Virtually Delivered High Performance 3D Graphics

Secure collaboration with 3D data on all devices

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Virtually Delivered High Performance 3D Graphics

Remote 3D graphics technology allows high performance computing hardware, used to support 3D design, to be implemented and managed centrally to provide support to physically distributed professionals. Sophisticated servers supporting CPU and GPU virtualization allow information technology to be managed effectively and allocated dynamically across different types of computing technology including mobile technology. This technology addresses a variety of business issues including data security, collaborative design support, 3D data access on mobile devices, engineering desktop consolidation, disaster recovery, and sharing expensive computing resources across distributed locations efficiently. IBM, Citrix and NVIDIA, long-time partners in desktop virtualization, have developed solutions that combine powerful infrastructure (server, storage, networking, and software) and cloud computing technology with advanced remote desktop software that uses server-based 3D graphics hardware to support professionals needing remote access to advanced graphics capabilities.

Introduction

"A picture is worth a thousand words." That old phrase is as true today as it ever was. Pictures (i.e., those with heavy graphical content) are still too large to easily transfer using the Internet or company wide area networks (WANs). Historically, high-powered desktop computers with dedicated 3D graphics hardware were required to support data creation and modification. In addition, the 3D data needed to be on the local area network (LAN), since opening the large files from remote servers was too time-consuming. In some companies, even the typical LAN (1Gb Ethernet) is too slow for the multi-gigabyte data sets that are becoming common.

In this paper, CIMdata reviews business issues associated with graphics-intensive data and 3D applications that can now be addressed by remote 3D graphics technology. This paper also includes an overview of virtualization—a key technology that facilitates flexible cost-effective implementation of a 3D visualization strategy.

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Going Global

Over the last few decades, businesses have become much more global. Medium-sized and even small businesses are able to leverage resources around the globe due to advances in transportation, logistics, computing, and communication

technologies. “Design Anywhere, Build Anywhere” has become an important strategy to take advantage of distributed resources for delivering better products faster and at lower cost. To execute this strategy, the right data and applications have to be accessible to the right people at the right time, independent of where the people are located.

To be successful in today’s competitive business climate, companies must improve continuously. For example, an important question that must be addressed regularly is how new technologies—or old technologies applied in new ways—can be used to improve business performance. Providing both secure access to 3D data and support collaboration with the appropriate application to view or edit that data—either in a remote office, on the shop floor, out in the field, or even at a supplier or customer site—can provide significant benefits to a business.

Competitive businesses need to be focused on innovation, time to market, quality, efficiency and cost reduction. To create or modify 3D data, high performance hardware is required but is often not well employed. Each person requiring access to the 3D CAD data authoring application requires their own dedicated engineering desktop computer, possibly another computer for running office applications, and the associated administrative overhead to manage both. The reality is that most 3D authors are not manipulating 3D data 100% of the time—they have meetings and other non-3D tasks that usually occupy a significant part of their day. In addition, the standard workday is eight hours, and then the lights go out. Few companies use their CAD hardware for two shifts, let alone three.

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As businesses become increasingly dependent on data as a critical asset, the risks associated with the data must be mitigated. Controlling access to data is a core risk, and it has several components, including security, speed of access, and quality of access. Only the right people must get access to data at the right time. Quality in this context is being able to access the data with the relevant tool to accomplish a desired activity.

CIMdata’s Research

At CIMdata, our research into remote 3D graphics, visualization and virtualization technology has shown that their benefits are real. Collaboration, data access and security issues can be addressed by leveraging remote 3D graphics technology. The latest virtualization solutions enable secure collaboration as well as predictable, scalable performance to be distributed efficiently for the rendering and visualization of large graphical data sets.

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Research Methodology

In addition to research and ongoing discussions with our industrial clients, CIMdata recently conducted an online survey focused on several scenarios or use cases related to remote 3D visualization. The survey ran for two weeks, promoted within the CIMdata and ConnectPress communities as well as on

Twitter and LinkedIn. The survey captured demographic information about the respondent and their company, including company role, 3D graphics related activities, and software used. Five use cases were described and a series of questions were asked about each use case. This paper focused on the top four use cases:

- Secure collaborative design
- Providing mobile access to data
- Reducing the impacts of hardware and software upgrades
- Disaster recovery support

In addition, some non-use–case-specific questions were asked to capture targeted data points. The use cases and our research results are detailed below.

Survey Demographics

It is important that survey respondents fit the right demographic for assessing the remote 3D visualization solution. Overall, CIMdata believes that our survey captured the right type of respondents to help us understand the relative value of the four use cases. Over 50% of our respondents came from companies larger than $1B, an appropriate target market for advanced hardware and software technologies.

Over 50% of our respondents come from companies larger than $1B and 63% of the respondants indicated that they act as authors, reviewers, or viewers of 3D data.

Our respondents are active users of 3D in their jobs, with 63% claiming roles as authors, reviewers, or viewers of 3D data. Nearly 90% of our respondents were in North America and Europe. Ideally the geographic spread would be broader, but based on our annual global PLM market analysis these geographies have historically been the largest investors in PLM-enabling technologies, making this a valuable set of survey respondents.

3D Remote Graphics Use Cases

A major purpose of the study was to determine which use cases the respondents saw as more valuable to their organizations. The use case discussions that follow are ordered based on the relative value placed on them by the survey respondents.

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Secure Collaborative Design

Collaboration is key to the modern product development organization. Activities requiring access to 3D data can be spread around the globe, which raises security and performance issues. This use case was the highest ranked by respondents, with a normalized score of 58.2 on a scale of 0 to 100, where lower numbers represent better scores. As shown in Table 1, almost all of our respondents are collaborating well beyond the four walls of their physical location.

Table 1—Collaboration Activities

Collaborative Design Activity	Percentage
Collaborate with people in other facilities or companies	97%
Collaborate across time zones	86%
Share 3D data and/or applications with collaboration partners	91%

Designing a complete, robust, and secure environment for data requires addressing both physical and electronic issues. Modern PLM solutions have sophisticated security schemes that allow granular control over what information users can access. Users log in to the corporate network, and have access to specific data and applications that control the information they may find, view, and modify. Access to the network is implied, and while it is normal for employees, typically only trusted partners are given this level of access. A significant risk with this level of access is physical data access. Both browser-based and client-server applications used to view or modify the data may download data to the local computer either in a temporary location or by executing a local save. This local copy of data can now be emailed or copied to a flash drive or otherwise be taken outside of corporate security.

For partners with less trust, such as a new or commodity-component supplier, companies often set up an external collaborative environment. This type of environment is usually disconnected from the main data repository, and resides outside the corporate firewall or in a separate security zone. Each supplier will only receive the data necessary for their job, possibly with data simplified and out of context from the whole product. The supplier will typically create a local copy of the data, which is again outside of corporate security and can be copied to a flash drive or e-mailed. This is important because, as shown in Table 2, many of our respondent companies are involved in outsourcing.

Table 2—Outsourcing

Outsourcing Activity	Percentage
Outsource some product development	66%
Transfer data to outsourcing partners	79%
Allow partners direct access to data	39%

Remote 3D graphics technology is compatible with direct data access or with external collaborative environments and improves data security. In this use case, a server executes the 3D CAD application and only sends the display information to the remote computer. The actual data never leaves the security environment of the data center, providing an additional layer of security.

In addition to security, remote 3D visualization also can provide improved data integrity and performance.

In addition to security, remote 3D graphics virtualization can also provide improved data integrity and performance. Data integrity is improved because the data stays within its environment (either the main repository or the collaborative workspace), and the authoring application configuration is controlled. Performance is improved because there is no longer a wait time to download

large datasets that in extreme cases can take hours. This can significantly improve productivity and reduce cycle time on projects. Also, the impact of network latency is reduced on client server applications, such as when a local copy of an application accesses data from a remote server. This approach could prove to be valuable to many of our respondents, as fewer than half of them synchronize data across multiple locations, and nearly 60% do not synchronize data with suppliers at all.

While a lot of collaboration is happening with 3D data, including outsourced design and manufacturing, asynchronous collaboration appears to be the most common method. A big question is whether the right data is being used due to the low rate of synchronization. Network performance and security are the biggest impediments to synchronous collaboration.

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Mobile Access to Data

Accessing data on the go is a relatively new phenomenon. Advances in hardware and wireless networking are core enabling technologies. Laptops today typically weigh less than five pounds; even mobile workstation-class laptops can weigh less than ten pounds. Screen sizes range from thirteen to seventeen inches, which are usable, though far from optimal. At this size, the equipment can be reasonably carried and set up on the shop floor or at a job site. Besides screen size, the Graphical Processing Unit (GPU) is where portable hardware is limited when compared to desktop hardware. High-performance GPUs consume significant power and therefore draw batteries down quickly. This use case was ranked second by our survey respondents, with a normalized score of 89.7 out of 100.

At the leading edge of mobile access, even five pounds is a lot to carry, and mobile professionals are transitioning to lightweight, lower powered laptops and tablets like the iPad. For example, Table 3 illustrates that while only 14% of our respondents currently access data on tablets, 61% would like to use a tablet to access 3D data. While the lighter devices generally work well for business tasks like e-mail, spreadsheets, and word processing, users struggle to manipulate 3D data on them—if it is even possible. In the case of tablets, few professional graphics-oriented tools have been converted run on them due to the low-performance hardware.

Only 14% of our respondents currently access data on tablets, 61% would like this type of access to be supported in their work environment.

At CIMdata we are following mobile PLM technology closely. So far, many vendors have released basic 3D applications on mobile devices, but few have full product functionality. Reasons for this include hardware and software limitations, and a clear understanding of mobile device use cases. Remote 3D software allows full native Microsoft Windows applications to be run even on non-Microsoft Windows hardware. It is not realistic to expect that significant 3D data authoring will occur on a tablet or smartphone, due to the small screen and touch interface, but measurements and simple changes are possible. A common example would be when a supervisor on a manufacturing shop floor accesses CAD data to answer a production question. As an additional benefit, administration is done on the server, minimizing overhead and support. And

finally, the same security issues that exist with collaboration also exist with mobile technology. Remote 3D graphics can eliminate the risks associated with lost or stolen mobile technology.

Table 3—Current and Desired Mobile Access Technology

Mobile Access Technology	Currently Use	Would Like to Use
Laptop	88%	12%
Tablet	14%	61%
Smartphone	9%	46%
Wi-Fi	61%	30%
Cellular (e.g., 3G, 4G)	16%	43%

Most of the respondents are able to work remotely with laptops and Wi-Fi, CIMdata expects that the 30% unable to access data via Wi-Fi cannot do so due to company security policies. Tablets and smartphones are not used broadly yet for 3D access, but there is a significant amount of interest to be able to do this.

Hardware and Software Upgrades

In any business, return on investment (ROI) is a key metric. It is usually not easy to calculate the ROI of desktop hardware upgrades. Faster hardware may only saves seconds or minutes from individual activities and if network transfer speed is an issue, there may be no improvement. What is missing in this analysis is an assessment of quality. Creating products using 3D data is an iterative process that rarely finishes early. There are usually ideas that are not included due to lack of time. Better software performance allows more iterations, resulting in better products. In addition, it can improve job satisfaction; waiting for a computer to respond is frustrating. Reducing the negative impacts of hardware and software upgrades was ranked third by our respondents, with a normalized score of 90.9.

It may be even more difficult to calculate the ROI of a software upgrade. New features certainly can have a positive impact, and fixing known software defects can reduce risks and improve quality. Unfortunately, the cost of rolling out a new version can be substantial if there are a lot of desktops involved, and it can be especially expensive if there is significant variation in the desktop configurations.

Remote 3D graphics supported by virtualization in the computer room can minimize the cost of desktop hardware and software upgrades, and can even be more ecologically friendly. As described in the sidebar, virtualization allows computing resources to be collapsed into a dense package that can be shared and dynamic scheduling software allows the resources to be dynamically allocated to where they are needed. This dense packaging minimizes power and space requirements. Since remote 3D graphics do not need high performance local resources, the desktop upgrade cycle can be lengthened, with lower-cost desktops purchased as necessary, saving both cost and landfill space.

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The infrastructure (servers, storage, networking and software) used to support virtualization is scalable and flexible. Once the base infrastructure is in place, incremental processing power can be added at a low cost when necessary. Management software allows resources to be optimally utilized and tracked. Compute-intensive software applications may be able to leverage many of the resources in parallel to create a much more powerful computing environment than could be put on a desktop. This solution can be leveraged by anyone with network access to the server and appropriate security privileges, regardless of their location. In addition, the cost and complexity of software upgrades can be reduced because the update only needs to be validated against the well-known virtual machine instance and loaded on the server once, not deployed to each desktop.

Table 4—3D Desktop Performance

Hardware and Software	Percentage
Does your company have a standard 3D desktop configuration?	79%
Is the performance of 3D desktop hardware adequate?	72%
Is non-standard 3D desktop hardware deployed to support tactical needs?	48%
Is the performance limit of 3D desktops exceeded more than 40% of the time?	34%
Is downtime experienced due to software upgrades?	30%

Table 4 shows the majority of respondents indicated that their companies have central control of hardware configurations, which reduces support costs, but almost half will deploy non-standard hardware to meet tactical requirements. Adding the non-standard 3D capacity and capability reduces economies of scale, adding to both the acquisition and support costs.

Disaster Recovery

Disaster recovery is typically not well considered. For example, fully one-third of our respondents said that product development tools are not adequately supported in their disaster recovery plans. Only 52% of respondents claimed that 3D tools are part of the plan.

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Information Technology (IT) typically performs backups, and the more advanced companies have backup data centers, but a big question is what happens to a product development center in a disaster. Disasters can range from relatively small power outages caused by hurricanes or sunspots to facility destruction caused by earthquakes or tsunamis. To properly support disaster planning, both manufacturing and product development need to be addressed. Setting up new office space is easier than setting up a new factory, but it is not trivial. Procuring specialized, expensive 3D workstations can be costly and time consuming and will have an impact on time-to-market. Remote 3D graphics technology offers the ability to use easily obtained commodity desktop

hardware, which should enable faster setup of a recovery site, and even offer the opportunity for employees to use their personal hardware at home.

Disaster recovery strategy was not well understood by the survey respondents. This lack of knowledge may be due to disaster recovery being an IT function in most companies. Ensuring access to 3D data is understood to be important, but how the risk is mitigated is not clear.

Discussion

Table 5 shows the comparative ranks of all five use cases. The collaborative design use case had by far the highest rank. More than half of the respondents rated it number one or two. It had more than twice the number of number-one votes than the second-place use case. The remaining three use cases were within about 10% of each other in importance.

Table 5—Use Case Importance Ranking

Use Case	Score*
Secure Collaborative Design	58.2
Mobile Access to Data	89.7
Hardware and Software Upgrades	90.9
Disaster Recovery	95.2

*Lower is better, normalized from 0 to 100

Based on the survey results, our respondents see value in remote 3D visualization technology. Price-performance issues are crucial to the adoption decisions for 83% of respondents.

Based on the survey results, our respondents see value in remote 3D graphics technology. Given that, what are the issues most likely to limit their adoption? Price-performance issues are crucial to adoption decisions for 83% of respondents. Table 6 provides more color on the most important issues.

Table 6—Impediments to Implementing Remote 3D Visualization

Impediment	Percentage
Network Performance	64%
Security	58%
Cost	38%
Support from PLM Solution Providers	34%
Other (most comments were regarding education & awareness)	17%

Not surprisingly, network performance is the number-one response, which is typical for solutions perceived as requiring significant bandwidth. Security, a big issue in the PLM space more broadly, comes in as number two.

Any companies offering solutions to cover these use cases must address these important user concerns.

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Remote 3D Graphics and Virtualization Solution

Citrix has provided remote access and visualization solutions on Microsoft server platforms since 1995. Their technology is used in thousands of companies by millions of users.

Remote 3D graphics visualization is a client-server process, but with a twist: the server can be virtual—even running in the cloud. Client software, known as a receiver, runs on the end-user's computer and communicates with the remote 3D graphics application on the Microsoft Windows server. The Microsoft Windows desktop runs on the server and only the display is transmitted to the end user. Since the data only traverses the datacenter network, higher performance is possible. Data compression enables good end-user performance with about 2 Mbps of bandwidth.

The Microsoft Windows desktop environment and any applications are run on the server's central processing units (CPUs) and GPUs and can access data as if it were a physical computer. The Citrix Receiver can also run on a variety of different platforms including Microsoft Windows, Linux, Mac OS, Android, and Apple iOS, among others. This variety of platforms provides support for mobile users out in the field or on the shop floor. It also provides access to the data on datacenter storage at high speed over datacenter networks eliminating slower local and wide area network access.

For PLM users, and especially 3D design software users, the most interesting part of the Citrix product line is XenDesktop with HDX 3D Pro. This solution can take advantage of GPU hardware to perform graphics calculations supporting both Microsoft DirectX and OpenGL. Using this solution allows data to be rendered quickly and smoothly for an optimal user experience. In addition, it allows support for most, if not all, 3D Microsoft Windows applications. The HDX 3D Pro can operate in several modes. It can be configured to share a GPU across multiple users, dedicate a GPU per user, and allow a single user to access multiple GPUs to support extreme graphic demands.

The second part of the remote 3D graphics visualization solution is the infrastructure, which includes the server, storage, network and software. IBM's solution enables GPUs to support many users, as well as allowing single or multiple GPUs to be dedicated to individual users. Virtualization allows remote 3D visualization users to appear to have their own Windows workstation and leverage the HDX 3D Pro technology. IBM can support this infrastructure with servers installed on-premise or can provide access to IBM's private cloud.

What is Virtualization?

Virtualization is the process of abstracting a resource and defining an interface to access that resource. IT or computing technology is commonly architected into layers. By rigorously defining the interfaces between layers, it becomes much easier to upgrade a layer or even change out its fundamental technology

without interrupting the overall solution. The TCP/IP networking protocol used by the Internet is a good example. At the lower levels the wiring has changed dramatically from thick wire to thin wire to 10BaseT to 100BaseT to 1000BaseT, and from copper wires to fiber optic cables. Any computer connected to the Internet is basically unaware of those lower-level changes, but can take advantage of the speed increases provided by new wiring-related materials.

GPU Virtualization

GPUs are processors optimized for graphics calculations and are now a standard processor in every smartphone, tablet and PC. Their parallel architecture enables them to calculate visual information much faster than a general purpose CPU. Up to now the options for putting GPUs into servers were limited, but with NVIDIA GRID GPUs widely being supported by server manufacturers IT professionals can find everything from rack mount servers to blades with a range of GPU options. This means users can experience the same level of graphics performance via a remote desktop or application as they have at their desk

Historically, remote 3D graphics software required a dedicated GPU per remote session, however, a new approach now available will support an arbitrary number of users on a single GPU when needs are lighter than those of a full GPU. This new approach will enable maximum performance and optimal utilization.

CPU Virtualization

Modern servers contain many central processing units (CPUs) that can operate in parallel. Infrastructure software from vendors such as Microsoft, VMware, and Citrix have technology that allows the server to create virtual desktop instances that appear as Microsoft Windows workstations on client computers. The magic of virtualization is that there does not have to be a one-to-one correspondence between Microsoft Windows desktop instances and CPUs. A single CPU may support multiple desktops with low performance demands or a single desktop instance may leverage multiple CPUs if it has high performance demands.

Concluding Remarks

The organization of computing technology moves in cycles from centralized to decentralized and back. The goal of these changes is always to improve performance and to adapt to new circumstances and technologies without taking on undo risk. Technology flexibility is the key to adaptation. 3D graphics terminals started with direct connections to a mainframe CPU. Over time they evolved into UNIX workstations and high-end PCs with local CPUs and GPUs. The latest iteration of technology enabled by network infrastructure, remote access software, and virtualized hardware is causing a shift back toward centralization.

The most interesting point of remote 3D graphics and virtualization is how flexible the technology is. This is demonstrated by the diversity of applicable use cases ranging from mobile and remote data access, collaboration, security, disaster recovery, and hardware upgrades. These are all mainstream issues experienced by businesses every day. The benefits of these technical applications allow companies to focus on their core product capabilities while minimizing the resources spent on complex IT systems.

The combination of IBM, Citrix and NVIDIA products and offerings can provide a solution that scales from the requirements of a small workgroup to those of large global companies to virtually deliver high performance 3D graphics. In addition, it can help smaller companies take advantage of global resources to compete more effectively and manage business issues more easily while reducing investments in hardware and software. And finally, it can enable full access to large 3D datasets on mobile devices.

The combination of IBM, Citrix and NVIDIA infrastructure, technologies, software and services can provide a solution that scales from the requirements of a small workgroup to those of large global companies.

Our survey results show that collaboration is the most important use case for remote 3D visualization. Using remote 3D graphics and virtualization to provide access to data and applications can make a significant impact. Enabling direct access to data to allow synchronous collaboration can improve product development speed and quality. The lack of data synchronization all but guarantees that mistakes are made from working on an outdated version of data. Proper planning is necessary to ensure that network performance and security do not become issues.

About CIMdata

CIMdata, a leading independent worldwide firm, provides strategic management consulting to maximize an enterprise's ability to design and deliver innovative products and services through the application of Product Lifecycle Management (PLM) solutions. Since its founding nearly thirty years ago, CIMdata has delivered world-class knowledge, expertise, and best-practice methods on PLM solutions. These solutions incorporate both business processes and a wide-ranging set of PLM-enabling technologies.

CIMdata works with both industrial organizations and providers of technologies and services seeking competitive advantage in the global economy. CIMdata helps industrial organizations establish effective PLM strategies, assists in the identification of requirements and selection of PLM technologies, helps organizations optimize their operational structure and processes to implement solutions, and assists in the deployment of these solutions. For PLM solution providers, CIMdata helps define business and market strategies, delivers worldwide market information and analyses, provides education and support for internal sales and marketing teams, as well as overall support at all stages of business and product programs to make them optimally effective in their markets.

In addition to consulting, CIMdata conducts research, provides PLM-focused subscription services, and produces several commercial publications. The

company also provides industry education through PLM certification programs, seminars, and conferences worldwide. CIMdata serves clients around the world from offices in North America, Europe, and Asia-Pacific.

To learn more about CIMdata's services, visit our website at www.CIMdata.com or contact CIMdata at: 3909 Research Park Drive, Ann Arbor, MI 48108, USA. Tel: +1 734.668.9922. Fax: +1 734.668.1957; or at Oogststraat 20, 6004 CV Weert, The Netherlands. Tel: +31 (0) 495.533.666.

About Citrix

Citrix (NASDAQ:CTXS) is the cloud company that enables mobile work styles—empowering people to work and collaborate from anywhere, easily and securely. With market-leading solutions for mobility, desktop virtualization, cloud networking, cloud platforms, collaboration and data sharing, Citrix helps organizations achieve the speed and agility necessary to succeed in a mobile and dynamic world. Citrix products are in use at more than 260,000 organizations and by over 100 million users globally. Annual revenue in 2012 was $2.59 billion. Learn more at www.citrix.com/Xendesktop/3D

About IBM Cloud Computing

IBM has helped thousands of clients adopt cloud models and manages millions of cloud based transactions every day. IBM assists clients in areas as diverse as banking, communications, healthcare and government to build their own clouds or securely tap into IBM cloud-based business and infrastructure services. IBM is unique in bringing together key cloud technologies, deep process knowledge, a broad portfolio of cloud solutions, and a network of global delivery centers. Learn more at www.ibm.com/smartcloud.

About NVIDIA

NVIDIA (NASDAQ: NVDA) awakened the world to computer graphics when it invented the GPU in 1999. From our roots in visual computing, we've expanded into super, mobile and now virtualized computing. The introduction of NVIDIA GRID and GPU virtualization delivers visually demanding applications from either on-premise or cloud based virtualized servers. Learn more at www.nvidia.com/GRID