



# How Virtualized Graphics Improve the Win 10 Education Experience





**Virtual desktop infrastructure (VDI) has evolved significantly in recent years, achieving unprecedented levels of mobility, capability, versatility and security. VDI has also become very popular in educational environments. Educational institutions value VDI for the cost-savings potential, but also for the rich user experience that VDI enables for teachers and students.**

However, the applications and technological tools integral to modern-day learning environments are becoming more graphics intensive. As a result, performance problems stemming from the use of graphics-intensive applications have become increasingly commonplace in educational environments. The typical approach of rendering graphics through the CPU diverts the VDI from enabling the top performance of the tools and applications upon which schools have come to depend. CPUs were not designed to process visual representations of objects efficiently.

Educational institutions from K-12 to universities are rapidly migrating from physical desktops to Citrix virtual desktops. Accordingly, there is a need to enable graphics capabilities in VDI that equals or exceeds the graphics capabilities of physical PCs. This paper describes how hardware-based virtualized graphics technology perfectly complements Citrix VDI in enabling everything from (standard) Windows 10 environments to the most advanced graphics applications. The paper also discusses the ancillary benefits that a hardware-based GPU solution provides, including reduced operational costs, superior performance and a personalized learning experience.



## Business Challenge Summary

### Reading, writing and 'rithmetic.

The three R's have formed the foundational bedrock of educational curricula for centuries. That is not likely to change. But the tools and processes with which those subjects are taught have shifted greatly.

As with all other aspects of modern life, the education system is transforming to keep up with the information age. In the United States alone, it is estimated that IT spending by K-12 schools increased to about \$4.7 billion in 2015, most of which on general PC upgrades or investments in applications.<sup>1</sup>

And, as with all transformations, some difficulties and challenges have happened along the way: the need to centralize operations, the need to lower the costs of providing each student access to

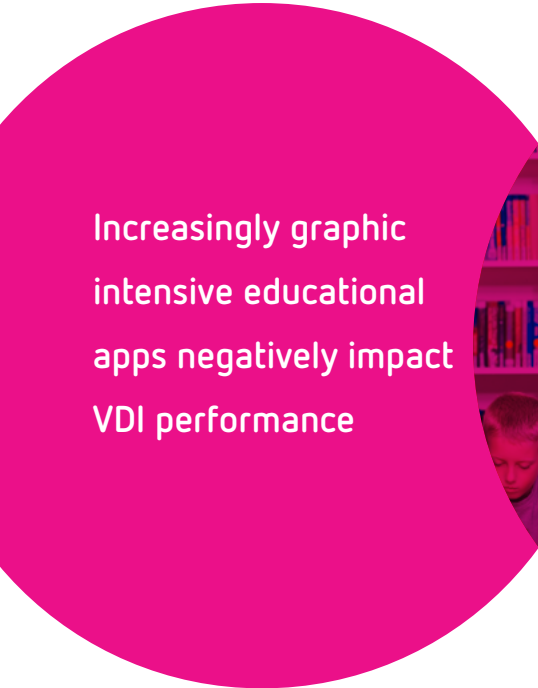
online content, the urgency of protecting confidential student and faculty data, the desire to provide anywhere, anytime access for instant collaboration. These are just a few of the issues education IT administrators face every day.

All these problems can be addressed with one of the technological marvels of the information age: VDI. For many educational institutions, the single most important benefit of VDI might be the centralization of hardware. Citrix VDI provides the ability to deploy centralized virtual environments to students.

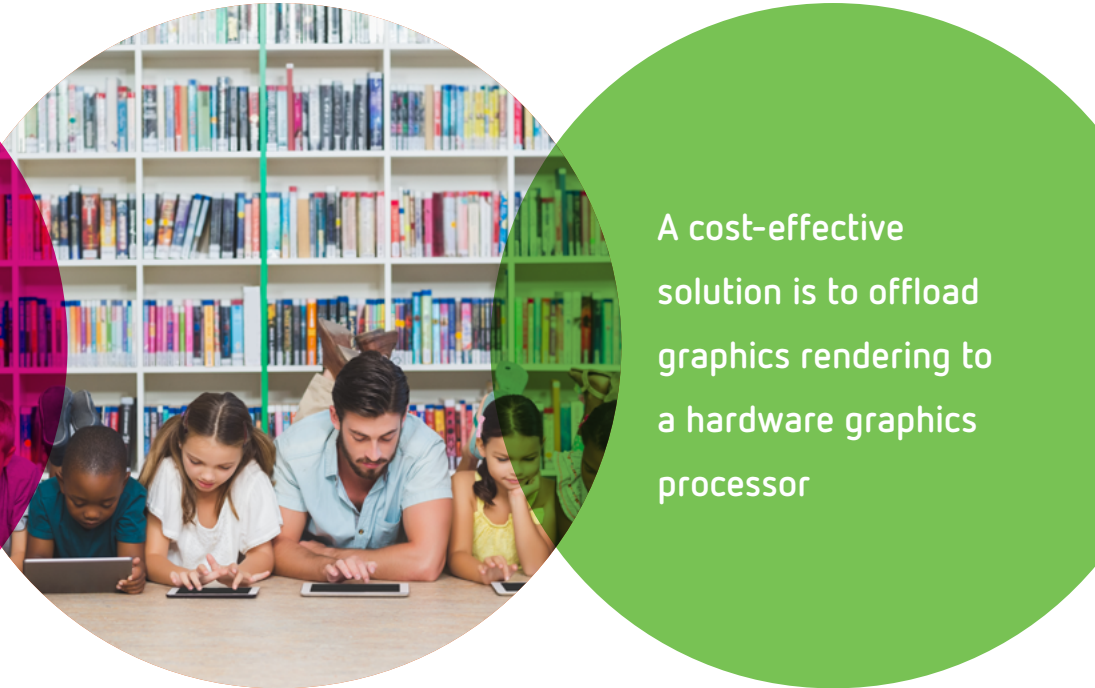
Many educational institutions are quite aware of the benefits of VDI, and have implemented virtual desktop solutions. But they have encountered a problem: graphics.

The increasingly graphics-intensive nature of standard Windows 10, commonly used applications and web content - as well as long standing professional design applications - has negatively impacted the performance of VDI systems. Slow load times, jerky video playbacks and a range of other performance issues have resulted.

Fortunately, an easily implemented, highly cost-effective solution exists. Education institutions can offload graphics rendering to a hardware graphics processor. Hardware-based virtualization eliminates the performance impact of modern, graphics-intensive apps, and restores the full range of VDI benefits to educational institutions.



Increasingly graphic intensive educational apps negatively impact VDI performance



A cost-effective solution is to offload graphics rendering to a hardware graphics processor

<sup>1</sup> <http://www.centerdigitaled.com/higher-ed/US-Education-Institutions-Spend-66-Billion-on-IT-in-2015.html>



## Overview: Citrix Ready Education Solutions Program

The Citrix Ready Education Solutions program has been launched with the sole objective of building and sharing a library of white papers and case studies to portray the best integrated joint solutions for education institutions. Each of these documents illustrates the teaming of a Citrix partner and Citrix solution in helping educational organizations to create a secure, mobile-ready campus that provides the seamless experience today's students expect — access anywhere, anytime and on any device.

Through this program, Citrix identifies and showcases partner technologies, such as applications, peripherals and endpoints, to help educators and schools find solutions that enable and support a rich and secure student experience. By expanding beyond traditional methods, educators can inspire and support lifetime learning, providing the tools of education wherever and whenever students, faculty and staff need them. These solutions help to satisfy a smooth

and reliable integration with the latest Citrix XenDesktop and XenApp versions that address the following challenges, initiatives and trends currently facing the education industry:

1. **Transforming the Student Experience**
2. **Learning Space Redesign**
3. **Secure Student & Research Data**
4. **Learning & Business Continuity**

### Overview of AMD MxGPU

AMD designs and integrates technologies that power millions of intelligent devices, including personal computers, game consoles and cloud servers.

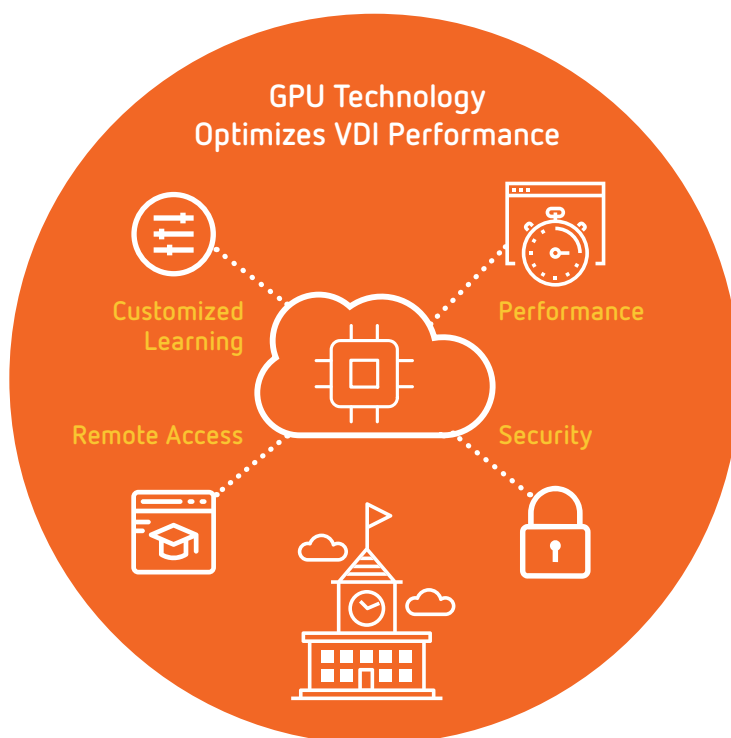
AMD's hardware-based virtualized graphics solution, MxGPU, delivers full GPU acceleration to remote connected users while expanding educational opportunities and reducing costs. MxGPU implements

Single Root I/O Virtualization (SR-IOV), which provides a device with the ability to replicate mirror images of itself — essentially, creating multiple true virtual GPU instances.

MxGPU lets educational institutions eliminate proprietary and complex software from the hypervisor while providing a dedicated frame buffer for consistent performance. Bypassing the software layer for graphics processing frees up CPU capacity that otherwise might be bogged down by graphics-intensive applications. Concurrently, each user enjoys the benefits of full GPU acceleration, which is currently lacking in most educational virtual environments.

MxGPU technology delivers a range of benefits that are crucial for optimizing VDI performance in educational institutions. Key benefits for educators include the following:

- **Performance:** All virtual desktop users are provided with access to a virtual GPU instance. And since virtual GPUs are attached to virtual machines, users do not experience any of the performance lags often experienced with graphics-intensive applications.
- **Security:** The elimination of graphics orchestration from the software virtualization layer eliminates a potential point of vulnerability. All user desktop data is stored in hardware, where it is more secure.
- **Remote Access:** Students and faculty are not restricted to any specific device or location. Virtual desktops and applications are available on almost any connected desktop, laptop or mobile device, from any location.
- **Customized Learning Experience:** VDI with GPU eliminates the need for students to remain in lockstep. Students can learn at their own pace, accessing course materials as needed. Self-paced learning helps keep students engaged and can boost academic performance.



AMD's hardware-based virtualized graphics solution, MxGPU, fulfills two key objectives of the Citrix Ready Education Solutions program.

One objective of the program focuses on **transforming the student experience**. The potential impact of modern technology on education is enormous — truly transformative. MxGPU helps realize that potential by enabling the improved performance that permits students, teachers and researchers to access all of the applications they need from a VDI environment. Everything from Learning Management Systems to Windows apps to graphics-intensive 3D apps can be delivered through comprehensive desktops with XenDesktop or as individual published apps with XenApp.

The ability to provide students with anytime, anywhere access permits students and staff to have the same high-quality experience whether on campus or off, whether it's an institutional or BYO device. This enables instant collaboration wherever learning occurs.

Last, each student can learn at a pace that is optimized for him or her — possibly the single most transformative benefit offered by VDI in combination with MxGPU technology.

MxGPU also helps IT administrators to maintain the infrastructure that optimizes the student experience. Many educational institutions currently face significant budget constraints. Investing in AMD's hardware-based virtualized graphics solution in a VDI

environment solution helps IT administrators make the tradeoffs to maintain and even improve performance on static or reduced budgets.

MxGPU also helps to **secure student and research data**, another objective of the Citrix Ready Education Solutions program. Unfortunately, education is one of the industries most frequently targeted by cybercriminals. University Business recently reported that between 2005 and 2016, higher education institutions suffered more than 500 breaches involving nearly 13 million data records. And in 2000, secondary educational institutions were subjected to the Federal Trade Commission's Safeguards Rule, which establishes compliance protocols for information security.<sup>2</sup>



Transforming the Student Experience

Secure Student and Research Data

<sup>2</sup> <https://www.universitybusiness.com/article/0816-wisp>



Educational institutions using AMD's hardware-based virtualized graphics solution significantly reduce their vulnerability profiles. Since MxGPU is hardware based, the software attack surface posed by software graphics virtualization is eliminated. Hardware-based virtualization is far more resistant to hacking attacks than software-based virtualization. And VDI combined with MxGPU technology helps enable the centralized management that further enhances security.

MxGPU integrates seamlessly with Citrix virtual desktop infrastructure. AMD virtual GPU can be available to any end user connecting to XenDesktop with the same configuration.

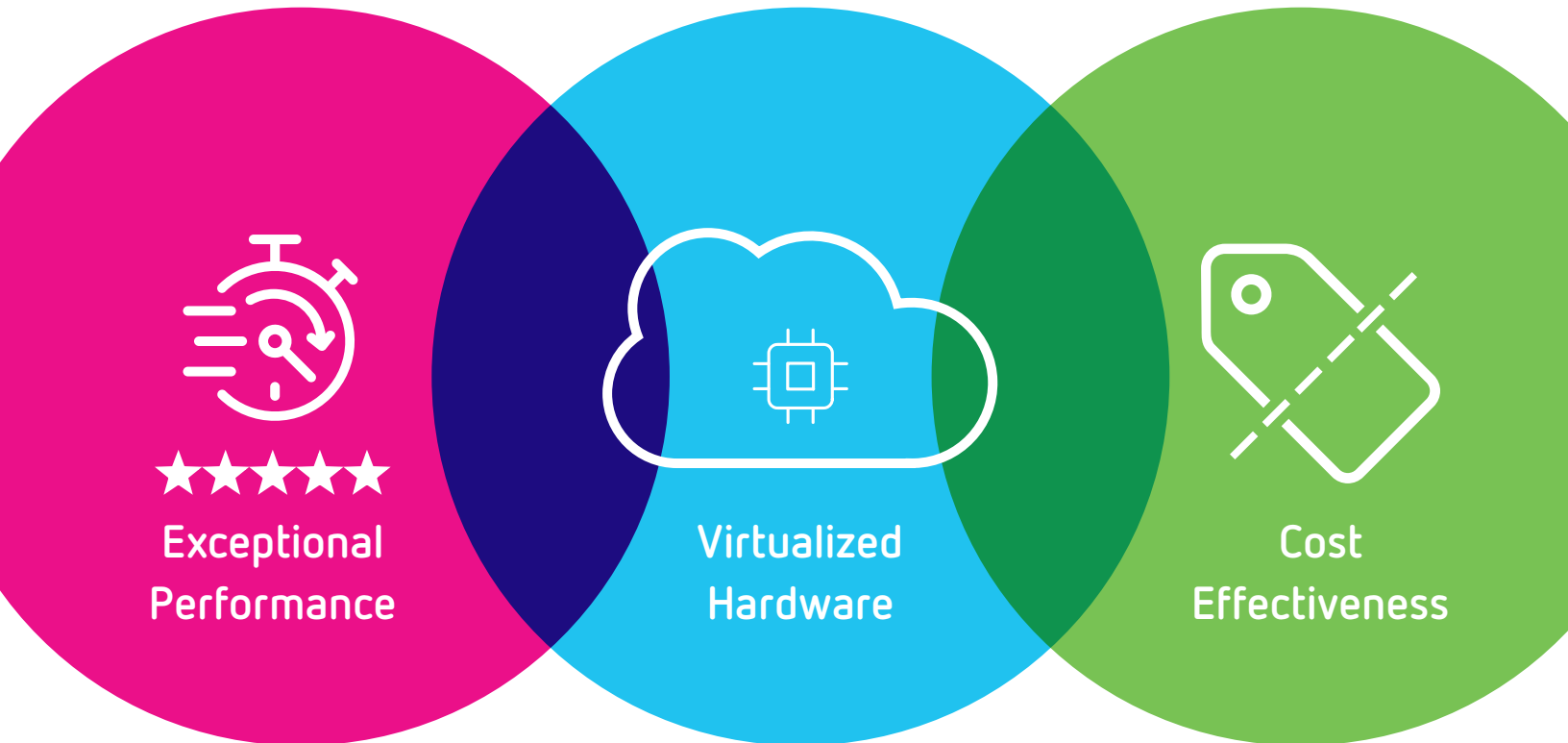
AMD's hardware-based virtualized graphics solution offers several innovative and unique features that simply aren't available with

any competing product. Features unique to MxGPU include:

- **Exceptional Performance:** MxGPU's hardware-based virtualization assures peak performance while helping ensure total compatibility by using native drivers — no long lead times are required for specialized drivers to integrate with XenDesktop and XenApp. Proprietary and complex software is also eliminated from the hypervisor while providing a dedicated frame buffer for consistent performance. The industry-best performance enabled by MxGPU enhances access to existing curricula, while simultaneously presenting opportunities for curricula expansion.
- **Virtualized Hardware:** From the user's perspective, AMD's hardware-based virtualized graphics solution is akin to

having a physical graphics card in their desktop system. Each virtual machine utilizes native AMD drivers that provide 100 percent compatibility with, and access to, all the GPU graphics and compute functions on the server.

- **Cost Effectiveness:** Centralizing compute and GPU resources reduces the need to purchase and maintain individual workstations or laptops, enabling greater reliance on secure and economical VDI deployments. Hardware-based virtualization eliminates the need to purchase and maintain costly software licenses. And once the initial AMD GPU cards have been purchased, there is no need for additional software purchases to virtualize the GPU.





## AMD Solution Detail

AMD has been selected to participate in the Citrix Ready Education Solutions program because its hardware-based virtualized graphics solution beneficially impacts the performance of VDIs in educational environments. AMD's unique approach to supporting graphics in VDI environments was highly instrumental in motivating the selection of AMD to the Citrix Ready program. AMD's products, in fact, are the world's first hardware virtualized GPUs.

Competitors take a different approach, placing a general-purpose GPU in the server, and then using software to "virtualize" the GPU, enabling the sharing of the GPU from the server to the users. In contrast, AMD's hardware-based virtualization has the ability to duplicate the GPU independently within each virtual machine, eliminating the need for a supporting software layer for tasks such as synchronization, scheduling, etc. A single AMD GPU card can support graphics acceleration for up to 32 simultaneous users.

Single-Root I/O Virtualization (SR-IOV) is the key to AMD's hardware-based graphic

virtualization. SR-IOV enables consistent graphics performance across all virtual machines, providing each VM user with equal access to GPU time. Accordingly, all users in a VDI experience graphic support equivalent to having "their own" GPU card.

Specific benefits made possible with SR-IOV technology include:

- Delivery of hardware GPU scheduling logic (with high precision quality-of-service) to each VDI user
- Preservation of the data integrity of virtualized machines and their application data through hardware-enforced, dedicated memory regions
- Provision of all GPU graphics functionalities to applications, enabling full virtualization support for both graphics APIs and compute APIs

While SR-IOV technology is not new, AMD has adapted it to bring virtualization to GPU hardware, making virtualization native to

the hardware. AMD's industry-first MxGPU combines with Citrix VDI to set new standards in:

- **Performance:** MxGPU technology enables consistent, predictable and secure performance for virtualized desktops, providing virtual machine users with up to workstation-class advanced graphics capabilities.
- **Memory:** Provides GPU memory sufficient to help accelerate applications and process computationally complex workflows with ease.

Citrix/AMD joint solutions provide secure, anytime access to instructional, research and administrative applications and data. They promote student success and engagement. And they also help to reduce operational costs by placing the management of complex, multi-campus environments under centralized IT administrative control.





Together, Citrix solutions team with AMD's hardware-based graphic virtualization to deliver a range of benefits that enhance and modernize the learning environment for all educational levels. Specific benefits for educational institutions include the following:

- **Simple and Easy Access:** Citrix/AMD solutions provide students, faculty and staff with a personalized desktop and application experience at home or at school. Simplified, anywhere, anytime access enables the use of educational resources that can increase student and staff productivity while making learning more engaging and enjoyable. And AMD's hardware-based graphic virtualization assures that the most advanced, graphics-intensive educational applications are always accessible.
- **Lower Operational Costs:** Citrix technology extends the life of PCs and other classroom devices by running desktops and applications on a centralized server instead of on individual devices. Schools can use existing devices in the classroom until their end-of-life, with no need to worry about older operating systems and applications that may no longer be supported. This provides

significant cost savings by minimizing the frequency of device replacement.

AMD's hardware-based graphic virtualization assures that virtual machines, served by a centralized server, offer users full graphics-intensive capability. And initial infrastructure investments and operational costs are also lowered since AMD's GPU can eliminate the need to pay many software licensing fees.

- **Stronger Data Protection:** Citrix solutions protect resources by storing them centrally, where they are managed directly by IT, instead of storing them on user devices. During user sessions, only keystrokes, mouse clicks and screen refreshes traverse the network. And from a centralized and scalable Citrix environment, desktops, applications and information are easily web-enabled and securely delivered to any device anywhere, with granular authenticated access.

AMD's hardware-based graphic virtualization provides an additional layer of security by making it more difficult for hackers to break-in at the hardware level. A hardware protection mechanism also enforces guest memory isolation.

- **Seamless Continuity:** Citrix solutions address both simple interruptions due to system upgrades or local power outages, and significant outages due to natural or man-made disasters. Server processing and utilization is easily balanced across multiple server farms at one or more datacenters. During an interruption, access to desktops, applications and data can be instantly redirected to an alternate site so that displaced faculty and students can continue teaching and learning seamlessly from an alternate location or their homes.

AMD's GPU enhances continuity by supporting mobile and remote access, both during the course of normal operations, and during transitions that may occur in response to system interruptions. Hardware-based graphic virtualization enables full graphics-acceleration on any connected device from virtually any location at any time.







## A Proven Partnership that Makes Modern Technologies and Applications Accessible for Students, Faculties, and IT Administrators

“Education is the foundation upon which we build our future.” That nugget of wisdom is attributed to Christine Gregoire, past Governor of the state of Washington. A related quote, slightly pithier but just as accurate, is attributed to the late British statistician Sir Claus Moser: “Education costs money, but then so does ignorance.”

It is likely that virtually all professionals in the field of education would wholeheartedly agree with both statements. But in recent years, the administrators of many educational institutions might be feeling the latter statement just a bit more fervently. Education does cost money, and those costs are moving in only one direction. And technology is a significant contributor to the rising costs of education. Assuring that students and faculties are supplied with the latest in cutting-edge technology is an expensive proposition.

But it is important. Technology has quickly grown into an integral component of educational systems worldwide. Technology provides a wealth of benefits to the educational process that simply cannot be overlooked.

According to the U.S. Department of Education, “Technology ushers in fundamental structural changes that can be integral to achieving significant improvements in productivity. Used to support both teaching and learning, technology infuses classrooms with digital learning tools, such as computers and hand held devices; expands course offerings, experiences, and learning materials; supports learning 24 hours a day, 7 days a week; builds 21st century skills; increases student engagement and motivation; and accelerates learning. Technology also

has the power to transform teaching by ushering in a new model of connected teaching. This model links teachers to their students and to professional content, resources, and systems to help them improve their own instruction and personalize learning.”<sup>3</sup>

Balancing the benefits with the costs of acquiring and maintaining technology is an ongoing challenge for school administrators. And technological solutions that combine cutting-edge capabilities with cost-controlling features are likely to be of great interest to any educational administrator.

Together, Citrix and AMD offer such a solution.

Citrix solutions have become integral components of the move toward modernization at many educational institutions. They are used to create flexible IT infrastructures that enable mobility in teaching and learning, protect student and research data, and foster collaborative learning environments.

Currently, Citrix solutions are utilized in:

- **The top 10 highest ranked universities**
- **All U.S. “Big Ten” universities**
- **The top 10 largest U.S. school districts**

But educational software applications have become far more graphics-intensive in recent years. Other modern-day educational tools, such as streaming video, also require graphics acceleration capability. Accordingly, many educational institutions find themselves facing the need to modernize the graphics capabilities of their IT systems.

“Education costs money, but then so does ignorance.”

*Sir Claus Moser*

Citrix VDIs in combination with AMD’s MxGPU offer a perfect solution. Citrix virtual desktops provide enhanced security, flexibility and capability, all while reducing costs. AMD’s hardware-based virtualized graphics solution, MxGPU, delivers full GPU graphics acceleration to remote connected educational users, and also provides cost-reducing benefits along with stronger data security.

AMD’s selection to the Citrix Ready Education Solutions program provides educational institutions with a proven, reliable solution for graphics acceleration in virtual environments.

<sup>3</sup> <https://www.ed.gov/oii-news/use-technology-teaching-and-learning>

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For more information about AMD, please visit:  
<http://www.amd.com/en>

To learn more about AMD's server graphics,  
please visit: <http://www.amd.com/en/products/servers-graphics>

For more information about Citrix application and  
desktop virtualization, please visit: <https://www.citrix.com/virtualization/>

## Appendix

Learn more about the Citrix Ready Vertical  
Solutions Program for Education at: [http://citrixreadyprogram.com/2017/citrix\\_ready\\_vertical\\_solution\\_programs/](http://citrixreadyprogram.com/2017/citrix_ready_vertical_solution_programs/)

To learn more about the Citrix Ready Program  
partnership with AMD, please visit: <https://citrixready.citrix.com/amd-advanced-micro-devices/amd-firepro-s7000.html>

To learn more advanced graphics capabilities for  
virtualized desktops, contact [Citrix](#) and [AMD](#).



### About Citrix Ready

Citrix Ready identifies recommended solutions that are trusted to enhance the Citrix Delivery Center infrastructure. All products featured in Citrix Ready have completed verification testing, thereby providing confidence in joint solution compatibility. Leveraging its industry-leading alliances and partner ecosystem, Citrix Ready showcases select trusted solutions designed to meet a variety of business needs. Through the online catalog and Citrix Ready branding program, you can easily find and build a trusted infrastructure. Citrix Ready not only demonstrates current mutual product compatibility, but through continued industry relationships also ensures future interoperability. Learn more at [citrixready.citrix.com](http://citrixready.citrix.com).



### About AMD

AMD is a semiconductor design innovator leading the next era of vivid digital experiences with its groundbreaking Accelerated Processing Units (APUs) that power a wide range of computing devices. AMD's computing products are focused on driving industry-leading cloud computing and virtualization environments. AMD's superior graphics technologies are found in a variety of solutions ranging from game consoles, PCs and workstations as well as supercomputers. For more information, visit <http://www.amd.com>.

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