For: Infrastructure
& Operations
Professionals

Accelerate Product Design With Digital Workspaces For 3D Visualization

by David K. Johnson, June 4, 2015

KEY TAKEAWAYS

Engineering Complex Systems Means Coordinating The Efforts Of Global Teams Of Experts

Global industries like automotive manufacturing, energy, and electronics are becoming increasingly dependent on globally distributed centers of expertise to coordinate with each other on designing and building ever more complex products.

Removing Boundaries Between Teams Will Help Them Coordinate Better And Accelerate Their Work

Complex systems design across centers of expertise requires new levels of information sharing because the products it produces must fit together and work the way your customers expect, regardless of complexity. Artificial technology barriers between teams, customers, and partners cannot stand.

Digital Workspace Technologies Help Distributed Design Teams Coordinate Their Efforts Better

Current generations of popular CAD software hail from the old world of design-in-isolation and need help to function as a more coordinated, collaborative global design system. Shifting the design models and data off distributed PCs into data centers speeds the design process and gives engineers more work-style freedom.

Accelerate Product Design With Digital Workspaces For 3D Visualization

Recent Innovations In Graphics Hardware And Digital Workspace Technologies Improve Coordination Across Distributed Design Teams

by David K. Johnson
with Christopher Voce, Michelle Mai, and Michael Caputo

WHY READ THIS REPORT

There are few things more fundamental to the competitiveness of your business than the way engineers design and develop products. 3D product design, visualization, and life-cycle management software like CATIA (Computer Aided Three-Dimensional Interactive Application), AutoCAD, and PTC Creo are powerful tools, but they're no longer a competitive advantage for engineering and design processes on their own. Instead, companies are finding competitive advantages by improving coordination and information sharing across globally distributed centers of expertise. Recent innovations in digital workspace delivery technologies, such as graphics processing unit (GPU) virtualization and rich applications-as-a-service are at the forefront because they can offer creative thinkers more autonomy, shrink the distance between teams, and move the design process closer to customers. This report draws on the experiences of early adopters and explains the digital workspace options available today, and what steps infrastructure and operations (I&O) professionals can take to prioritize and evaluate these technologies. Please note that this is an updated version of a previously published report; recent market events necessitated changes to the report to ensure accuracy.

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Forrester interviewed nine vendor and user companies: Applied Materials, Citrix, Entisys Solutions, Esri, Gulfstream Aerospace, IMSCAD, Nvidia, ThinClient Computing, and VMware.
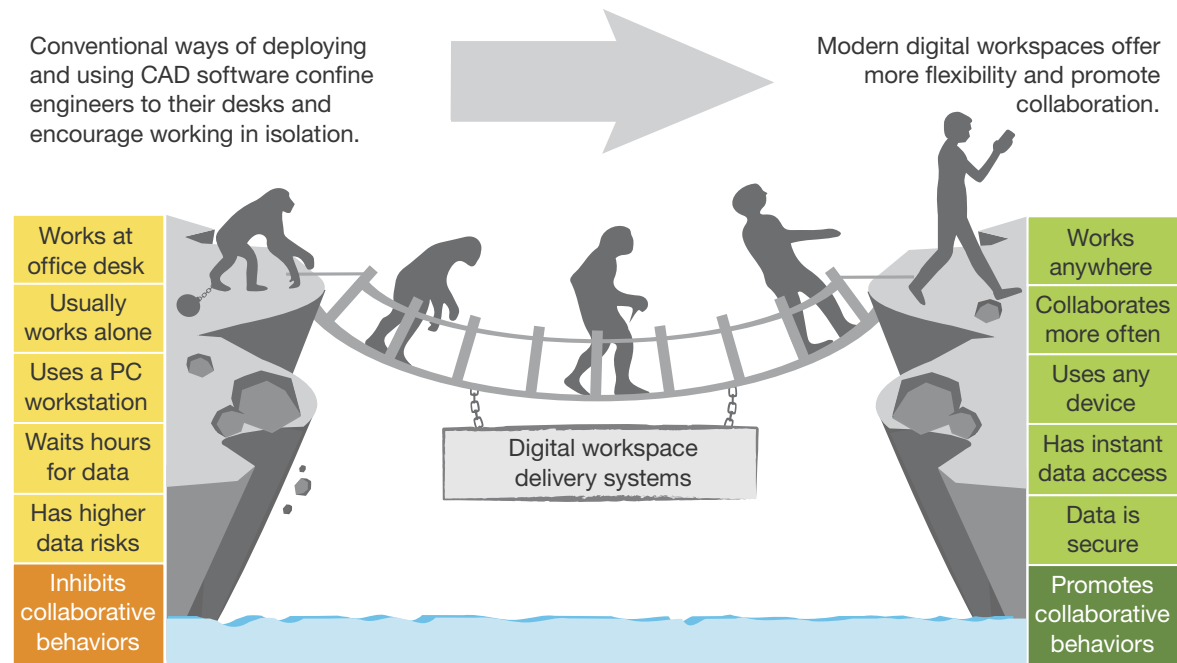
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SUCCESS IN GLOBAL MARKETS DEMANDS NEW PRODUCT DESIGN METHODS

The global flow of goods, services, and finance grew 50% between 1990 and 2012 and will triple by 2025.[1] Manufacturers are capitalizing on this now by rapidly modeling their product development operations around regional centers of expertise. Ford Motor is focusing on automobile engine design and manufacturing in Dagenham, UK, and Dearborn, Michigan, where it already has core expertise. The days of design teams working on small parts of a product in isolation are quickly coming to a close, but the current aging generation of computer-aided design (CAD) is optimized for use on high-powered PC workstations and tends to reinforce working in isolation because the processing power and data are local and out of sync with the work of others (see Figure 1).

Figure 1 Digital Workspaces Bridge The Creative Divide

Conventional ways of deploying and using CAD software confine engineers to their desks and encourage working in isolation.

Modern digital workspaces offer more flexibility and promote collaboration.

Works at office desk

Usually works alone

Uses a PC workstation

Waits hours for data

Has higher data risks

Inhibits collaborative behaviors

Digital workspace delivery systems

Works anywhere

Collaborates more often

Uses any device

Has instant data access

Data is secure

Promotes collaborative behaviors

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I&O Pros Must Build Around Existing CAD Systems To Create New Ways Of Working

By adopting new ways to deploy and use current-generation CAD technology, technology managers can help designers overcome barriers and improve their company's competitiveness in meaningful ways. Specifically, I&O pros have the opportunity to create a technology environment that:

- **Gives engineers the power of mobility and autonomy.** Engineering is a creative discipline. Psychological research shows that the most powerful motivator for creative work is the ability to make progress toward important work, every day.[2] Other key ingredients include making sure that engineers have a say in how the work will be done and that they have ample opportunities to experiment and learn new skills in the process.[3] Anything that gets in their way, disturbs their concentration and flow, or constrains their options will have subtle but disastrous effects on productivity.[4]

- **Allows for customer and partner engagement in the design process . . .** Technology investments should help make engaging customers and partners easier without sacrificing security. For example, make the relevant visual and design information more readily available and enable engineers to make changes to the design while on-site with the customer or partner when the ideas are fresh. Thin and light mobile devices allow engineers to work with designs in real time from anywhere, including at a customer site.

- **. . . while keeping trade secrets and data safe from theft.** Directly involving customers and partners in the design process does not mean giving them copies of all of the models and designs for a given product or unlimited access to your design systems. A successful technology approach is one that will allow them to see in rich visual detail the parts of the product they are directly involved with while preventing access to and protecting information they don't need. It also means that employees who travel should not have the models and designs on their computers where they can be taken or copied.

- **Eliminates the need to transfer massive models.** 3D models for complex products now routinely reach many gigabytes in size. With conventional approaches, downloading the latest versions to local workstations or transferring completed work back to the servers can take several hours. If 100 engineers are working on a project and it's time for a design review, merely uploading the models to the servers can easily consume 400 total man-hours.

- **Improves collaboration between design teams.** As designs now span multiple centers of experience spread across the globe, effective collaboration is more critical than ever. Near-real-time updates of models collapse the distance between globally distributed design teams — allowing companies to recruit top talent in more locations.

■ **Makes rich visual data accessible to more people on more devices.** It's not just the designers who can benefit from rich visual design information — others will as well. A key driver for several digital workspaces for engineering projects we reviewed is to help others, such as workers on the manufacturing floor or field service personnel, have quick and easy access to the actual models for reference purposes.

DIGITAL WORKSPACE TECHNOLOGIES PROVIDE THE KEY TO TRANSFORMATION

Forrester introduced the concept of digital workspaces in 2014 to describe the collection of technology solutions that I&O leaders could employ to ensure that workers have access to the technology they need to do their best work.[5] For engineering and design use cases, server-hosted virtual desktops will be your primary tool, as they offer the most flexibility to meet different levels of graphics processing needs. Other digital workspace technologies, such as session-based desktops, can also play a role.
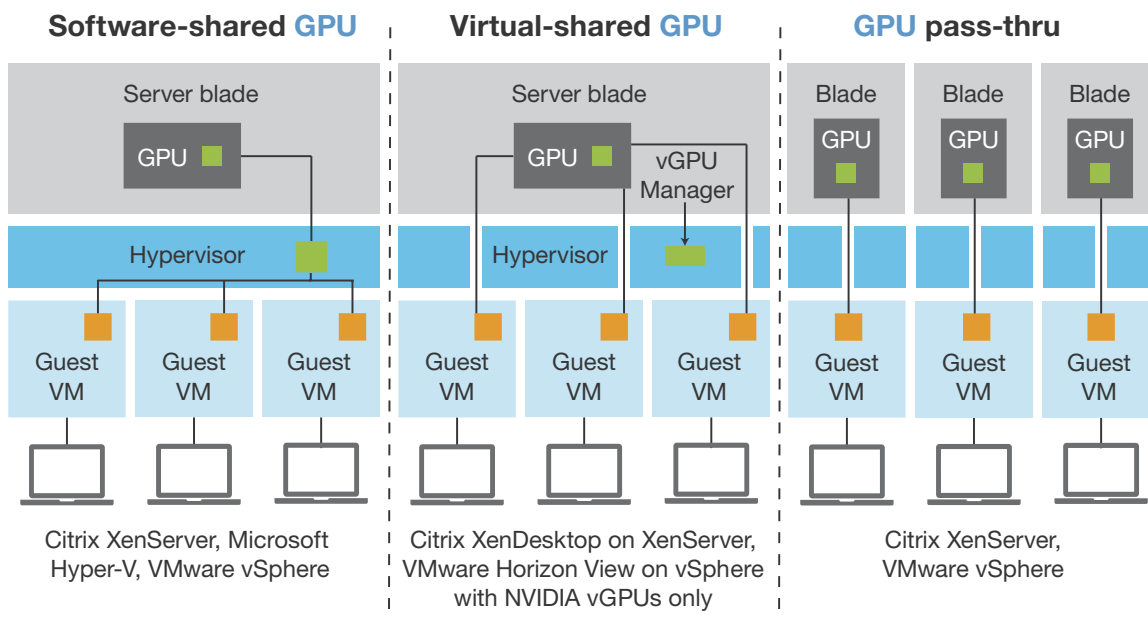
Server-Hosted Virtual Desktops (VDI) Can Now Meet A Much Wider Range Of Needs

Moving the data off the PC and into the data center opens new doors. Near-real-time model updates, faster model loading, and better collaboration, security, analytics, and transparency are vectors for new innovation and value that VDI makes possible. It can also put you in the crosshairs of some of the most vocal and motivated people in your company, if the user experience suffers. The good news is that the combination of a strong business case and high expectations from users is giving vendors the incentive to work together. Citrix led the charge in 2014 in a partnership with GPU titan Nvidia to fully virtualize server-side GPUs for VDI, followed by VMware in 2015. Our research with firms that are deploying the technology reveals that VDI:

■ **Scales to meet the needs of task workers to animators with virtual-shared GPUs.** Most VDI environments lack GPUs and instead rely on either the server's CPUs, a less-sophisticated offload card on the server, or a GPU-equipped thin client to do the rendering. This hodgepodge approach — which isn't optimal — is a root cause of VDI's mixed user experience reputation. Dedicated pass-through GPUs for VDI have been available for a few years but require one GPU for each VDI session — which is prohibitively expensive. Virtualizing the GPU with a purpose-built driver is what Citrix, Nvidia, and VMware now offer. It means that multiple VDI sessions can now have direct access to each physical GPU, and it makes a big difference in the user experience — enough to make VDI a feasible solution for all but the most demanding design work (see Figure 2).

■ **Offers a full Windows desktop environment for best application interoperability.** Engineers and designers often rely on several applications working together to get things done. For example, SolidWorks users use Microsoft Excel to clean up data and perform custom calculations, so basic functions like copy and paste or heavy use of macros and objects mean that these tools must reside in the same Windows instance to be useful. Other approaches like rich applications-as-a-service or application virtualization and streaming won't work for them.

- **Improves manageability and security of the desktop environment.** Distributed PCs are notoriously difficult and costly to manage — often requiring technicians to make desk-side visits to reimage a machine or remove malware. With VDI, desktop admins can manage every task, including OS images, and reprovision and patch individual instances centrally.[6]

- **Centralizes data and applications where they can perform better and remain safe.** When all of the applications and data — including large models — are collocated in the same data center, they can use the same high-speed data center network fabric, nearly eliminating latency, improving responsiveness, and allowing models to load in seconds instead of minutes. Also with VDI, information is only presented on the end user device's screen, so no data remains at rest on the device itself, keeping models and intellectual property safe.

Figure 2 Architectural Differences Between Approaches

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Other Digital Workspace Technologies Can Round Out Your Portfolio

Server-hosted virtual desktops are only one way to enhance the visual design and manufacturing process. Other technologies, such as rich applications-as-a-service, application streaming, and local virtual desktops, are viable options for some needs. If you're not quite ready to make the investment in VDI, or you have segments of workers that have lower GPU requirements, there are alternative digital workspace options:

- **Session-based desktops are a less costly alternative to VDI.** Citrix XenApp or Microsoft Remote Desktop Services may be viable options if you only need to offer users access to a few applications and they happen to be compatible with a session-hosted solution.[7] XenApp can also directly leverage Nvidia GPUs on the host server blades, and because there is no hypervisor involved, it doesn't require any GPU virtualization. As always, check your licensing and compatibility requirements with your design software vendor, and be aware that there are limitations to this approach. For example, application interoperability between the Citrix Receiver client for XenApp and local apps might not work as your users expect it to.

- **Native-applications-as-a-service is an option if users only need to use one or two apps.** This is a very new battleground with rapid innovation.[8] The two standouts so far are Mainframe2 and Amazon's AppStream, with Microsoft's RemoteApp currently in Tech Preview. Mainframe2 leverages the Nvidia GPUs on Amazon Web Services' G2 infrastructure. With it, you can install your 3D design apps in the Mainframe2-enabled AWS instance, and its software handles the rendering, presenting your apps through any HTML5-enabled web browser. It offers a surprisingly good user experience. Amazon's AppStream is less appealing for now because it requires modifications to application code to work. Application interoperability at the presentation layer is limited, however, so it's a better fit for users who need just a few apps and don't do a lot of data loading or processing with local files and apps.

- **Hyper-converged infrastructure achieves VDI-like rack density, without the hypervisor.** HP released Converged System 100 for Hosted Desktops (Moonshot) in December 2013. It's an "ultra-dense" chassis with blades that each hold four AMD X2150 systems-on-a-chip (SoC), which combines the CPU and GPU on a single silicon die. What makes it unique is that no hypervisor is needed because the hardware itself is so densely packed, and each instance of Windows 7 runs directly on bare metal. Citrix XenDesktop serves up the instances just like it would if they were running in virtual machines. The net result is 180 desktop instances per 4.3U chassis that still benefit from Citrix's advanced HDX remote desktop protocol. The specs are not strong enough for high-end rendering but adequate for less demanding uses, such as on the factory floor.

Visualization Needs Determine The Optimal Digital Workspace Approach

One of the advantages in using digital workspace technologies with CAD applications is that you can offer a much more tailored solution for users at different levels. It's this flexibility that makes it possible to provide more people with access to the rich visual information that the models offer. Three different tiers of service should be adequate for most environments: Tier one is the top end of engineering and graphics performance needs; tier two includes users with less intensive needs; and tier three is for the lightest editing needs and viewers (see Figure 3).

Figure 3 A Three-Tier Model Highlights The Differences Between Use Cases

Tier and typical role	Applications typically used	Typical use cases	Optimal digital workspaces	Optimal GPU configuration
Tier 1: Professional engineer or designer	• Dassault Systems SolidWorks • Autodesk AutoCAD • Siemens NX • PTC Creo	• Shading • Ambient occlusion • Meshing • 3D rendering • Animation	• Citrix: XenDesktop on XenServer • VMware: Horizon View on vSphere	• Dedicated GPU (pass-thru) • Virtual-shared Nvidia GPU
Tier 2: Power users	• Dassault Systems SolidWorks • Autodesk AutoCAD • Siemens NX	• Schematic capture • Line drawing • Simulation • Testing and verification	• Citrix: XenDesktop on XenServer only • VMware: Horizon View on vSphere	Virtual-shared Nvidia GPU
Tier 3: Knowledge workers	• Eclipse • Microsoft Visual Studio • Microsoft Excel • Adobe Illustrator	• Basic graphics creation • Line drawing • Text editing • Spreadsheets • Design viewing	• Citrix: XenApp or XenDesktop • VMware: Horizon View	• Virtual-shared Nvidia GPU • Software-shared GPU

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CASE STUDIES VALIDATE THE PREMISE AND OFFER LESSONS LEARNED

The digital workspace vendor community offers several case studies of companies advancing their engineering and design processes with digital workspace technologies long enough to see meaningful business outcomes. Forrester was able to cross-examine some of them, as well as speak with experts who specialize in the design and deployment of digital workspaces for CAD environments to gather lessons learned. We learned that:

- **Applied Materials' VDI solution outperforms its PC workstations.** Before Applied Materials' technology management team could deploy digital workspaces to its CAD users, it had to prove that the Windows Experience Index score of its desktop cloud environment would exceed what it could get on its local PC workstations. Using Citrix XenDesktop, it succeeded with a score

of 7.1 for its VDI solution versus 5.9 for its PC workstations. It also tested routine tasks with five different CAD applications, such as loading a 1.2-gigabyte SolidWorks assembly, and saw a 50% to 60% performance improvement over its PC workstations. With a dedicated GPU and six concurrent VMs running the test routines, the same routine task performance was still 35% better than its PCs.

■ **Gulfstream Aerospace mobilized its CATIA system to the factory floor and the field.** Business jet aircrafts are extremely complex assemblies of often-delicate parts that are easy to damage or assemble incorrectly. Gulfstream is deploying a combination of Citrix XenApp and XenDesktop on mobile thin client carts to workers on the factory floor to improve accuracy and quality while reducing assembly time. It gave a mix of iPads and laptops to its field service team members to use with the Citrix Receiver running over Wi-Fi and LTE networks to provide them with better information. It also allows them to manipulate the models in real time so they can make sure they know how to perform service work.

RECOMMENDATIONS
TAKE SEVEN STEPS TO SUCCEED WITH DIGITAL WORKSPACES FOR CAD

As model sizes and design complexity continue to increase, forcing new levels of collaboration across increasingly mobile teams, CAD use cases are an unusually good fit with digital workspace technology. It solves problems unique to manipulating large, visually rich data. To succeed, I&O professionals should:

■ **Put user experience at the center of their strategy and priorities.** Employees will reject technologies that make their work more challenging, so before choosing any technology, consider carefully how the technology will affect employees' enjoyment of their work — this is especially true for engineers and designers. Use user experience and satisfaction metrics to track the health of your digital workspace delivery projects. Manage expectations by starting small with a group of supporters, and give them a strong voice in guiding the initiative. Steve Greenberg, president of Thin Client Computing, told us during an interview that the most important step is to form a detailed picture of your users and how they work before selecting a digital workspace technology.

■ **Take the opportunity to enrich the desktop experience with cloud services and personalization.** The experience that employees end up having with your digital workspace investment should be better than they had with their PC workstation. For example, you can enrich their desktop environment with cloud services, such as file sharing and an enterprise app store, while making sure their personal settings and applications persist from one session to the next.

- **Hire outside expertise to help plan and execute.** One of the top things that technology management decision-makers say they would do differently next time is to hire more outside expertise and capacity. Choose a provider with deep expertise with all of the digital workspace solutions of your primary software vendor for the initiative, along with any third-party add-ons you're planning to implement at the same time.

- **Put together an overlay team to collapse technology silos.** Another common sentiment was that if they could go back, they would put together an overlay team to collapse the technology silos and settle debates. Digital workspace technologies rely on several parts of IT infrastructure, and a separate team typically manages each, such as storage, networking, servers, and application management teams, who each may have conflicting priorities and plans. Because the user experience will be critically important to the overall success of the project, appoint a senior person to head the overlay team and empower that person to override technology-led decisions when necessary to ensure that the user experience remains the top priority.

- **Consider add-on technologies to enhance the user experience.** Interviewees said third-party add-ons are common in CAD environments. Tools like VMware's vSAN, Citrix Melio, and Atlantis ILIO boost storage performance, tools from Riverbed Technology and Citrix boost network performance, and tools from AppSense and RES Software manage the user environment to allow all users to personalize their environment while minimizing storage costs.

- **Consider investing in more sophisticated monitoring capabilities.** Because digital workspace delivery systems bring together and cross many elements of your technology infrastructure, it can be very difficult to troubleshoot the root causes of performance issues and anomalies. Investing in better instrumentation and analytics for infrastructure monitoring is a wise investment. Interviewees frequently mentioned tools from eG Innovations and Lakeside Software for this purpose.

- **Use Nvidia vGPUs with XenDesktop or Horizon View for a better user experience.** A driver-based approach to virtualizing the GPU offers better performance than conventional GPU sharing approaches across a wider range of media and conditions, and with broader graphics API support. Both Citrix and VMware now offer a driver-based GPU virtualization solution.

SUPPLEMENTAL MATERIAL

Companies Interviewed For This Report

Applied Materials	IMSCAD
Citrix	Nvidia
Entisys Solutions	ThinClient Computing
Esri	VMware
Gulfstream Aerospace	

ENDNOTES

[1] "Flows of goods, services, and finance in 2012 reached $26 trillion, or 36% of global GDP — 1.5 times as large relative to GDP as they were in 1990. If the spread of digital technologies and rising prosperity in emerging economies continues, global flows could nearly triple by 2025 and boost economic growth." Source: James Manyika, Jacques Bughin, Susan Lund, Olivia Nottebohm, David Poulter, Sebastian Jauch, and Sree Ramaswamy, "Global flows in a digital age," McKinsey & Company, April 2014 (http://www. mckinsey.com/insights/globalization/global_flows_in_a_digital_age).

[2] Source: Teresa M. Amabile and Steven Kramer, *The Progress Principle: Using Small Wins to Ignite Joy, Engagement, and Creativity at Work*, Harvard Business Review Press, 2011.

[3] "The need for control from above must be balanced against the need for autonomy that even the humblest person holds dear. Especially destructive is the behavior of those managers who insist upon controlling others not for the benefit of the organization but to bolster their own personal quest for power." Source: Mihaly Csikszentmihalyi, Flow: The Psychology of Optimal Experience, Harper Perennial Modern Classics, 2008.

[4] Knowledge workers face a paradox: The technology intended to make them more effective actually distracts, drains, and demotivates them instead. Rapidly changing customers and market conditions demand creativity and the highly productive cognitive state called "flow." But a workplace optimized for routine tasks destroys flow and saps energy. See the "A Crisis Of Attention: Technology, Productivity, And Flow" Forrester report.

"In conclusion, achieving flow at work is made difficult by obstacles that militate against the conditions necessary for flow to occur. All too often, the job fails to provide clear goals, adequate feedback, a balance of challenges and skills, a sense of control, and a flexible use of time. Considering all these obstructions, it is remarkable how often people at work are still able to experience flow. Nevertheless, redesigning the workplace promises to lead to an enormous improvement in the 'bottom line' of human happiness." Source: Mihaly Csikszentmihalyi, *Flow: The Psychology of Optimal Experience*, Harper Perennial Modern Classics, 2008.

[5] Forrester's digital workspace delivery systems (DWDSes) framework captures the rapidly evolving landscape of technologies for delivering access to applications and resources from any device and provides a snapshot of key information within each category so you can make better decisions. See the "Build Digital Workspace Delivery Systems To Give Employees The Right Tools For Their Job" Forrester report.

[6] In order to drive out cost and complexity, I&O pros have been trying to standardize on a single PC image stamped out across the company. Workers come to the table with different requirements, and the homogenous approach means that you overspend on some and underserve others, and employees lack the freedom to use new apps that help them do their jobs better. Forrester's workforce enablement playbook focuses on how I&O leaders need to rethink the people, processes, and technology in workforce computing. See the "Create A Habitat Of Technology Engagement And Enablement For Your Workforce" Forrester report.

[7] Rather than instances of desktop OSes running individually as with VDI, Remote Desktop Services sessions run in a single shared server operating system (e.g., Windows Server 2012) and can provide connections to both individual applications or full desktops as needed. This is a very mature market space with proven technologies. See the "Build Digital Workspace Delivery Systems To Give Employees The Right Tools For Their Job" Forrester report.

[8] When ready, a worker can begin using the application almost immediately — it looks and behaves like a locally installed application while the download process continues in the background until all "pages" are locally installed and available online or offline. See the "Build Digital Workspace Delivery Systems To Give Employees The Right Tools For Their Job" Forrester report.