
- Architectural updates to automatically pick up **new GPUs and vGPU profiles**
  - K280Q allowing a full GPU to be managed as a vGPU
- vGPU for XenApp, for specialized use cases
- **Generic USB Redirection** on XenApp, including USB 3.0 device compatibility
  - 3D mouse support on XenApp (previously just on XenDesktop)

2015: Citrix expands vGPU support to vSphere

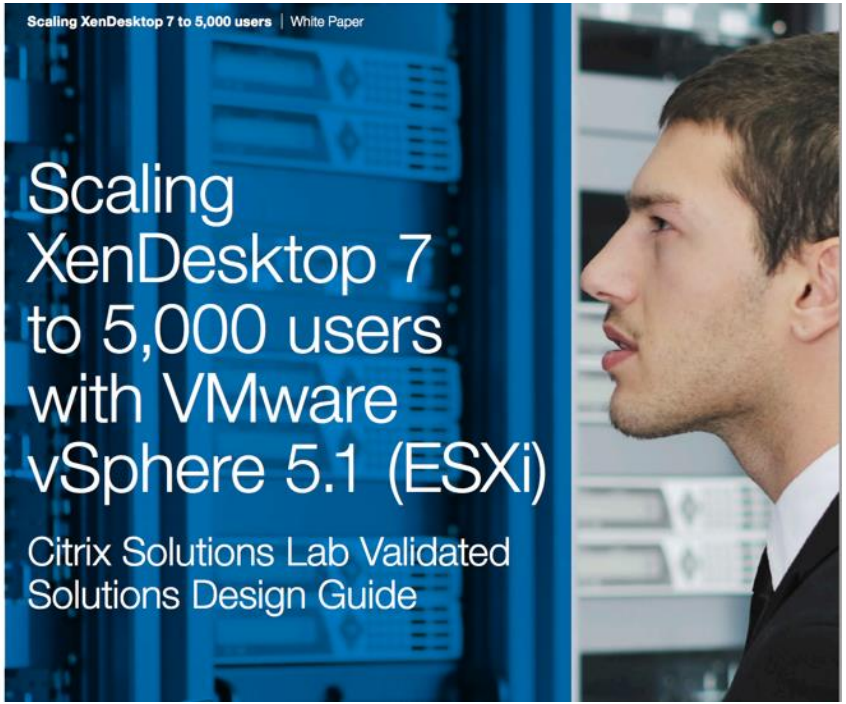
- This week, Citrix announces Day 1 support of hypervisor-agnostic XenDesktop on vSphere 6 with NVIDIA GRID vGPU
  - VMware has switched from vSGA (API Intercept) to GRID vGPU
  - No further Citrix investment in VMware's vSGA technology



XenDesktop and XenApp have always been hypervisor-agnostic

- Nearly 50% of Citrix XenDesktop and XenApp customers run it on VMware vSphere in large-scale production

- With expanded GRID™ vGPU hypervisor support, HDX 3D Pro customers can choose either vSphere 6 or XenServer



http://blogs.citrix.com/2015/03/17/citrix-expands-vgpu-hypervisor-support/

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Success stories…

This is not bleeding edge, this is prime time

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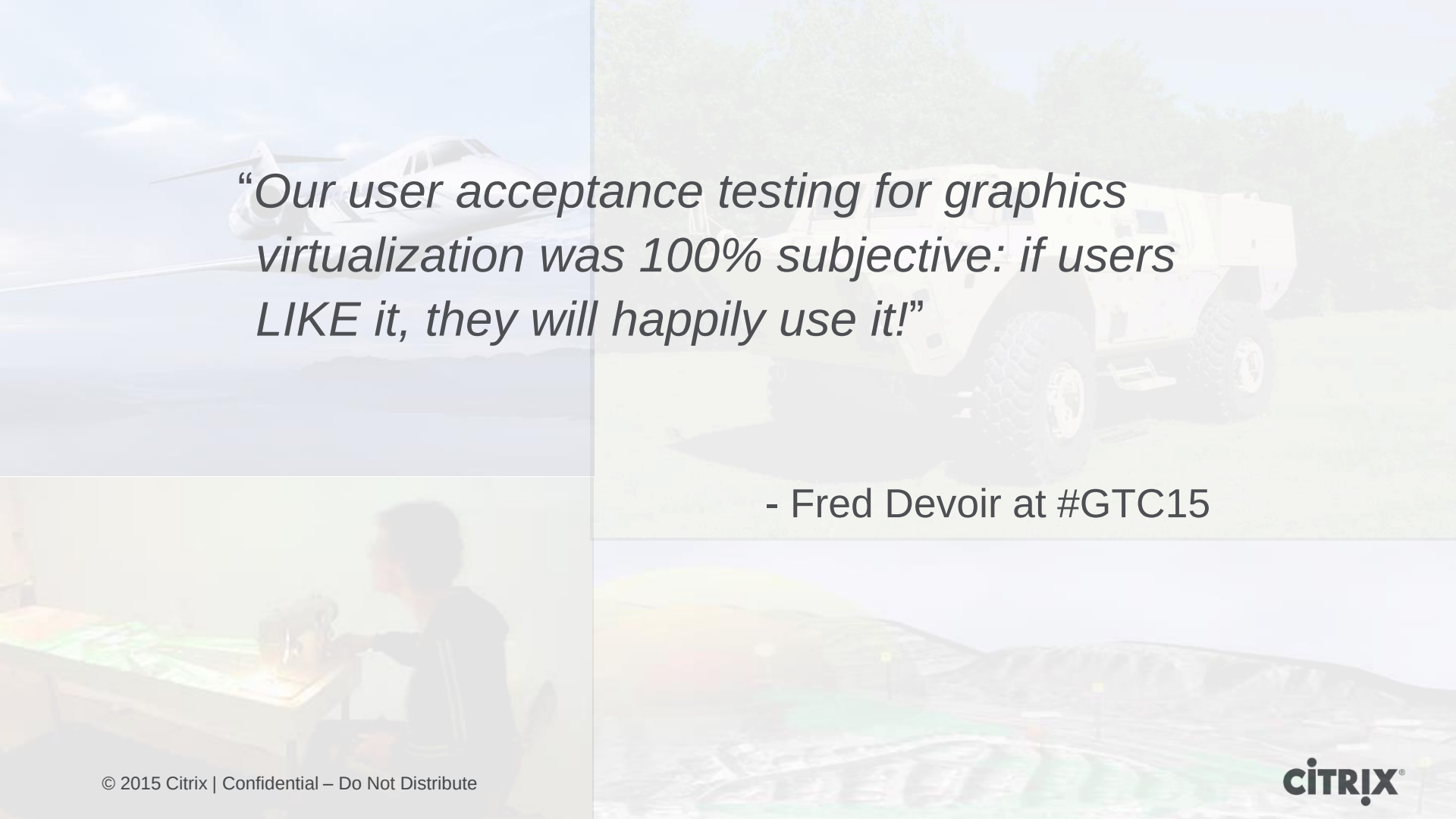
Graphics Virtualization Stack

Users, User Interface, Peripherals, Location

Platform, Protocols, Security

Server, Graphics Card, Hypervisor



"Our user acceptance testing for graphics virtualization was 100% subjective: if users LIKE it, they will happily use it!"

- Fred Devoir at #GTC15

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Graphics Virtualization: Success Checklist

1. Full app compatibility for direct hardware GPU acceleration

2. Responsive user experience from any device, with any peripheral, on real world network connections

3. Tools to monitor system status and resolve issues quickly, accurately

No compromise GPU acceleration

CRITERIA #1

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#1: No compromise GPU acceleration

- Compute on any platform
- Full Compatibility
- Large-scale Deployments

  - Bare Metal
  - vSphere
  - XenServer
  - CloudPlatform
  - Hyper-V (RemoteFX)

#1: No compromise GPU acceleration

- Compute on any platform
- Full Compatibility
  - Largest HCL of Servers
  - Most Certified ISV Apps
- Large-scale Deployments

#1: No compromise GPU acceleration

- Compute on any platform
- Full Compatibility
- Large-scale Deployments
  - 10’s of Thousands of Users
  - 10’s of Case Studies
  - Up to 300ms deployments
  - Over 6 years of operational experience

Workstation-quality user experience

CRITERIA #2

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#2: User Experience and Security

- Full Peripheral Support
- Bandwidth Optimization
- Integrated Security
- Adaptive Protocol

  - Wacom drawing pads
  - 3D mouse support
  - Printers
  - Cameras
  - Thin Clients
  - Windows, Mac, Linux
  - iOS and Android

#2: User Experience and Security

- Full Peripheral Support
- Bandwidth Optimization
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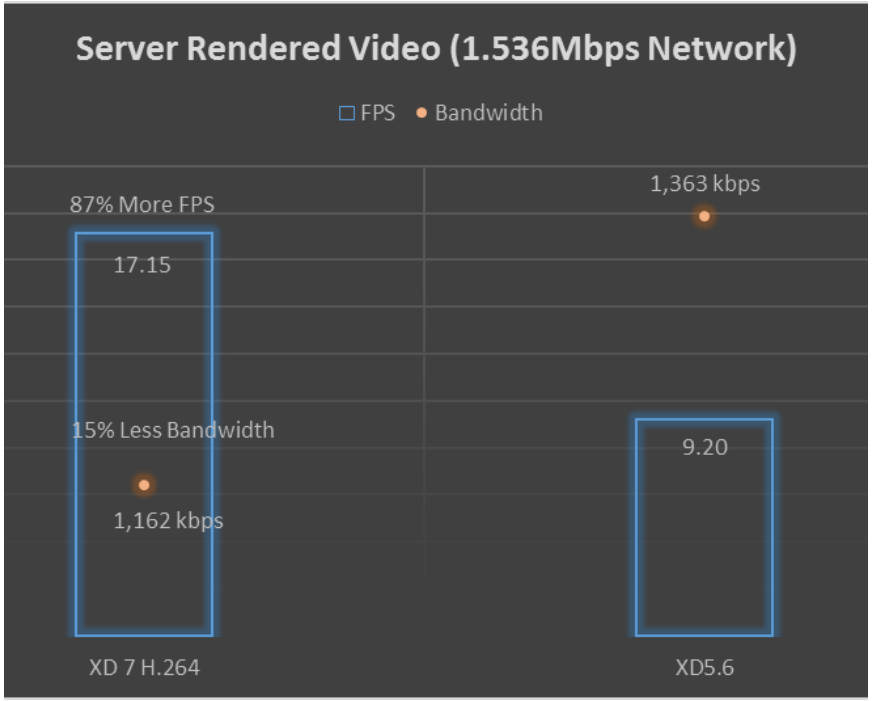
- Adaptive Protocol



http://blogs.citrix.com/2013/11/06/go-supersonic-with-xendesktop-7-x-bandwidth-supercodecs/

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#2: User Experience and Security

- Full Peripheral Support
- Bandwidth Optimization
- Integrated Security
- Adaptive Protocol

  - Block or allow USB storage
  - Client Drive Mapping
  - End Point Scan
  - Location Based Access
  - IP stays in Datacenter

#2: User Experience and Security

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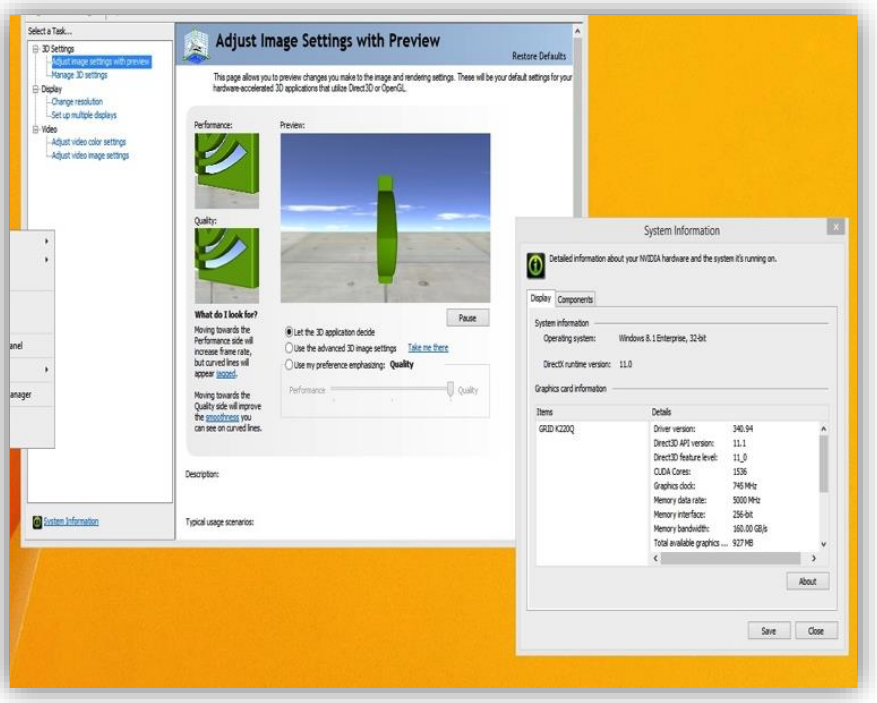
http://blogs.citrix.com/2014/10/22/whats-new-with-hdx-display-in-xendesktop-xenapp-7-x/

Minimum downtime and disruption

CRITERIA #3

#3: User Management at Scale

- Up-to-date drivers
- Quick roll-out and roll-back
- Purpose-built Helpdesk UI



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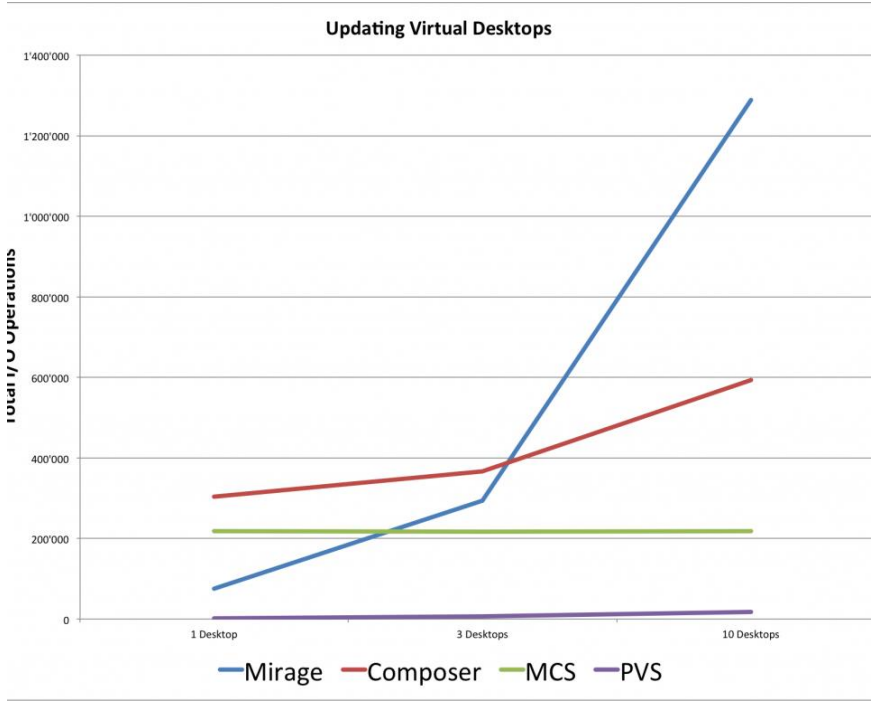

http://www.citrix.com/tv/videos/11178

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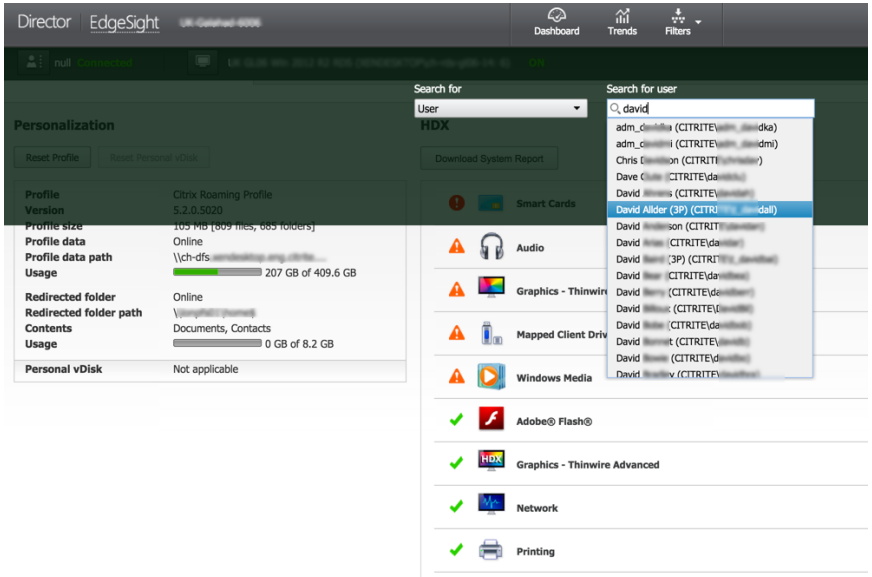


http://blogs.citrix.com/2014/05/20/compare-citrix-xendesktop-vs-vmware-horizon-view-end-user-monitoring-and-support/

Success story after success story…

Local-like Experience

HDX 3D Pro Delivery

GRID vGPU Compute

Successful deployments

paid attention to the

User Experience Checklist –

not just the infrastructure blocks

Automotive

PSA PEUGEOT CITROËN

- GTC S5625, Alain Gonzalez
- **1,250 users online everyday** with 3D virtual machines on XenApp/XenDesktop, including PSA employees, partners and subcontractors (across 9 countries)

- 6 GPUs per HP blade; 48 users per chassis
- AutoCAD, NVH, Crash, 3DCom, CATIA, ANSA, V.Lab, Metpost
- Security, mobility, cost savings (60% cheaper), access from any device
- **User acceptance was key**; users especially love that they can disconnect and then reconnect from another device

Textron / Bell Helicopter

GTC S5482 & S5485

The Customer

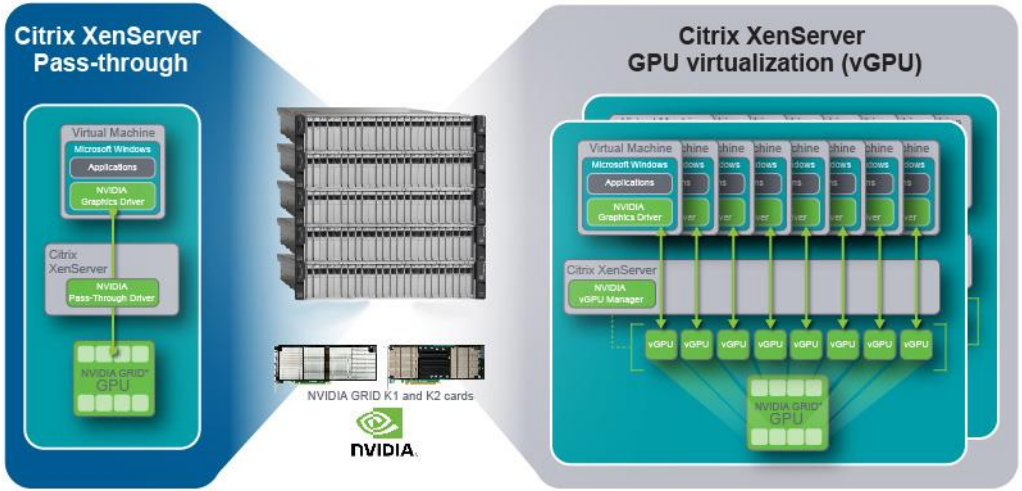
Bell Helicopter, a division of Textron, is a rotorcraft manufacturer headquartered in Texas. Bell manufactures military helicopter and tilt-rotor products in Texas and commercial rotorcraft products in Quebec, Canada.

The Challenge

- Ever design a helo? Massive 3D models
- Multiple locations
- Load times increased with distance from LAN
- Employees chained to Beige Boxes
- Intellectual Property on local laptops? Yikes!

Textron / Bell Helicopter

Solution



Impact

- Pooled Virtual Desktops based on job roles
- Model load times 30-50% faster
- Like-for-like hosted to physical model
- All compute resides in Fort Worth
- All Intellectual Property remains in Fort Worth – “The Vault”
- Employees enabled:
  - Flexibility
  - Enhanced User Experience
  - Security

Tata Technologies

- GTC S5593, V. Balaji (CIO)
- Engineering services outsourcing
  - 7,500 engineers in 25 countries
- Ramping up a Design Center used to take 2-3 months
- Now using Citrix XenDesktop HDX 3D Pro, XenServer and NVIDIA GRID cards
- PTC Pro/E, Dassault CATIA, Siemens Teamcenter NX, Windchill, HyperMesh
- Benefits:
  - Quick, easy provisioning and agility for growth
  - Anywhere access
  - Data security
  - “Green” savings (energy): 55%
  - Management savings due to centralization: 90%

Global Architecture

KPF

The Customer

Kohn Pedersen Fox Associates (KPF) is one of the world's pre-eminent architecture firms, with 6 global office hubs and projects in more than 35 countries

Challenge

- To virtualize Autodesk Building Design Suite 2013, Adobe Creative Suite 5.5, Rhino, MS Office
- KPF wanted to offer **mobile workers** the same performance as a workstation in the office

AUTODESK.

Adobe

Microsoft Office

IMSCAD™

CITRIX®

KPF

The Solution

- Citrix XenApp & XenDesktop
- Cisco UCS and HP servers
- NVIDIA GRID K1 and K2 cards
- 20 CAD users per HP DL380p
- Citrix NetScaler for secure access by 3rd parties and remote staff

The Results

- "*Within a short period of time users were logging on remotely on their iPad's and using Revit, and one user even connected when on a plane flying from New York to London.*"

"We were impressed with the performance of all the applications, in particular when accessing from home... It doesn't matter what type at device our architects are using. Using any hardware from anywhere."
--- Ryan Gyselinck, KPF IT manager

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Where do we go from here?

Derek’s predictions for 3D graphics remoting

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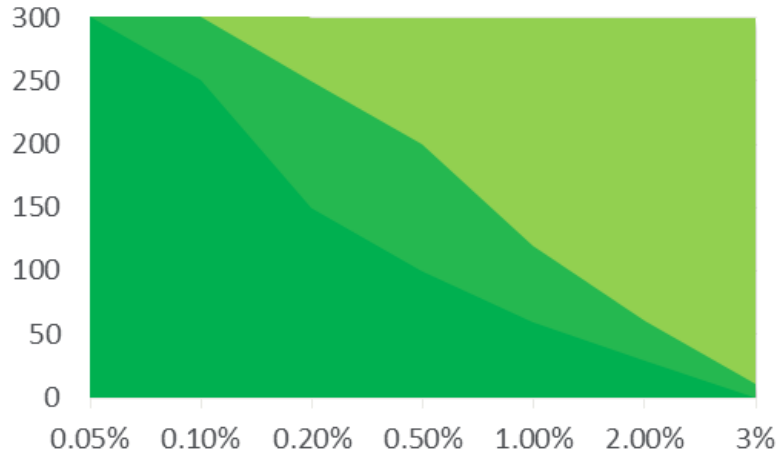
3D apps from Cloud Service Providers

- DaaS / RAaaS growth
- Lots of benefits to keeping data centralized
- Subscription model
- Seasonal/bursty demand
- Quick onboarding
- Software trials / beta testing
- CSP handles software patches/updates
- New vendor partnerships will emerge

“Framehawk” for nasty wireless connections

- Framehawk HDX technologies (now in limited Tech Preview) address the mobile worker user experience
- New ICA virtual channel based on “Human UX protocol” techniques
  - Image/pattern recognition
  - Instantly interruptible graphics layer
  - Intent engine
  - QoS signals amplifier
  - Time-based heat map



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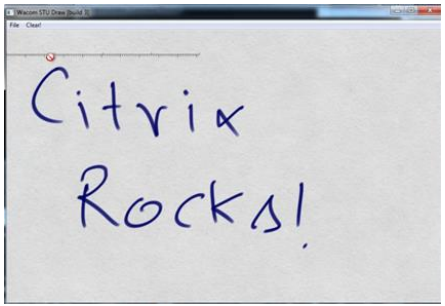
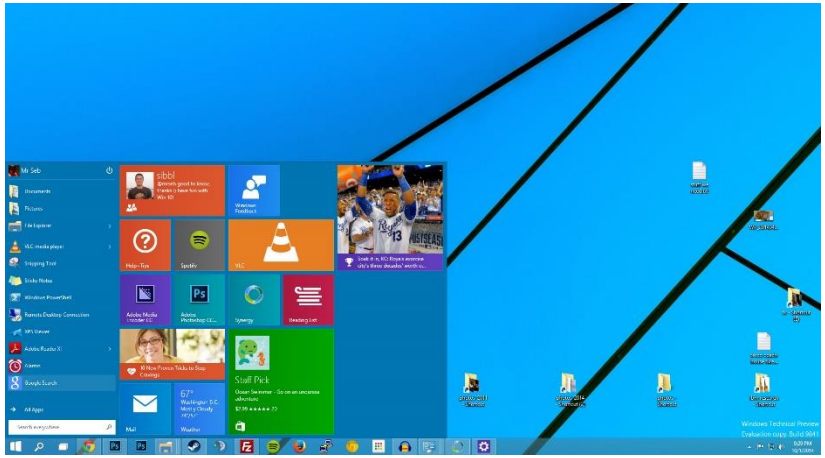
Ever-improving WAN performance

- New codec technologies (e.g. H.265)
- Continued Framehawk innovations
- WAN optimization techniques for drawing tablets (e.g. Wacom)
- Enhanced interop between XenApp/XenDesktop and CloudBridge



GPU acceleration for the masses

- No longer limited to 3D graphics professionals
- Moore's Law will improve scalability and drive down costs
- NVIDIA will see more competition from Intel and AMD



Office

Windows 10

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Tablets for content creation? How?

- Connect your tablet to a monitor, keyboard
- And soon, even a mouse for the iPad

Citrix “X1 Mouse”

Remoting of Linux apps

- IDC reports 26M paid Linux commercial client licenses
- Citrix Tech Preview of Linux VDI (initially 2D)
  - Link to sign-up: now.citrix.com/LinuxPreview
- Significant opportunity for 3D apps and HPC
- Full integration with XenApp/XenDesktop
- Use cases
  - Extend XenApp/XenDesktop to Linux app users
  - Linux ISV's and developers
  - Transition from Unix (already supported by Citrix) to Linux

This is not bleeding edge, this is prime time!

Work better. Live better.