
Virtual Computing Laboratory

**Aaron Peeler, Josh Thompson,
Dr. Mladen Vouk, Andrew Kurth**

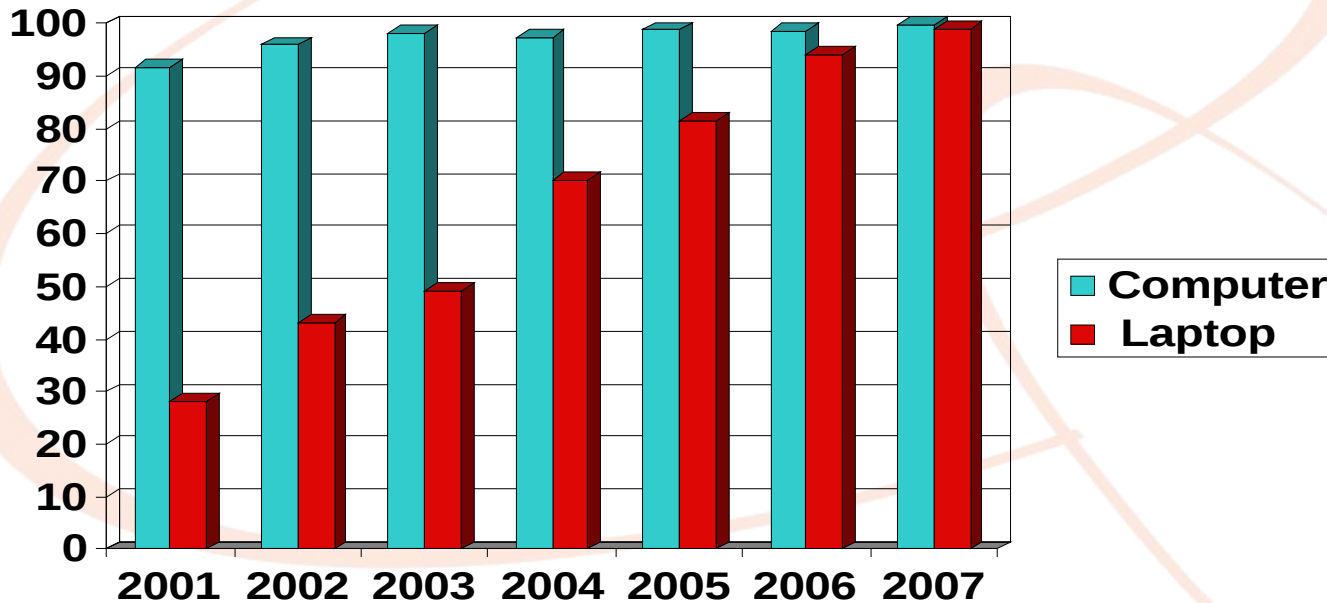
**North Carolina State University
May 2008**

Virtual Computing Lab

- **What is it?**
 - An environment delivery service
 - Remote access to high-end software, custom environments
- **Motivation**
 - Student Owned Computing
 - Distance Education
 - Traditional Lab Model
 - Shared Compute Resources
 - Custom Compute Environments
 - Continuous Cycles

Motivation - Student Owned Computing

- **University** expectation / requirement
- **Stats** - NCSU Engineering incoming Freshman



Motivation - Distance Education

- **Distance education** - how do we get software to the DE student?
- **Two plus Two program**
 - Community Colleges
 - **Lenoir Community College**
 - **Craven County Community College**
 - Cross Institutional curriculums -
 - **UNC-CH** - Bio Medical Engineering
 - **UNCA** - Mechatronics Engineering
- **Software restrictions** - vendor licensing, must run on university owned hardware. Violation to distribute

Motivation - Traditional Labs

Traditional “On campus” computing labs are important, but are they changing ...

- **Traditional Labs**
 - Rows & rows of machines
 - Single image fits all -- 60+ apps
 - Lack of multiple SW versions
 - Lead time to include new applications
- **Collaborative Learning Spaces**
 - Flexible - convert the meet instructor demand
 - Make use of the user-owned hardware
- **Get more cycles after labs hours**
 - Provision idle lab machines for remote use.

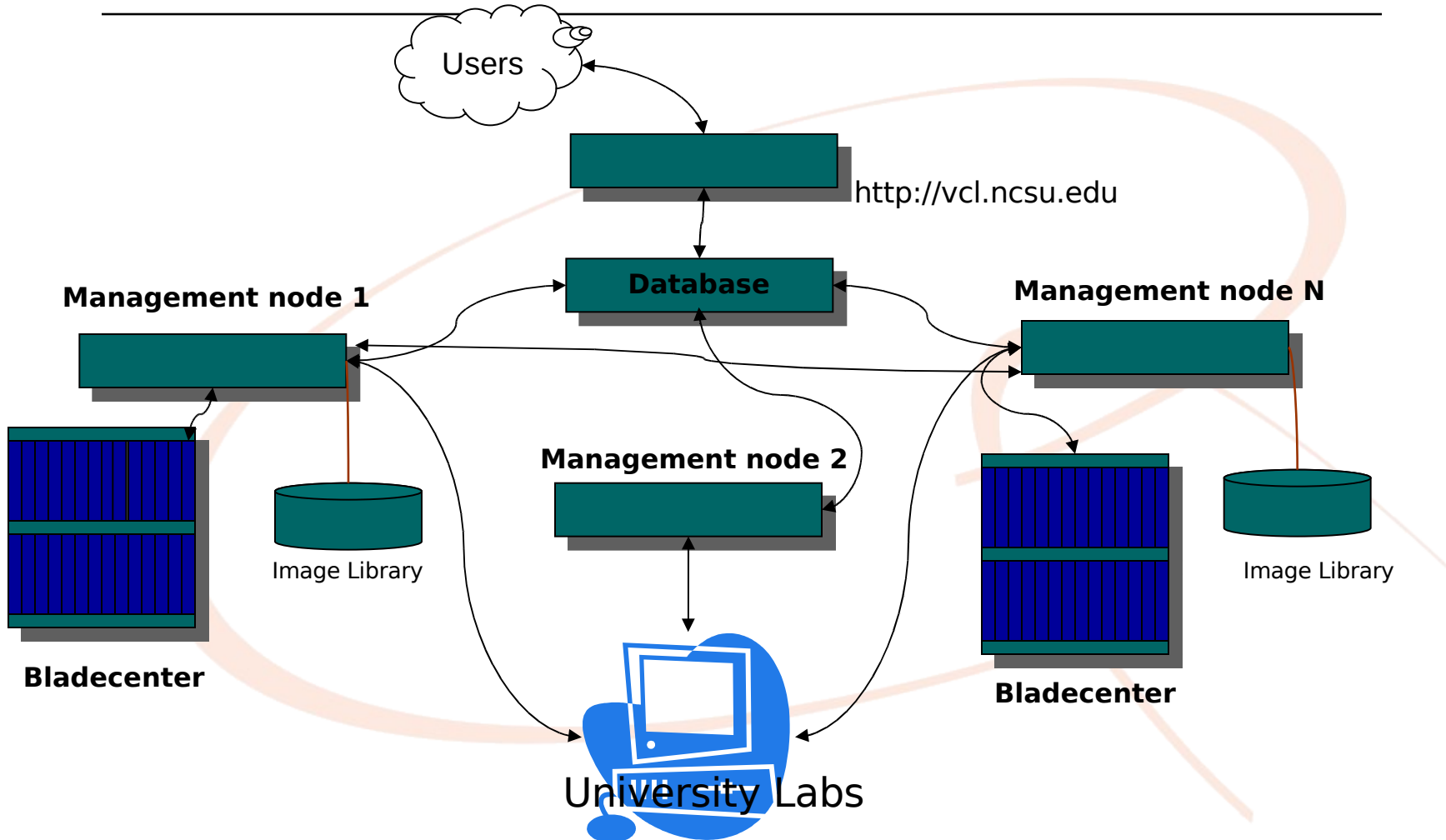
Motivation - Shared Resources / Custom Env.

- **Shared Resources** - Unix “dial-up” servers or Windows Terminal Server farms
 - Ok -- for limited set of users performing limited actions.
 - Problems occurs for - special projects or users running intensive applications. Lack of root/admin access. Just not scalable!
- **Custom Environments**
 - Previously -- could not create unique environments in traditional labs or they could not be supported centrally, ie. Linux Apache,PHP server for a CSC web development course - with root access. Through VCL the user can create these environments which are saved as images and can be recalled at a later date.

Motivation - Continuous cycles

- **Creative** ways to **increase** the compute cycle of a single piece of hardware, while meeting the needs of both **researchers** and **students**.
- **Multi-purpose hardware** - on-demand use, dedicated use. Bare-metal, hypervisor(VMware,KVM,Xen,etc)
- **Switching Blades from VCL to HPC use**
 - In same Data Center(s)
 - Research and Academic computing are out of phase.

VCL Infrastructure



VCL Infrastructure

- **Web server** - Linux Host, RHEL
 - Apache
 - PHP
- **Database** - Linux Host, RHEL
 - MYSQL 5.1
- **Management node** - Linux Host, RHEL
 - DHCP, tftp, PXE, kickstart install server, all run on private network
 - VCLD - perl, calls xCAT commands, or VMWare commands, process assigned requests, extensible...

VCL Infrastructure - Web portal

Web server - LAMP,AJAX

- **Scheduler** - based off user's request provides optimal hardware. Aware of what is running where. Assigns request to a Management node
- **Management interface**
 - **Assign user rights** - what they can use and do
 - Check out environments
 - Manage Computers
 - Manage Images
 - Manage Management nodes
 - Manage User and Resource Groups
 - Modify User Privileges

VCL Infrastructure - Web portal

Web server - Management Interface(cont'd)

- **Resource Management**
 - **Add/Delete Resources**
 - Computers, Management Nodes, Schedules, Groups
 - **Create New Images**
 - **Toggle Computers and Management Nodes between Available and Maintenance states**
 - **Manage Resource Group Memberships**

VCL Infrastructure - Web portal

Web server - Management Interface(cont'd)

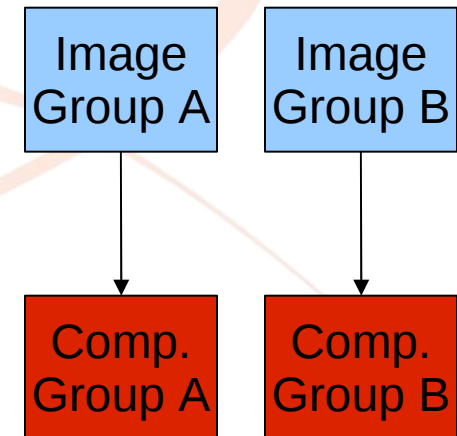
○ Resource Grouping and Mapping

- Resources managed by the groups they are in
- Resource groups of different types are mapped together

Example:

- **Image** Groups **A** & **B**
- **Computer** Groups **A** & **B**
- **Image** Group **A** mapped to **Comp.** Group **A**
- **Image** Group **B** mapped to **Comp.** Group **B**

Now, only images in Group A can be run on the computers that are in comp. Group A. If all of the computers in comp. Group B are in use and someone requests an image in image Group B, user must wait until a computer in comp. Group B is available.



VCL Infrastructure - Database

Database - Linux, MySQL 5.X

○ **Stores all data in tables - few examples**

- Admin levels - determines what users see
- BlockRequest - workshop course
- Changelog - log of changes to requests
- **Computer** - info on machines
- **Image** - info on images
- **Imagerevision** - revision control
- Managementnode - info, lastcheckin
- Subimages - for cluster based reservations
- **Request** - core table checked by Management node
- Resourcepriv - privs associated with resource grps
- User - user information
- Usergroup - groups users can be in, custom or LDAP
- Userpriv - privs associated with user groups

VCL Infrastructure - Management node

Management Node (MN)

- **State driven**, polls database for assigned tasks
 - **New** - new request, checks assigned blade, confirms or loads image, bare metal or VM
 - **Reserved** - waits for user ACK, moves to inuse/timeout
 - **Inuse** - monitors user connection, notifies user of end time, if user disconnected for given time period, reclaim
 - **Timeout** - based off laststate, reload or mark available
 - **Deleted** - user initiated delete can be at anytime, reload or make available depending on laststate
 - **Imageprep** - prep environment for imaging mode
 - **Image** - image the machine, partimage for Bare metal, transfer VM files for hypervisor to Image Library
 - **MakeProduction** - sets images into production based on image owners request
 - **Preload** - preloads blades for future reservations
 - **Block Request** - prepares blocks of machines for course/workshops
 - **Reload** - reloads a blade through web app can choose to reload a specific machine

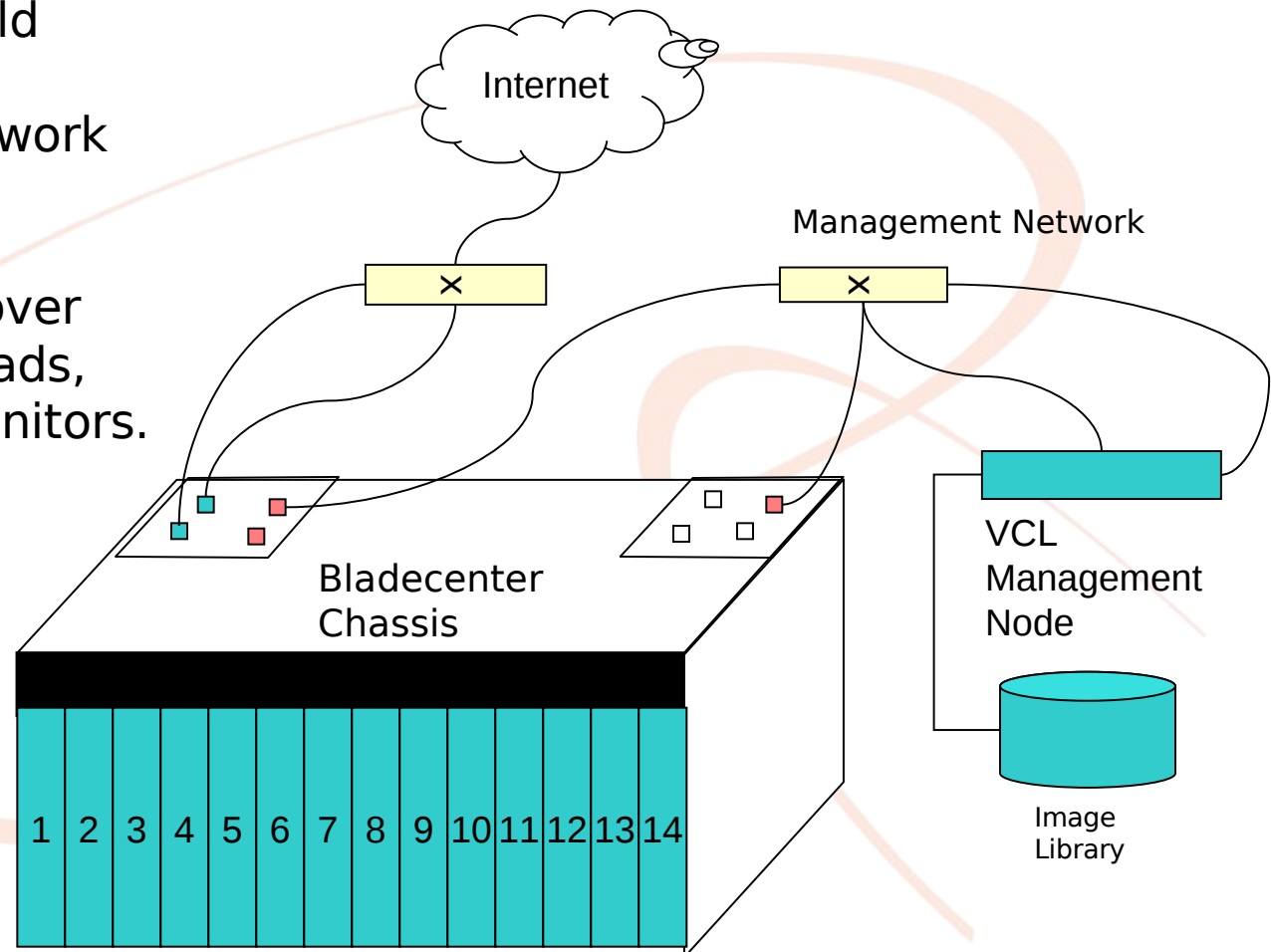
VCL Infrastructure - Management node

Management Node(MN)

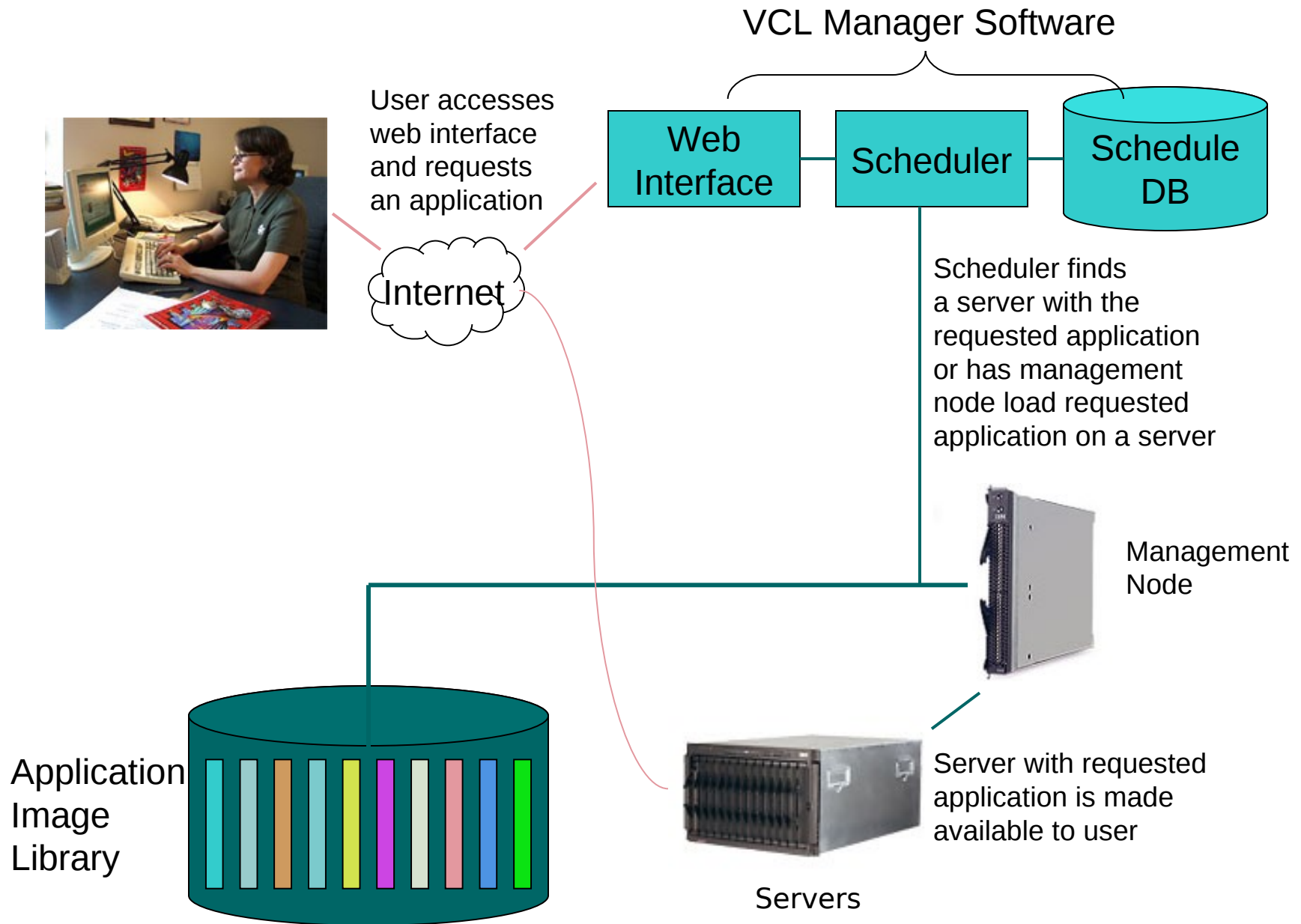
- **Loading process flow**, the **MN** performs these basic checks when provisioning a blade. Based off the image profile, different sub tasks are preformed.
 - Confirms requested image exists in image library
 - Confirms assigned blade/resource is under **MN** control
 - Checks if requested image is preloaded on assigned blade
 - Loads blade using xCAT commands if bare metal, if VM copies vm disk files to VM Host server and starts vm guest
 - Monitors loading process
 - Updates the request state that blade/resource is ready
 - Moves to next state
- Different provisioning techniques can be implemented, just need to add support for it into VCLD. xCAT preferred.

VCL Infrastructure Management node

- o VCL daemon -- vclld
- o xCAT
 - DHCP - priv network
 - PXE
- o Image library
- o Manages blades over private network, loads, performs tasks, monitors.



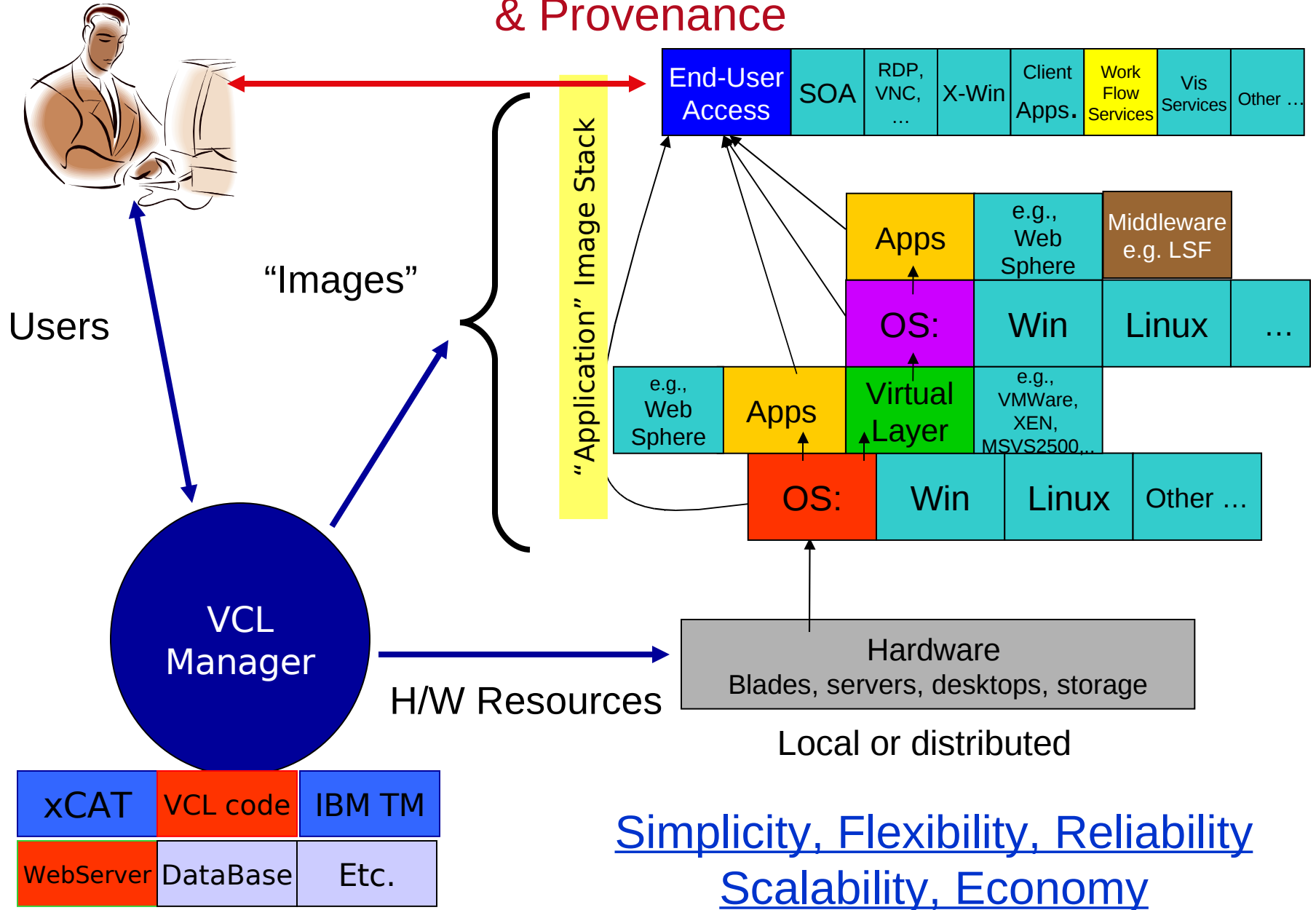
North Carolina State University Virtual Computing Lab Model





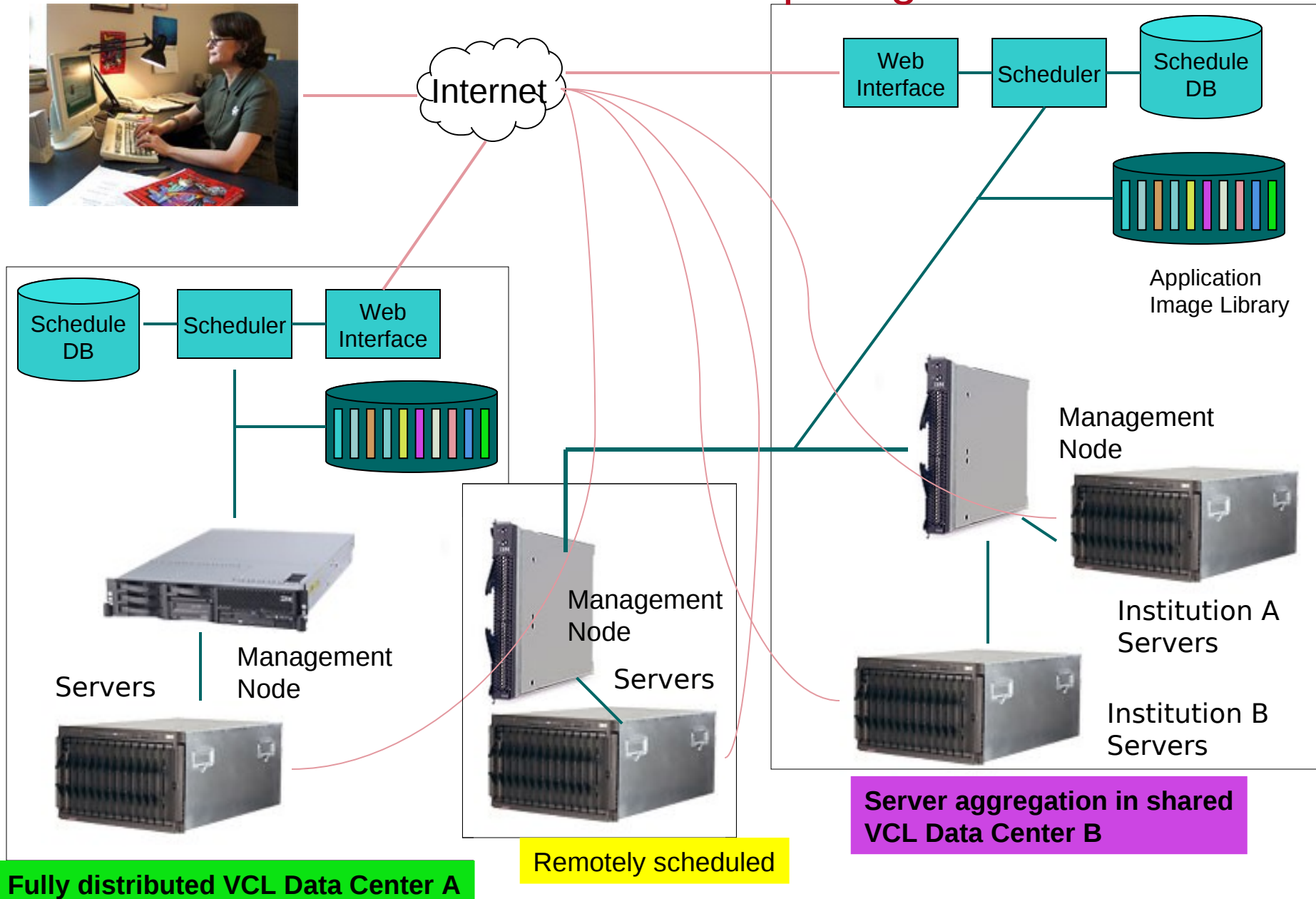
DEMO

Differentiator: User to Image to Resource Mapping, Management & Provenance



Simplicity, Flexibility, Reliability
Scalability, Economy

The Virtual Computing Initiative: Anytime, Anywhere On Demand Computing



VCL :: Virtual Computing Lab - Netscape

File Edit View Go Bookmarks Tools Window Help

VCL :: Virtual Computing Lab

NC STATE UNIVERSITY

VIRTUAL COMPUTING LAB

VCL.NCSU.EDU
JOINT VENTURE OF HPC AND ITECS

HOME

New Reservation

Current Reservations

User Preferences

Manage Groups

Manage Images

Manage Schedules

Manage Computers

Management Nodes

View Time Table

Privileges

Statistics

Help

Logout

LINKS

- ITECS

- HPC

New Reservation

Please select the environment you want to use from the list:

SAS v9.1.3 with Enterprise Guide v3 (WinXP)

When would you like to use the application?

Now

Later: Monday At 1 00 am

For 1 hour

Submit

High Performance Computing (HPC)
Information Technology and Engineering Computer Services (ITECS)

This support page is for students, faculty, and staff at North Carolina State University. Copyright © 2004-2006 by NC State University and others. All Rights Reserved.

- Ongoing:
- Tipping pt.
- Usability
- Availability
- Pedagogy
- ...
- Currently scaling to 8000+ users
- N-M-K

vcl.ncsu.edu

VCL :: Virtual Computing Lab - Netscape

File Edit View Go Bookmarks Tools Window Help

VCL :: Virtual Computing Lab

NC STATE UNIVERSITY

VIRTUAL COMPUTING LAB_

VCL.NCSU.EDU
 JOINT VENTURE OF HPC AND ITECS

HOME

- New Reservation
- Current Reservations**
- User Preferences
- Manage Groups
- Manage Images
- Manage Schedules
- Manage Computers
- Management Nodes
- View Time Table
- Privileges
- Statistics
- Help
- Logout

Current Reservations

You currently have the following normal reservations:

	Environment	Starting	Ending	Initially requested
<i>Pending...</i> Est: 1 min remaining	SAS v9.1.3 with Enterprise Guide v3 (WinXP)	Monday, Mar 27th, 9:59 am	Monday, Mar 27th, 11:00 am	Monday, Mar 27th, 9:59 am

This page will automatically reload every 20 seconds until the *Pending...* reservation is ready.

LINKS

- ITECS
- HPC

High Performance Computing (HPC)
 Information Technology and Engineering Computer Services (ITECS)

This support page is for students, faculty, and staff at North Carolina State University. Copyright © 2004-2006 by NC State University and others. All Rights Reserved.

Done

VCL :: Virtual Computing Lab - Netscape

File Edit View Go Bookmarks Tools Window Help

VCL :: Virtual Computing Lab

NC STATE UNIVERSITY

VIRTUAL COMPUTING LAB_

VCL.NCSU.EDU
JOINT VENTURE OF HPC AND ITECS

HOME

- New Reservation
- Current Reservations
- User Preferences
- Manage Groups
- Manage Images
- Manage Schedules
- Manage Computers
- Management Nodes
- View Time Table
- Privileges
- Statistics
- Help
- Logout

LINKS

- ITECS
- HPC

Connect!

You will need to use a [Remote Desktop program](#) to connect to the system. If you did not click on the **Connect!** button from the computer you will be using to access the VCL system, you will need to cancel this reservation, request a new one, and make sure you click the **Connect!** button in a web browser running on the same computer from which you will be connecting to the VCL system. Otherwise, you may be denied access to the remote computer.

Use the following information when you are ready to connect:

- ◆ **Remote Computer:** 152.1.14.151
- ◆ **User ID:** vouk
- ◆ **Password:** 2hdb7g

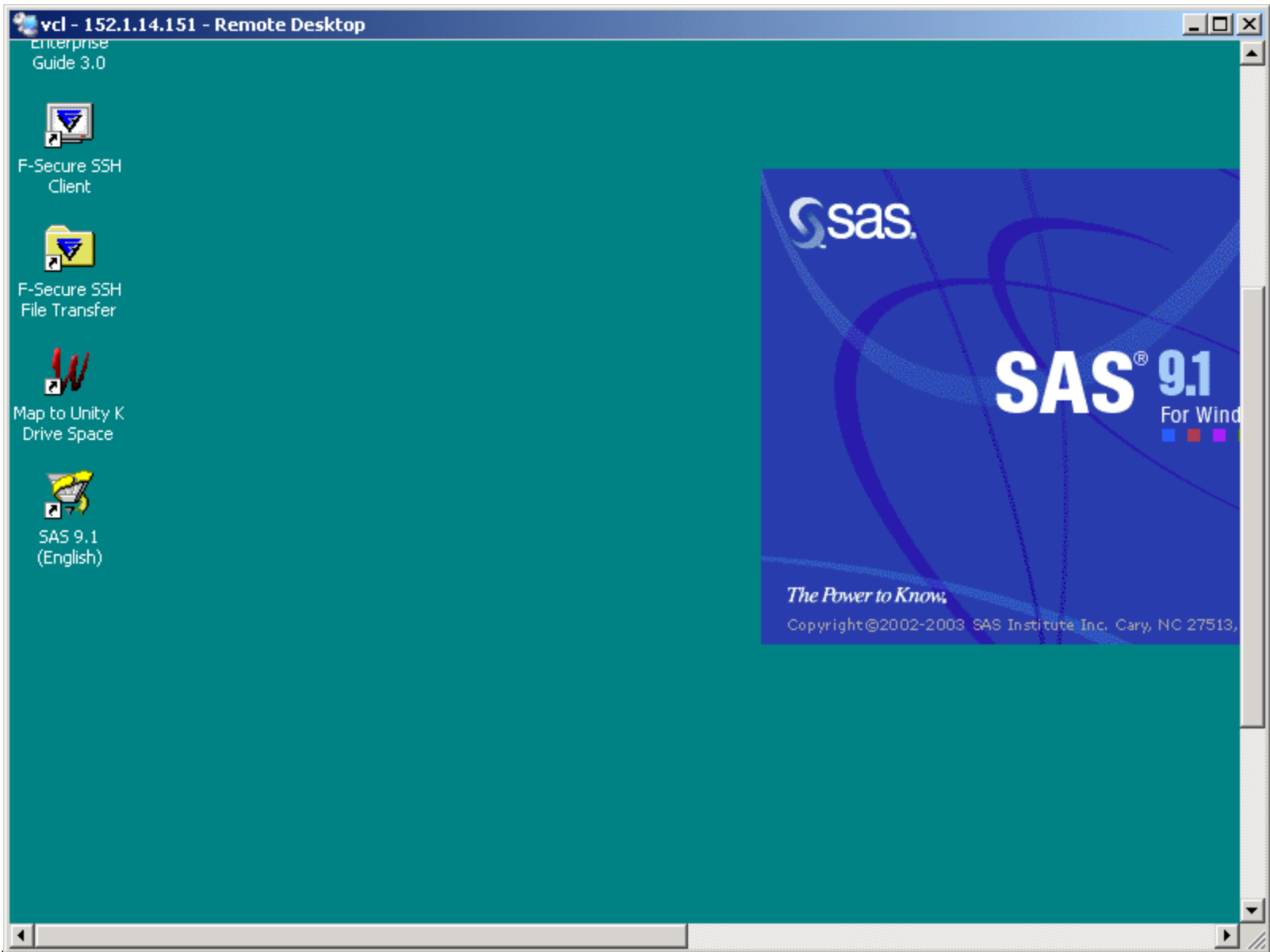
NOTE: The given password is for *this reservation only*. You will be given a different password for any other reservations.

For automatic connection, you can download an RDP file that can be opened by the Remote Desktop Connection program.

[Get RDP File](#) [What is an RDP file?](#)

High Performance Computing (HPC)
Information Technology and Engineering Computer Services (ITECS)

This support page is for students, faculty, and staff at North Carolina State University. Copyright © 2004-2006 by NC State University and others. All Rights Reserved.



vcl - 152.1.14.151 - Remote Desktop

VCLB3-3

File Edit View Favorites Tools Help

Back Search Folders

Address VCLB3-3

Name	Type	Total Size	Free Space	Comments
Files Stored on This Computer				
Shared Documents	File Folder			
Hard Disk Drives				
WinXP2 (C:)	Local Disk	33.8 GB	27.3 GB	
Network Drives				
all on 'vclb3-3-afs...	Network Drive	1.99 TB	0.99 TB	
vouk on 'vclb3-3-...	Network Drive	1.99 TB	0.99 TB	
Other				
C on VOUK7	System Folder			Disk from Remc
D on VOUK7	System Folder			Disk from Remc

System Tasks

- View system information
- Add or remove programs
- Change a setting

Other Places

- My Network Places
- My Documents
- Shared Documents
- Control Panel

Details

VCLB3-3
System Folder

Explorer

Contents of 'SAS Environment'

- Libraries
- File Shortcuts
- Favorite Folders
- VCLB3-3

Log - (Untitled)

NOTE: Copyright (c) 2002-2003 by SAS Institute Inc., Cary, NC, USA.
NOTE: SAS (r) 9.1 (TS1M3)
Licensed to NORTH CAROLINA STATE UNIVERSITY-CAMPUSWIDE-T/R, Site 0027585003.
NOTE: This session is executing on the XP_PRO platform.

NOTE: SAS 9.1.3 Service Pack 3

NOTE: SAS initialization used:
real time 34.18 seconds
cpu time 1.56 seconds

9.1 Getting Started with SAS

New to SAS programming or 9.1? Try our quick-start guide to explore SAS programming, the SAS interface, and sample programs. Or see our resource guide for new 9.1 features and online support.

[Start Guides](#)

Close

Don't show this dialog box again

Editor - Un

VCL :: Virtual Computing Lab - Netscape

File Edit View Go Bookmarks Tools Window Help

VCL :: Virtual Computing Lab

NC STATE UNIVERSITY

VIRTUAL COMPUTING LAB_

VCL.NCSU.EDU
JOINT VENTURE OF HPC AND ITECS

HOME

- New Reservation
- Current Reservations
- User Preferences
- Manage Groups
- Manage Images
- Manage Schedules
- Manage Computers
- Management Nodes
- View Time Table
- Privileges
- Statistics
- Help
- Logout

Manage Images

- Edit Image Information
 - Include details
- Edit Image Grouping
- Edit Image Mapping
- Create A New Image

Submit Query

LINKS

- ITECS
- HPC

High Performance Computing (HPC)
Information Technology and Engineering Computer Services (ITECS)

This support page is for students, faculty, and staff at North Carolina State University. Copyright © 2004-2006 by NC State University and others. All Rights Reserved.

VCL :: Virtual Computing Lab - Netscape

File Edit View Go Bookmarks Tools Window Help

VCL :: Virtual Computing Lab

HOME

- [New Reservation](#)
- [Current Reservations](#)
- [User Preferences](#)
- [Manage Groups](#)
- [Manage Images](#)
- [Manage Schedules](#)
- [Manage Computers](#)
- [Management Nodes](#)
- [View Time Table](#)
- [Privileges](#)
- [Statistics](#)
- [Help](#)
- [Logout](#)

LINKS

- [- ITECS](#)
- [- HPC](#)

Statistic Information

Reservation information between 8/21/2005 and 3/27/2006:

Total Reservations:	25040
"Now" Reservations:	23396
"Later" Reservations:	1644
Unavailable:	303
Total Unique Users:	2533
Unique Users of Windows XP:	1660
Unique Users of Red Hat Enterprise Linux 3.0:	166
Unique Users of Realm Red Hat Enterprise Linux 3.0:	1087
Unique Users of Realm Red Hat Enterprise Linux 4.0:	385
Unique Users of Solaris 5.8:	469
Unique Users of Windows 2003 Server:	2

	Reservations	Unique Users
Access Visio Excel 2003 (WinXP):	1475	294
Access,Visio & Excel (Windows XP):	51	28
ArcGIS (Windows XP):	7	3
ArcGIS9 (WinXP):	377	38
Aspen 2004 (Win XP):	142	33
Aspen 2004.1 (WinXP):	203	35
AutoCad2006 Civil3D Land (WinXP):	30	13
AutoCad2006 Civil3D LandDesk (WinXP):	17	5
Comsol3.2 with Matlab7.1 Faculty (WinXP):	12	4
Comsol3.2a with Matlab7.1 (WinXP):	35	3
CSC295 Apache PHP Tomcat (RHEL3):	1046	38

Waiting for vcl.ncsu.edu...

VCL :: Virtual Computing Lab - Netscape

File Edit View Go Bookmarks Tools Window Help

VCL :: Virtual Computing Lab

Reservations by Day

Reservations with start time on given day

Date	Reservations
8/21/2005	~100
9/21/2005	~150
10/22/2005	~280
11/21/2005	~400
12/22/2005	~100
1/22/2006	~250
2/22/2006	~350
3/25/2006	~150

Max Concurrent Reservations By Day

Maximum concurrent reservations per day

Date	Max Concurrent Reservations
05	~20
05	~40
05	~60
05	~75
05	~10
06	~70
06	~85
06	~60

Done

