

A Virtual Computer Lab for Distance Biomedical Technology Education

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Abstract

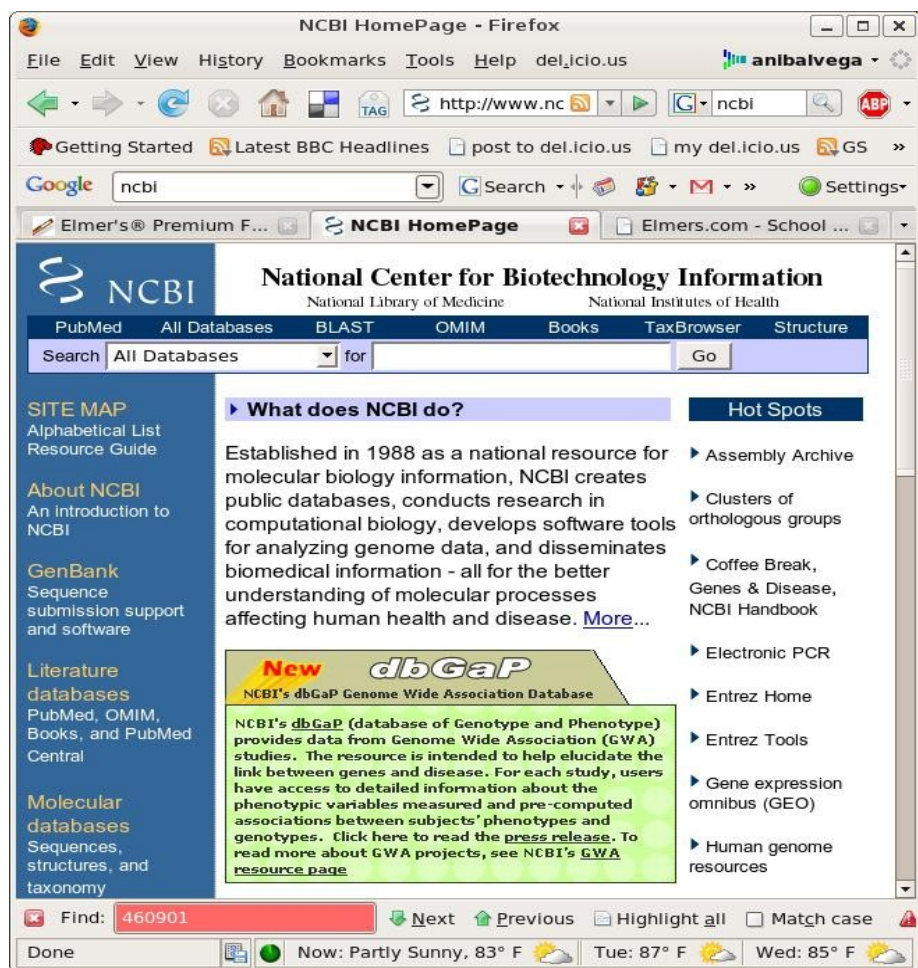
A strategy for creating and operating a virtual computer lab for biomedical technology education is described. The method, which can be employed with varied videoconferencing software and selected open source desktop sharing tools, was used to provide one of the mini-courses offered by the National Center for Biotechnology Information at a distance. The mini-course, which was previously only offered face to face, is one of several that entail applying concepts in biochemistry and genetics to search genomic databases and other information sources. This is a highly interactive course, and involves use of 3D molecular modeling software that can be computationally taxing.

An important goal in offering the course at distance was to maintain as much as possible the functionality of a computer lab, the venue where it is normally taught. Specifically, our aims were to 1) allow students to see demonstrations by the instructor; 2) allow the instructor to observe remotely the work of individual students at their desktops; and 3) allow the instructor to interact remotely with each student by sharing operation of individual desktops as necessary to optimize the learning experience. Extensive tests were performed in advance to find the right combination of software and data transmission rates that could provide this level of functionality, including real time manipulation of the 3D molecular models.

The instructor was located at the National Library of Medicine in Bethesda, Maryland, while trainees were located at the University of Puerto Rico Medical Sciences Campus in San Juan, Puerto Rico. Both institutions are connected to the Internet2 network. Videoconferencing over IP was used in combination with desktop sharing software. The instructor's desktop ran a server enabling it to be accessed by a client on a remote workstation which was projected at the distant site for students to see. Each student workstation ran similar servers, allowing the instructor to use a second computer to access their desktops and provide assistance when problems were encountered. An operator at the remote site would simultaneously redirect its client to the same student computer, so its display could be projected on a screen and all students could see the assistance that the instructor provided.

The pilot course was highly successful, both in terms of the versatility of the technology and students' evaluations. Additional courses will be provided in this fashion to continue the assessment of these technologies.

Objective



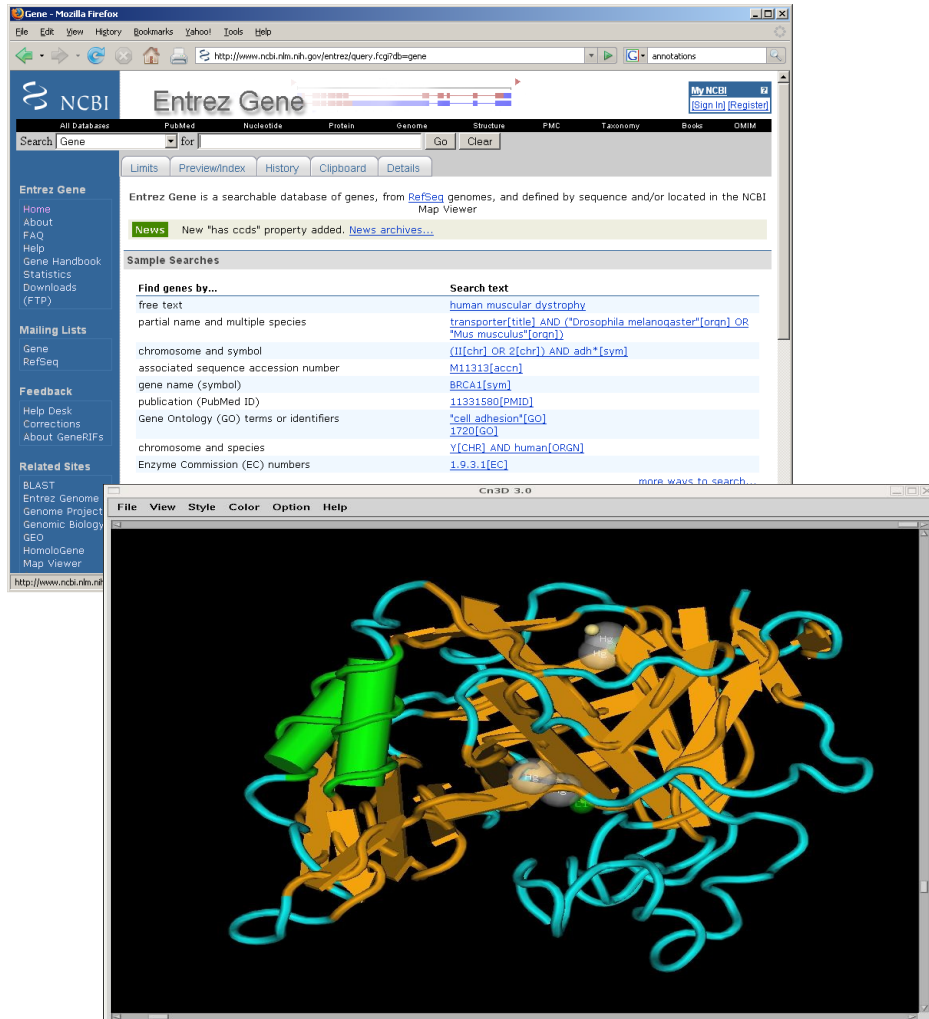
The screenshot shows the NCBI homepage in a Firefox browser window. The browser's address bar displays 'http://www.ncbi.nlm.nih.gov'. The page features the NCBI logo and navigation links for PubMed, All Databases, BLAST, OMIM, Books, TaxBrowser, and Structure. A search bar is visible with the text 'Search All Databases for'. The main content area includes a 'What does NCBI do?' section, a 'Hot Spots' list, and a 'New dbGaP' announcement. The 'dbGaP' announcement states: 'NCBI's dbGaP (database of Genotype and Phenotype) provides data from Genome Wide Association (GWA) studies. The resource is intended to help elucidate the link between genes and disease. For each study, users have access to detailed information about the phenotypic variables measured and pre-computed associations between subjects' phenotypes and genotypes. Click here to read the press release. To read more about GWA projects, see NCBI's GWA resource page'. The browser's status bar at the bottom shows the search term '460901' and weather information for Tuesday (87°F) and Wednesday (85°F).

The National Center for Biotechnology Information (NCBI) at the National Library of Medicine, offers eleven mini-courses that are either problem-based or NCBI-resource-based. The courses are 2.5 hours in length with the first hour and half devoted to an overview that is followed by a one hour hands-on session.

Although primarily given on the NIH campus, NCBI is beginning to offer the mini-courses at extramural institutions as well. In these cases, NCBI pays for the travel expenses of the instructors within the United States. If these courses could be taught remotely from NCBI facilities in Bethesda, there would be no travel requirements, so time and resources could be used more effectively.

The goal of this project was to develop a strategy for creating and operating a virtual computer lab for biomedical technology education. During the first phase of the project, a group of applications was identified and tested for technical factors. Then, a two-hour course was offered remotely to assess the effectiveness of these technologies in an actual didactic session.

The Course: Entrez Gene QuickStart Minicourse



The image shows a screenshot of the Entrez Gene website in a Mozilla Firefox browser window. The browser address bar shows the URL <http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?db=gene>. The website header includes the NCBI logo and navigation tabs for All Databases, PubMed, Nucleotide, Protein, Genome, Structure, PMC, Taxonomy, Books, and OMIM. A search bar is visible with the text "Gene" and a "Go" button. Below the search bar, there is a table of "Sample Searches" with columns for "Find genes by..." and "Search text".

Find genes by...	Search text
free text	human muscular dystrophy
partial name and multiple species	transporter[title] AND ("Drosophila melanogaster"[organ] OR "Mus musculus"[organ])
chromosome and symbol	(11[chr] OR 2[chr]) AND adh*[sym]
associated sequence accession number	M11313[accn]
gene name (symbol)	BRCA1[sym]
publication (PubMed ID)	11331580[PMID]
Gene Ontology (GO) terms or identifiers	*cell adhesion*[GO] 17220[GO]
chromosome and species	Y[CHR] AND human[ORGN]
Enzyme Commission (EC) numbers	1.9.3.1[EC]

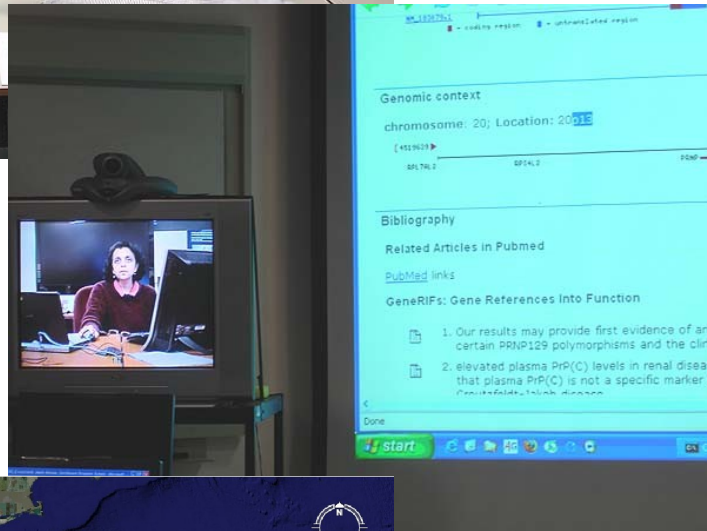
Below the search results, there is a window titled "Cn3D 3.0" showing a 3D ribbon diagram of a protein structure. The protein is colored in shades of orange and yellow, with a prominent green cylinder representing a specific domain or region. The structure is set against a black background.

NCBI's Entrez Gene provides gene-based information such as chromosome location, sequence, expression, structure, function, and homology data. Each record represents a single gene from an organism. Entrez Gene includes organisms for which there is a RefSeq genome record.

In this course, students learn how to obtain information about a human gene such as its mRNA and genomic sequence, gene structure (exon-intron locations), function and phenotypes associated with mutations. They also learn how to determine whether the SNPs in the coding region of a gene are known to alter the function of the protein product .

A special feature of this course is the use of Cn3D. Cn3D is a helper application for web browsers that allows researchers to view 3-dimensional structures from NCBI's Entrez retrieval service. Cn3D runs on Windows, Macintosh, and Unix. Cn3D simultaneously displays structure, sequence, and alignment, and now has powerful annotation and alignment editing features.

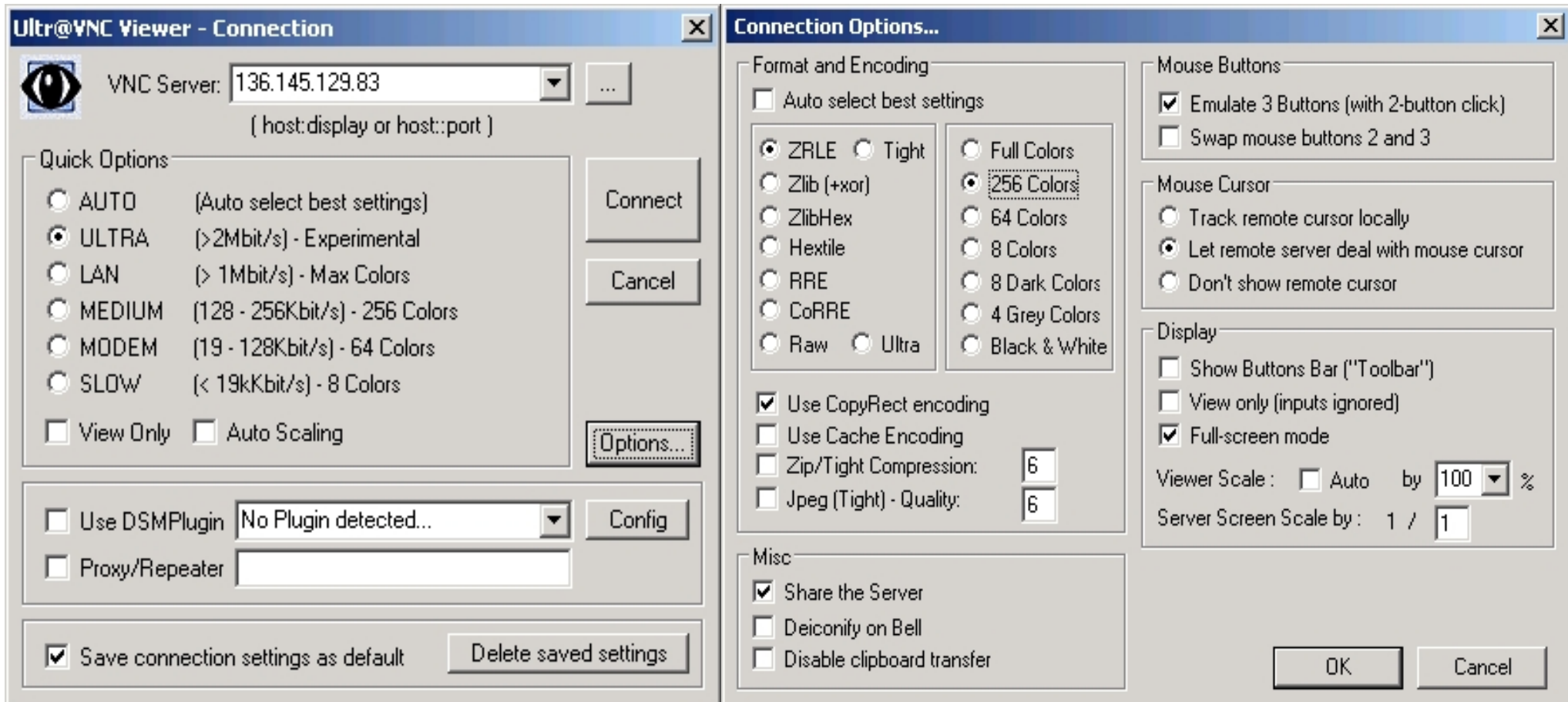
Course Logistics



The course was offered remotely by an instructor located at the National Library of Medicine in Bethesda, Maryland, to a group of eleven faculty and graduate students at the University of Puerto Rico Medical Sciences Campus in San Juan. Both institutions are members of Internet2. Videoconference (H.323) over IP provided audio and video communications between the two sites. The instructor's desktop ran a UltraVNC server enabling it to be accessed by a client on a remote workstation which was projected at the distant site for students to see. Each student workstation ran similar servers, allowing the instructor to use a second computer to access their desktops and provide assistance when problems were encountered. An operator at the remote site would simultaneously redirect its client to the same student computer, so its display could be projected on a screen and all students could see the assistance that the instructor provided. The pilot course was highly successful, both in terms of the versatility of the technology and students' evaluations. Additional courses will be provided in this fashion to continue the assessment of these technologies.

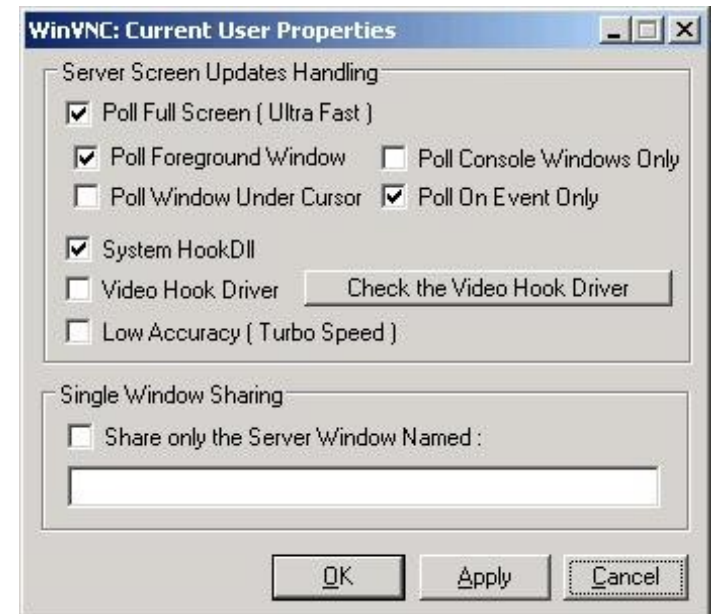
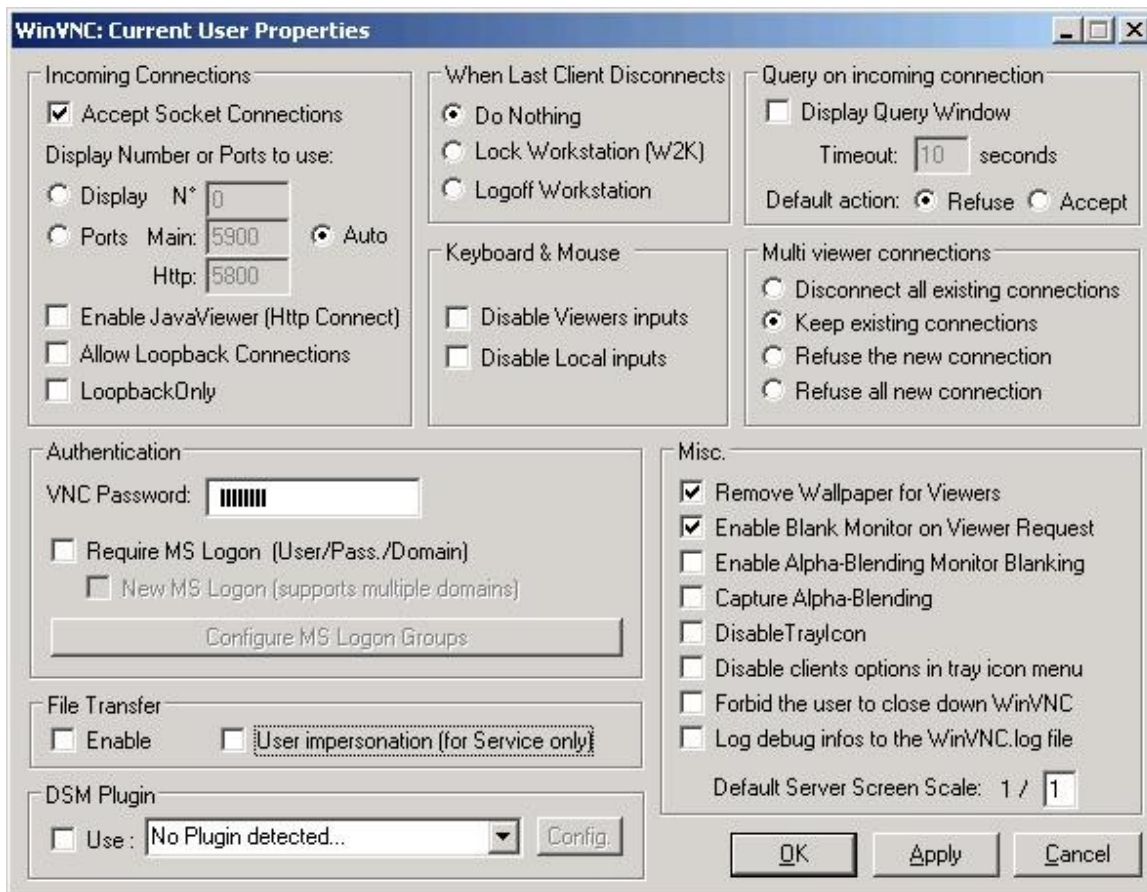
Why UltraVNC?

UltraVNC is a powerful, easy to use and free software that can display the screen of another computer (via internet or network) on your own screen. The program allows you to use your mouse and keyboard to control the other PC remotely. We tested several VNC software, and Ultra VNC was the best in displaying the CN3D structures. After setting up the display properties of the monitors to a resolution of 800 x 600 at 16bit colors, we found the client software worked optimally when configured as follows:

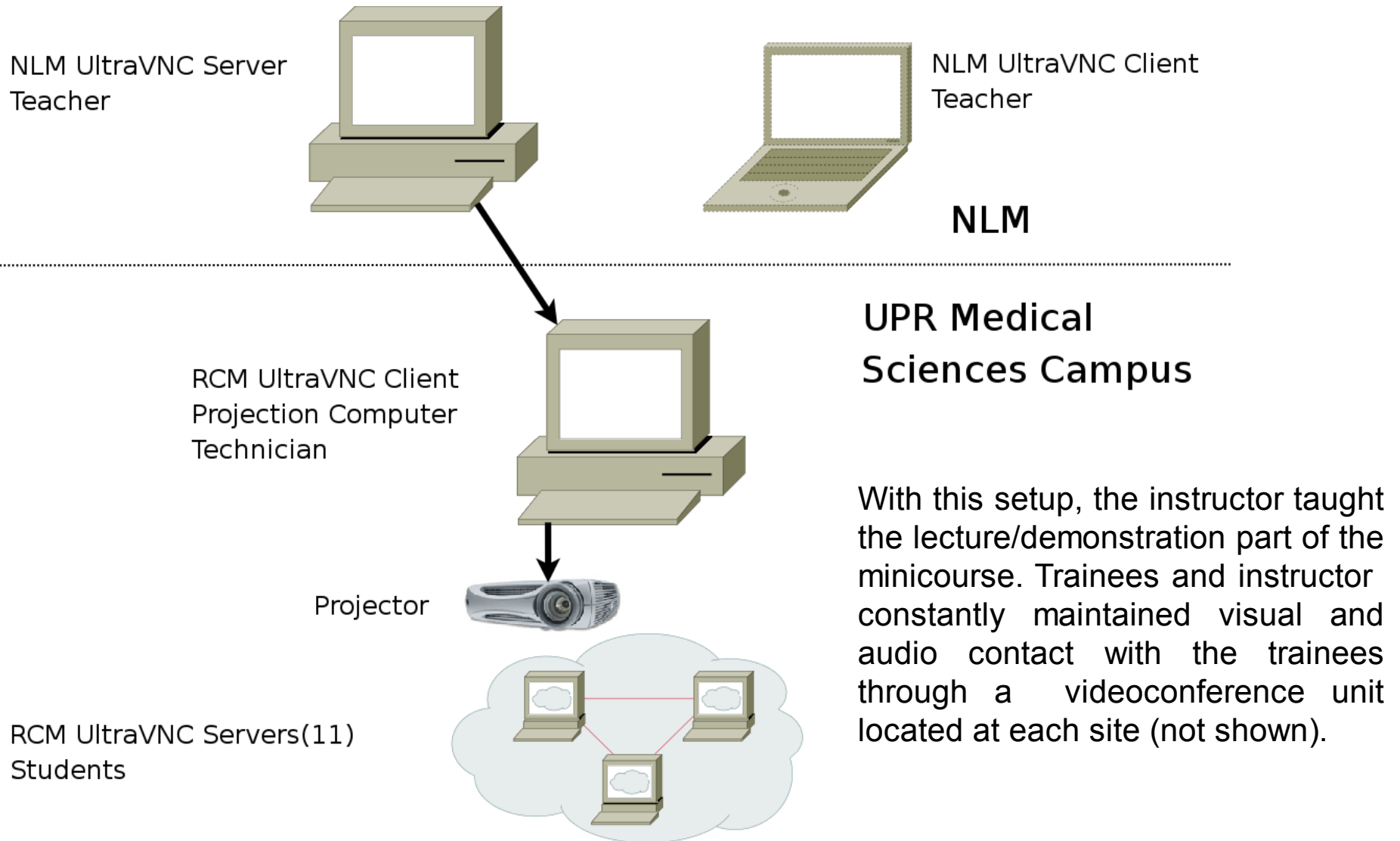


UltraVNC Server Configuration

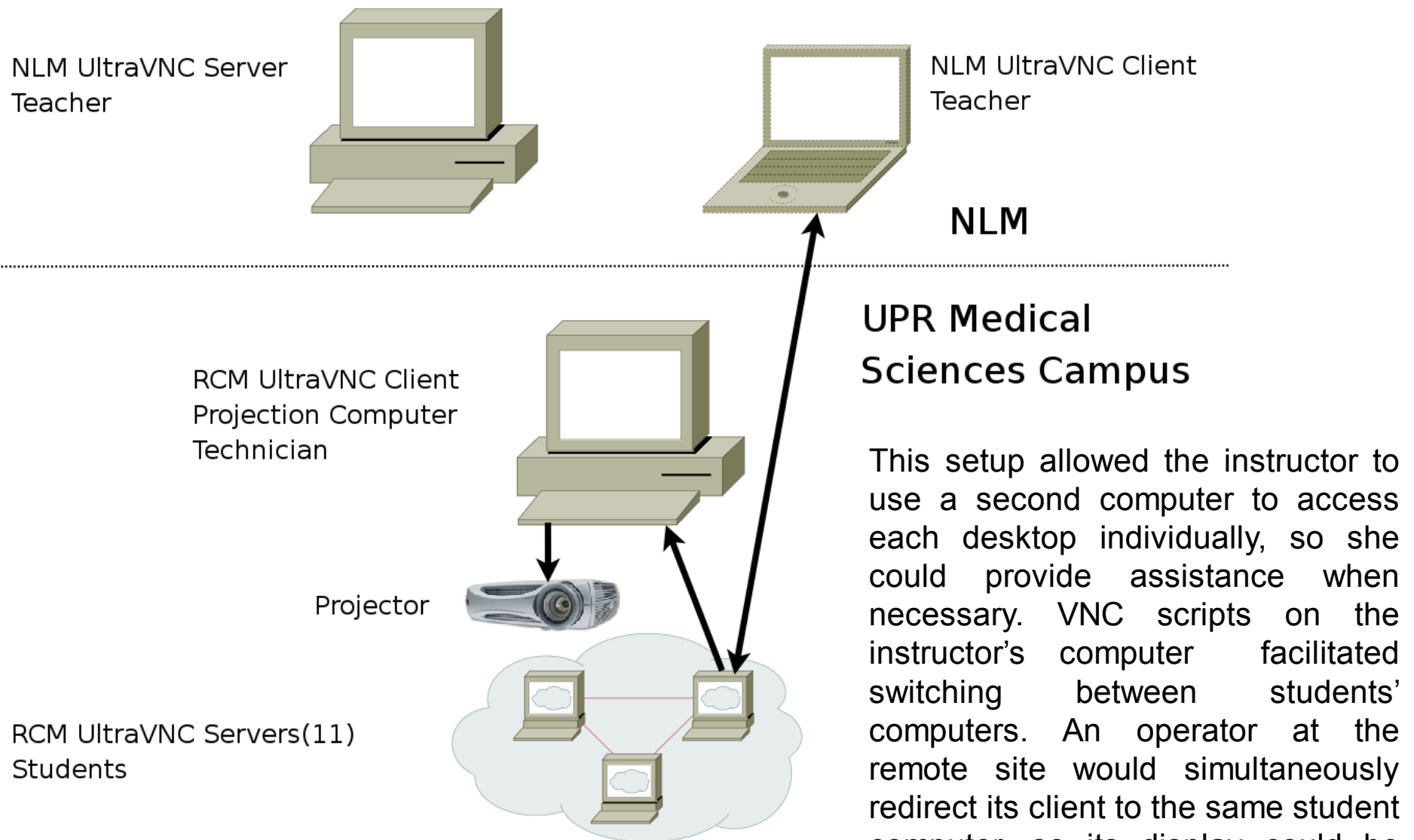
When installing the UltraVNC server, do not install the UltraVNC Mirror Driver. The UltraVNC server setup has two configuration windows. The windows are accessible by a right click on the program icon in the Windows Taskbar. Select Admin Properties, and configure as shown below on the larger screen. Go back to the Windows Taskbar and select Properties, then configure as shown on the smaller screen below.



Instructor's Display Projected Remotely from Bethesda to SanJuan



Instructor's Display Projected Remotely from Bethesda to SanJuan



UPR Medical Sciences Campus

This setup allowed the instructor to use a second computer to access each desktop individually, so she could provide assistance when necessary. VNC scripts on the instructor's computer facilitated switching between students' computers. An operator at the remote site would simultaneously redirect its client to the same student computer, so its display could be projected on a screen, and all students could see the assistance provided by the instructor.

Conclusion



The combination of VNC software and videoconference technologies creates an excellent environment for teaching computer-based courses remotely over high-speed networks. This approach provides for both one-to-one and one-to-many interactions between instructor and trainees.

Reference

www.uvnc.com [homepage on the Internet]
[updated 2007 Jan 28; cited 2007 Mar 21].
Available from: <http://uvnc.com>



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