

---

# Server-based Computing in Education



**CITRIX<sup>®</sup>**

---



Today's academic institutions face critical IT challenges that rival those of any industry. Students, faculty and administrative staff, whether they are on campus, at home or working from remote facilities, need access to a growing number of academic applications, as well as the Internet. Every year, IT professionals working for schools, colleges and universities must support a new influx of students using a variety of computing equipment—from 286 PCs to the latest hand-held devices. Academic institutions of all sizes, confronted with limited IT budgets, are searching for innovative ways to support students and faculty, while simultaneously leveraging their existing computing investments.

In this paper, we will look at the IT challenges of the education community, and explore how Citrix® Server-based Computing solutions can benefit any academic institution, regardless of size, location or computing environment.

- Section 1: IT Challenges of Academic Institutions
- Management Challenges
  - Access Challenges
  - Performance Challenges
  - Security Challenges
- Section 2: Citrix Server-based Computing: A Better Approach
- How Does Citrix Server-based Computing Work?
  - What is Citrix ICA (Independent Computing Architecture)?
  - Role of ICA
  - Server-based Computing Compared to Network Computing and Traditional Client/Server Computing
- Section 3: How Citrix Server-based Computing Solves the Challenges of Academic Institutions
- Management Solutions
  - Access Solutions
  - Performance Solutions
  - Security Solutions
- Section 4: Citrix Server-based Computing Scenarios for Academic Institutions
- Satellite Campus Computing
  - Cross-Platform Computing
  - Web Computing
  - Remote Computing
  - Thin-Client Device Computing

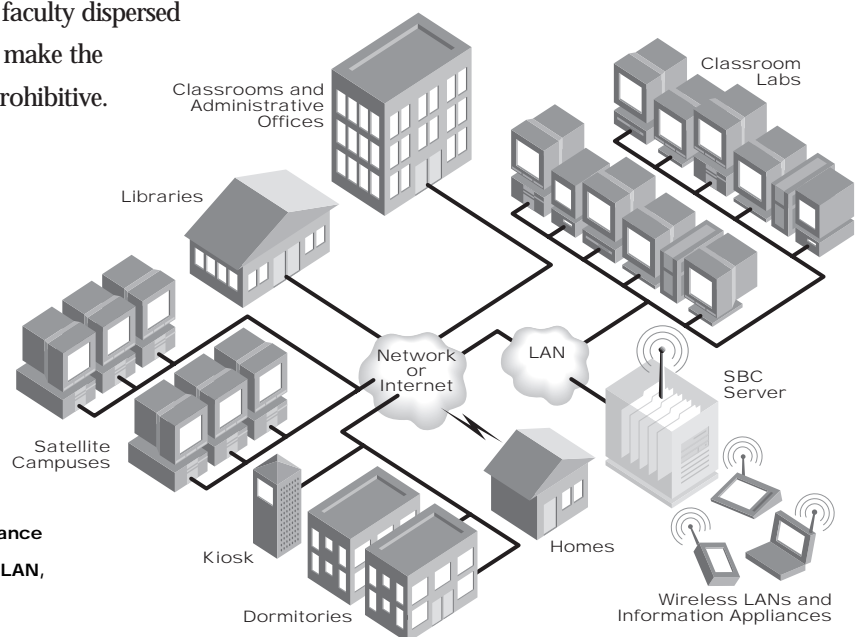
## IT Challenges of Academic Institutions

The fiscal restraints and special user needs of the academic community provide a select set of IT challenges. Finding solutions for these challenges is all the more difficult because of the limited range of solution products available today. While some products are targeted at one or two problem areas, IT professionals in academia need technology solutions which can address the total scope of management, access, performance and security.

### Management Challenges

Deploying vital applications in an academic environment has always been complex, time-consuming and, ultimately, expensive. Beyond having to physically distribute applications to every client device, IT staff must solve the inherent problems associated with version control, support, multiple system configurations and data replication. Managing IT for a large university campus with thousands of students and faculty dispersed across a variety of locations can quickly make the expense of application ownership cost-prohibitive.

**Server-based computing leverages your existing resources by extending applications and data to your various classrooms, departments and campuses. Students and administrators can use virtually any device and get LAN-like performance over multiple types of connections, including LAN, WAN, Internet and direct dial-up.**



### Access Challenges

Most academic computing environments comprise a broad mix of disparate client devices, operating systems, LAN protocols and network connections. Providing students and faculty with access to Windows®-based applications in this type of environment is difficult at best and often involves costly upgrades, problematic emulation software and complete application rewrites.

### Performance Challenges

Applications designed for high-bandwidth networks and powerful desktop computers are not well-suited for the variety of client devices and network connections in use at academic institutions today. These applications strain already congested networks and yield poor performance over low-bandwidth and remote connections. As a result, many students and faculty simply avoid using the applications altogether, and the institution's investment in the application is wasted.

## Security Challenges

Security issues are especially difficult because, in traditional client/server architectures, critical applications and data exist not only on the server, but also on client desktops spread across the network. With classified data dispersed to so many client devices, the risk of unauthorized users gaining access to confidential information, or data getting lost or stolen, is greatly increased.

## Citrix Server-based Computing: A Better Approach

Citrix Server-based Computing is an innovative approach to delivering vital applications to end-user devices (clients). With this approach, all applications are deployed, managed, supported and executed 100 percent on the server. It doesn't matter if the client device is a full-featured PC, a notebook computer, a legacy PC, a Macintosh® system, a UNIX® workstation or a true "thin-client" device like a Windows-based terminal or hand-held information appliance. In server-based computing, all client devices function as "thin clients" and all have the ability to access and work in highly graphical, Windows-based applications on the server.

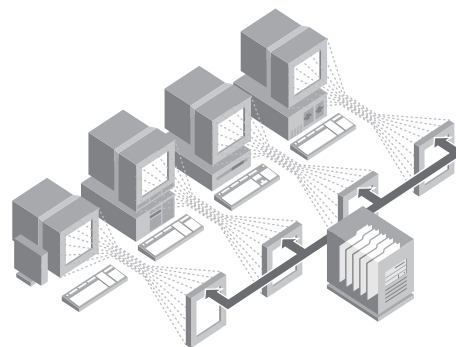
The benefits of the Citrix approach are unparalleled. Universities and other academic institutions are better able to extend the use of their existing hardware and networks. Application installations, updates and additions are made only once—on the server—and then are instantly available to users anywhere, with exceptional performance. IT staff have the ability to manage applications on the network from a single point and provide system-wide security for data and applications.

The end result: server-based computing is rapidly becoming the most reliable way to reduce the

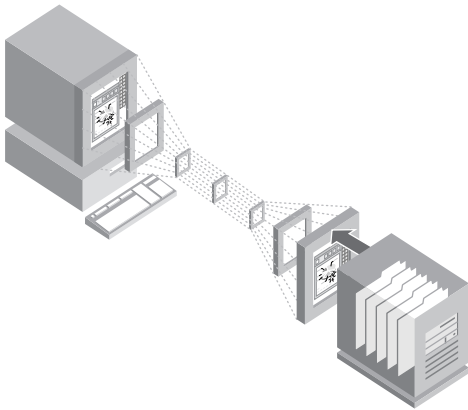
complexity and total costs associated with large, complex computing environments.

## How Does Citrix Server-based Computing Work?

Citrix Server-based Computing is comprised of three critical technology components. The first is a multi-user operating system which enables multiple concurrent users to log on and run applications in separate, protected sessions on a single server. The second is a remote presentation services protocol that separates the application's logic from its user interface, so only keystrokes, mouse clicks and screen updates travel the network. As a result, application performance is bandwidth-independent. The third key component, centralized application and client management, enables large computing environments, such as a state university system, to overcome the critical application deployment challenges of management, access, performance and security.



In server-based computing, multi-user capabilities allow applications and data to be deployed, managed, supported and executed 100 percent on the server.



A highly efficient remote presentation services protocol separates an application's logic from its user interface and allows only keystrokes, mouse clicks and screen updates to travel the network.

### What Is Citrix ICA (Independent Computing Architecture)?

Citrix ICA® is a computing architecture which shifts the burden of application processing from client device to server. This allows organizations to deliver applications and information anywhere, to any device, operating system or network infrastructure.

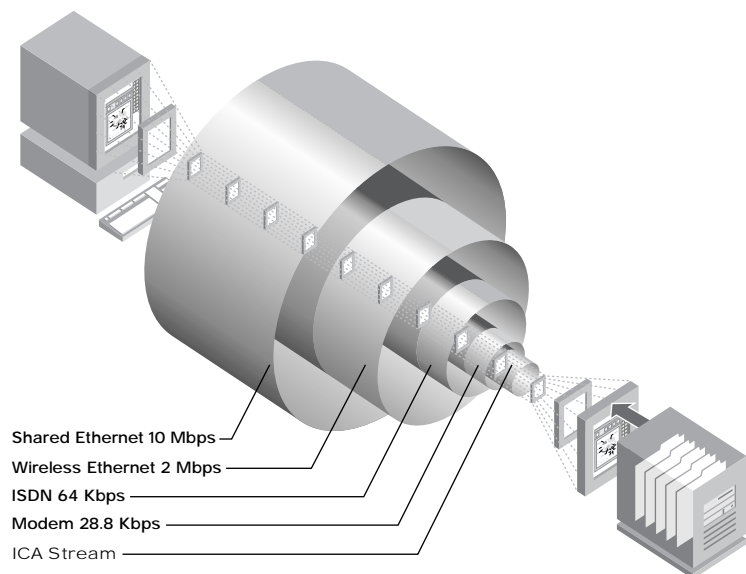
Citrix ICA includes a server software component, a network protocol component and a client software

component. On the server, Citrix ICA has the unique ability to separate the application's logic from the user interface at the server and transport it to the client over standard network protocols—IPX, SPX, NetBEUI, TCP/IP and PPP—and over popular network connections—asynchronous, dial-up, ISDN, Frame Relay and ATM. On the client, users see and work with the application's interface, but 100 percent of the application logic executes on the server. Citrix ICA transports keystrokes, mouse clicks and screen updates over standard protocols to the client, consuming less than 20 kilobits per second of network bandwidth.

### Role of ICA

The efficiency of Citrix ICA enables the latest, most powerful applications to be accessed with exceptional performance from existing PCs, Windows-based terminals, network computers and a new generation of business and personal information appliances. With over two million ports in use worldwide, Citrix ICA is a mature, reliable technology that is quickly becoming the *de facto* industry standard for server-based computing.

Server-based computing provides an ideal solution for bandwidth-constrained environments. It offers users LAN-like application performance over virtually any type of connection.



## Server-based Computing Compared to Network Computing and Traditional Client/Server Computing

While all three computing models have a valid role in today's enterprises, it's important to note the differences between them. In the traditional client/server architecture, processing is centered around local execution using fat, powerful hardware components. In the network computing architecture as defined by Sun, Oracle, Netscape, IBM and Apple, components are dynamically downloaded from the network into the client device for execution by the client. But with the Citrix server-based

computing approach, users are able to access business-critical applications—including the latest 32-bit Windows-based and Java™ applications—without requiring them to be downloaded to the client. This approach also provides considerable total cost of application ownership savings since these applications are centrally managed and can be accessed by users without having to rewrite them.

Some of the other differences in the three types of architectures are listed in the following chart:

Computing Architecture	Server-based Computing	Network Computing	Traditional Client/Server
Processing Model	100% Server Execution	Download and Execute	Local Execution
Hardware Footprint	Thin or Fat	Fat	Fat
Application Architecture	Monolithic, Component or 2- or 3-Tier Client/Server	Component	2- or 3-Tier Client/Server
Native Device	Variable or Fixed Function (PC, NPC, NC, WBT)	Variable Function (NC)	Variable Function (PC)
Native Application Type	Windows or Java	Java	Windows

Basically, the server-based computing approach delivers all the benefits of both host computing and personal computing.

### Host Computing Benefits

- Single-point management
- Physically and technically secure
- Predictable ownership costs
- Mission-critical reliability
- Bandwidth-independent performance
- Universal application access

### Personal Computing Benefits

- Thousands of off-the-shelf applications
- Low-cost and fast-cycle application development
- Standards based
- Graphical, rich data and easy to use
- Wide choice of device types and suppliers

## How Citrix Server-based Computing Solves the Challenges of Academic Institutions

Citrix Server-based Computing is an ideal solution for schools and universities because it enables every student, faculty member and administrator to increase productivity regardless of their connection, location or operating system. Citrix provides solutions in each of the areas that most concern IT professionals in academia.

### Management Solutions

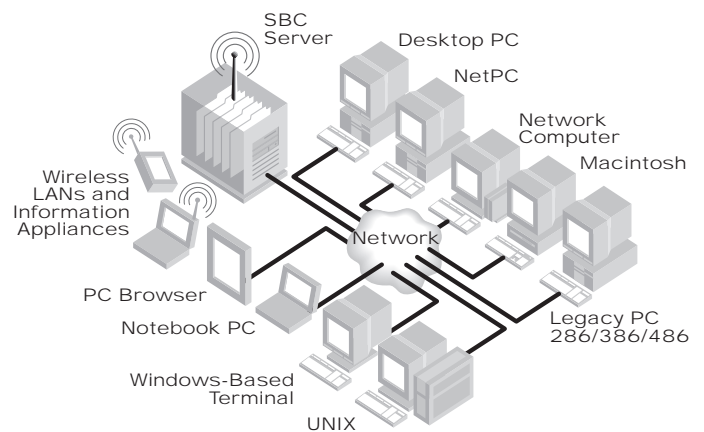
Citrix Server-based Computing solutions enable IT staff to deploy, manage and support applications in minutes, instead of hours—all from a single location. Network administrators can assign applications to servers and provide applications to students and faculty over LAN, WAN and dial-up connections.

Through our strategic partnership, Microsoft® has licensed the Citrix MultiWin™ technology to create multi-user functionality for Windows NT® 4.0 and the upcoming Windows 2000 Server operating system. The resulting product, Microsoft Windows NT Server 4.0, Terminal Server Edition delivers multi-user capabilities to enterprises using the Windows NT Server operating system. Citrix Server-based Computing software adds significant value to Terminal Server by delivering a broad range of server-based computing capabilities, including the ability to cost-effectively manage and support large enterprises as they grow in size and complexity. Citrix Server-based Computing solutions enable enterprises to extend Windows-based applications to heterogeneous computing environments, provide enterprise-scale management capabilities and ensure seamless integration of the user's local and remote resources and applications with exceptional performance.

### Access Solutions

Citrix Server-based Computing provides access to virtually any Windows-based application, across any type of network connection to any type of client. Since all applications and data are centralized, users anywhere can gain access to their email, database information, critical applications, student data, accounting and human resource tools, or the Internet. Citrix Server-based Computing works with any client—from the latest Pentium® PCs, Windows-based terminals and network computers to legacy DOS PCs, Macintosh systems, UNIX workstations and OS/2® desktops. It is even possible to embed Windows applications right into a school's Intranet Web pages. The application looks, feels and performs as if it were running locally, but it is actually executing on the server. Faculty and staff can work in real time with critical databases such as student records and lesson plans.

Citrix Server-based Computing solutions provide high-speed remote access over LAN, WAN or Internet connections, making it possible for schools and school boards to share applications and other resources between districts and regions.

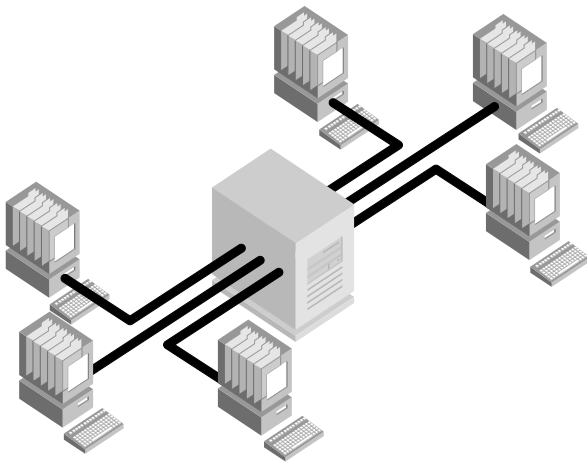


**Server-based computing is the high-performance software solution that allows concurrent access to server-based Windows applications from any client**

## Performance Solutions

Citrix Server-based Computing solutions provide bandwidth-independent performance for students, faculty and administrators, regardless of how they access academic resources. Since application activity occurs on the server, users get blazing speed over the existing LAN. With this approach, an older machine, such as a 386 PC, delivers the same performance as a Pentium workstation.

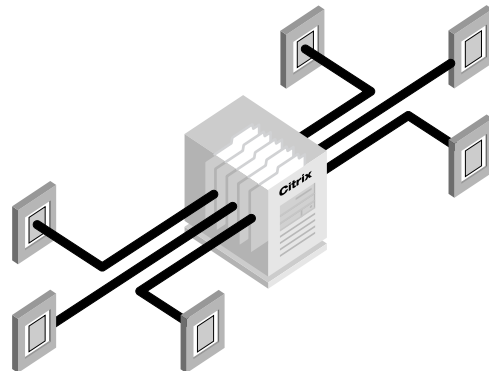
Remote users can connect to the network using 14.4 Kbps modems, and get LAN-like performance. The Citrix approach works effectively over analog or ISDN modems, WANs, wireless LANs and even the Internet with performance levels up to 10 times faster than existing remote-node servers.



Without server-based computing, your vital files and applications are spread throughout the enterprise, making security a serious problem.

## Security Solutions

With server-based computing, the security of academic applications and data is dramatically improved since all vital information is kept on a centralized server. Actual data never gets downloaded to an end-user device, so critical applications and sensitive student information remain safe. By fully incorporating Windows NT multi-level security, Citrix Server-based Computing solutions ensure that only authorized users have access to secure data. Administrators can “lock down” specific files, directories and system areas as well as the entire system, improving the security of servers on the LAN/WAN or Intranet.



With server-based computing, you get eyes-only security since business-critical data and applications can be seen and used without being downloaded to the end user.

## Citrix Server-based Computing Scenarios for Academic Institutions

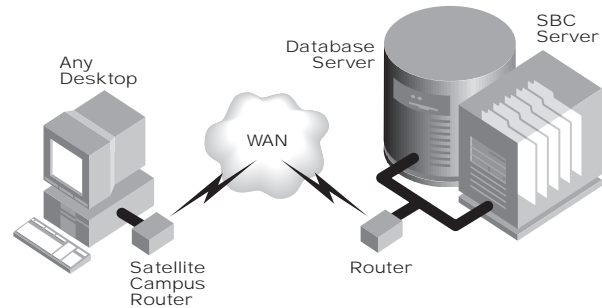
The following scenarios demonstrate how Citrix Server-based Computing can help academic institutions overcome the challenges of application deployment and management in large, complex computing environments.

### Satellite Campus Computing

#### Problem

To better serve and support communities across a wide geographic region, many colleges and universities are opening satellite campuses. While these off-site facilities are helpful to students who cannot attend classes at a central campus, they create considerable problems for IT staff who must support users at these remote locations. Traditionally, new individual LANs have been built for each satellite campus. But configuring and managing these LANs—and the information on them—can create substantial management obstacles. In addition, since most remote campuses are connected by WANs to the central campus, vital data and applications must travel back and forth across the network.

This type of setup creates user delays and unacceptable application response. Until now, the only solution option was to regularly invest in new higher-capacity WAN connections.



#### Solution

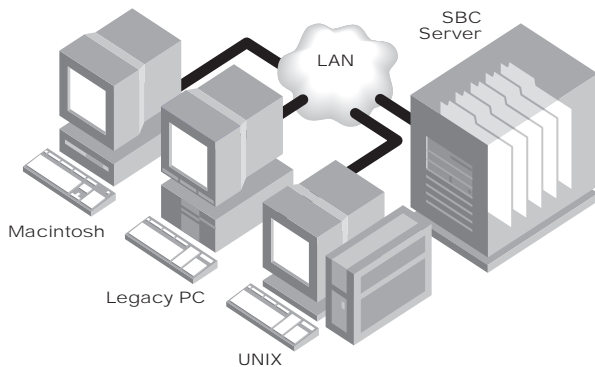
Citrix Server-based Computing solves the problems associated with satellite campuses because it minimizes network traffic, even for Windows-based, 32-bit applications. This server-based approach allows applications to be deployed, supported and managed from the central campus without the need for satellite campus administrators.

## Cross-Platform Computing

### Problem

As schools and universities embraced technology in the classroom, they purchased generation after generation of the “latest” hardware, software and networking equipment. More often than not, this resulted in a stockpiles of diverse client devices, including 286/386/486 PCs, Macintosh systems and UNIX workstations. Many institutions are now forced to employ a variety of operating systems, processing power and connectivity options.

For IT professionals attempting to deploy the latest 32-bit Windows-based applications to students and faculty system wide, these existing technology investments are a formidable impediment. As a result, many academic institutions have resorted to using problematic emulation software or investing in costly application rewrites.



### Solution

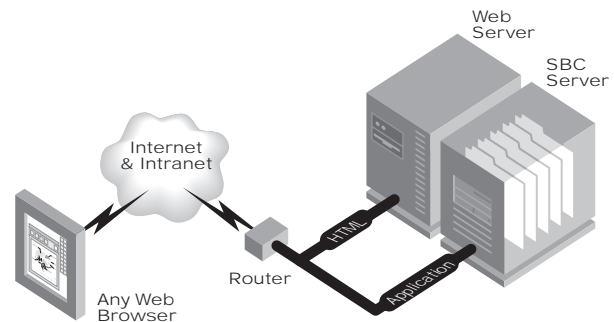
Citrix Server-based Computing is a better, more cost-effective solution because it enables virtually any existing device in the enterprise to access Windows-based

applications without special emulation software, changes in system configuration or application rewrites. This means that schools and universities can maximize their investment in existing technology while allowing students, teachers and administrators to work in their preferred computing environments.

## Web Computing

### Problem

While Web computing continues to gain in popularity, the task of deploying interactive applications on an Intranet or the Internet remains difficult and time consuming. New hardware and software are usually required to deploy these solutions, and every time the application changes, the Web-based application needs to change as well.



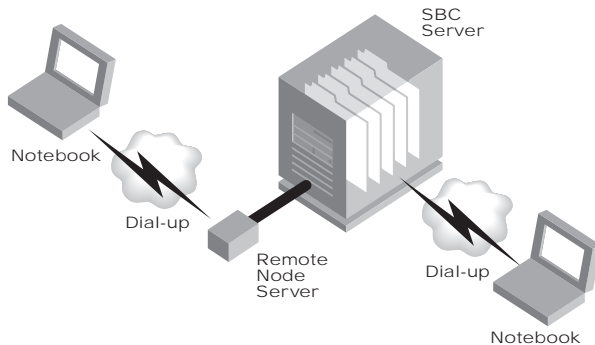
### Solution

With Citrix Server-based Computing, administrators can launch and embed Windows-based applications into HTML pages without rewriting a single line of code. Students and faculty can access academic applications quickly and easily from the school Intranet or public Internet sites affiliated with the institution.

## Remote Computing

### Problem

The changing technology environment is allowing more and more students, faculty and administrators to work at home and from other remote locations. As a result, a variety of network connections are being used to access academic applications. Unfortunately, lower bandwidth severely inhibits application performance. This poor performance leads many users to abandon trying to access applications altogether.



### Solution

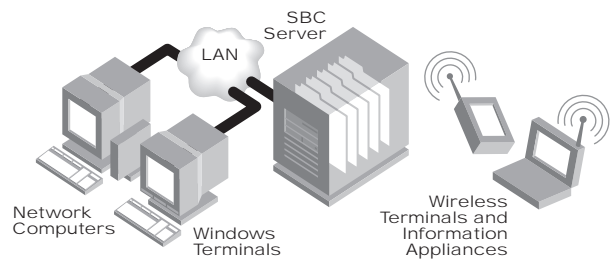
Citrix Server-based Computing works for remote users because it keeps all application processing on the server, meaning less traffic is sent across the network. Plus, it's optimized for low-bandwidth connections so users can get LAN-like performance over analog or ISDN modems, WANs, wireless LANs and even the Internet. With Citrix Server-based Computing, IT staff can deploy and manage vital applications and support remote users—all from one location.

## Thin-Client Device Computing

### Problem

While some schools and universities have installed mini- and mainframe computing systems that deliver a few of the same “centralized computing” benefits as server-based computing, these types of machines weren't designed for the thousands of GUI-based Windows applications available today. In addition, many of today's new devices, like Windows-based terminals, PDAs and wireless tablets are not compatible with the Windows-based academic applications unless rewrites are performed.

Also, teachers and students who work on these devices and are familiar with their text-based interfaces are typically slow to adopt to new operating systems.



### Solution

With server-based computing, the latest Windows-based academic applications can be extended to any thin device without application rewrites. This enables students and faculty to work in their preferred environments and still access the Windows-based applications they need to be productive. As a result, the academic institution reaps the financial benefits of using comparatively inexpensive ICA clients.

Worldwide Headquarters  
Citrix Systems, Inc.  
6400 NW 6th Way  
Fort Lauderdale, FL 33309 USA  
Tel: +1 (954) 267 3000  
Tel: +1 (800) 437 7503  
<http://www.citrix.com>

European Headquarters  
Citrix Systems GmbH  
Airport Business Center  
Am Söldnermoos 17  
85399 Hallbergmoos  
Munich, Germany  
Tel: +49 (0) 811 830000  
<http://www.eu.citrix.com>

Asia Pacific Headquarters  
Citrix Systems Australia Pty Ltd  
State Forest Building  
423 Pennant Hills Road  
Pennant Hills NSW 2120  
Sydney, Australia  
Tel: +61 (0)2 9980 0800  
<http://www.citrix.com.au>

Japan Headquarters  
Citrix Systems KK  
Heiwa Daiichi Bldg. 8F  
1-4-5 Hirakawacho, Chiyoda-ku  
Tokyo 102-0093 Japan  
Tel: +81 3 3288 2171  
<http://www.citrix.co.jp>

