NC STATE UNIVERSITY
College of Engineering

NC State Information Technology Division

Virtual Computing Laboratory

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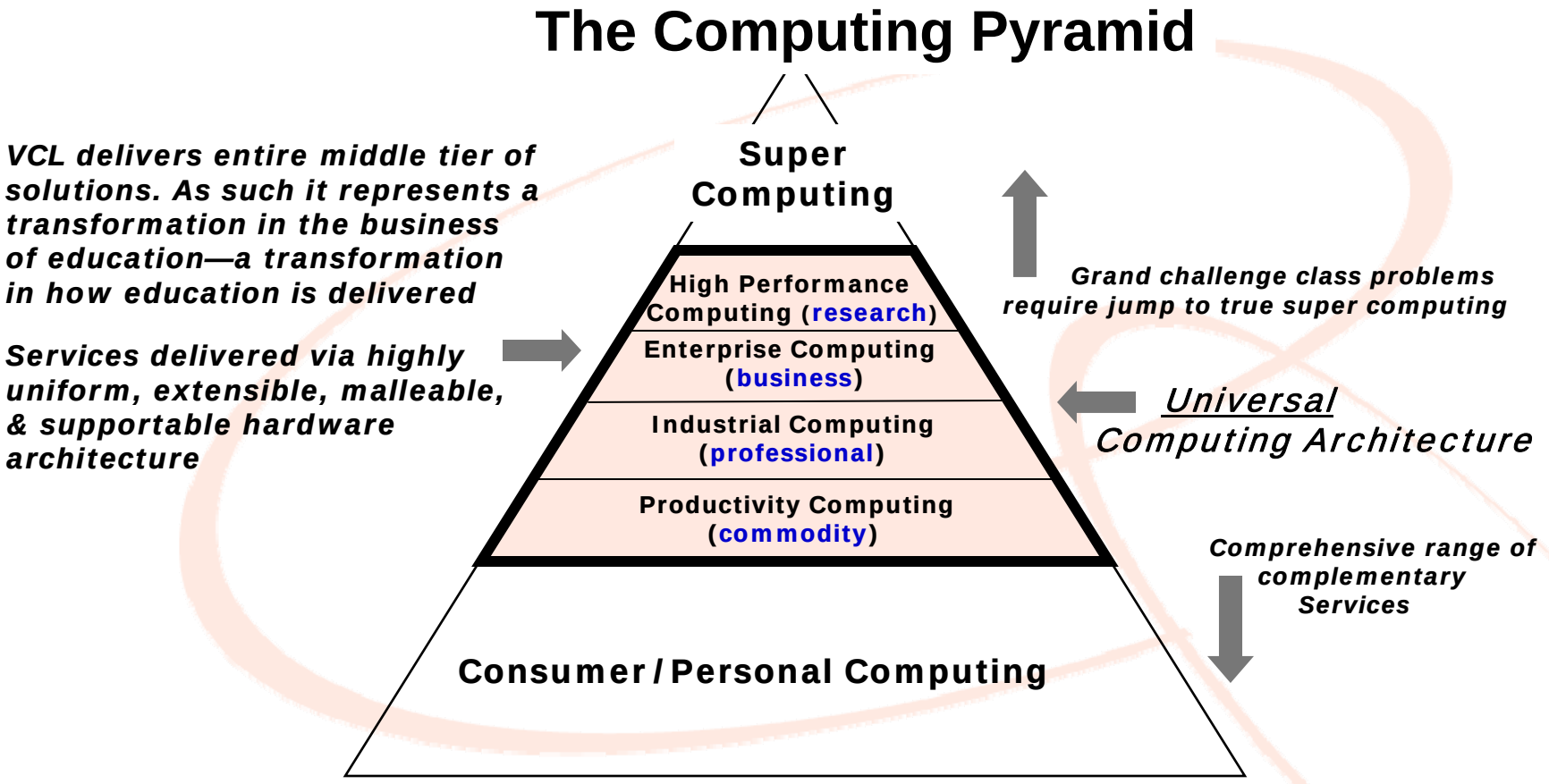
North Carolina State University

May 07, 2007

Virtual Computing Lab

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

What is VCL.


The Computing Pyramid
Super Computing
High Performance Computing (research)
Enterprise Computing (business)
Industrial Computing (professional)
Productivity Computing (commodity)
Consumer / Personal Computing
VCL delivers entire middle tier of solutions. As such it represents a transformation in the business of education—a transformation in how education is delivered
Services delivered via highly uniform, extensible, malleable, & supportable hardware architecture
Grand challenge class problems require jump to true super computing
Universal Computing Architecture
Comprehensive range of complementary Services

Motivation - Student Owned Computing

- **University expectation / requirement**
- Stats - NCSU College of Engineering incoming Freshman
  - Fall 2005
    - **81.21%** brought laptops
    - **98.39%** brought a computer
  - Fall 2006
    - **92.99%** brought laptops
    - **98.48%** brought a computer

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
  - Long 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.

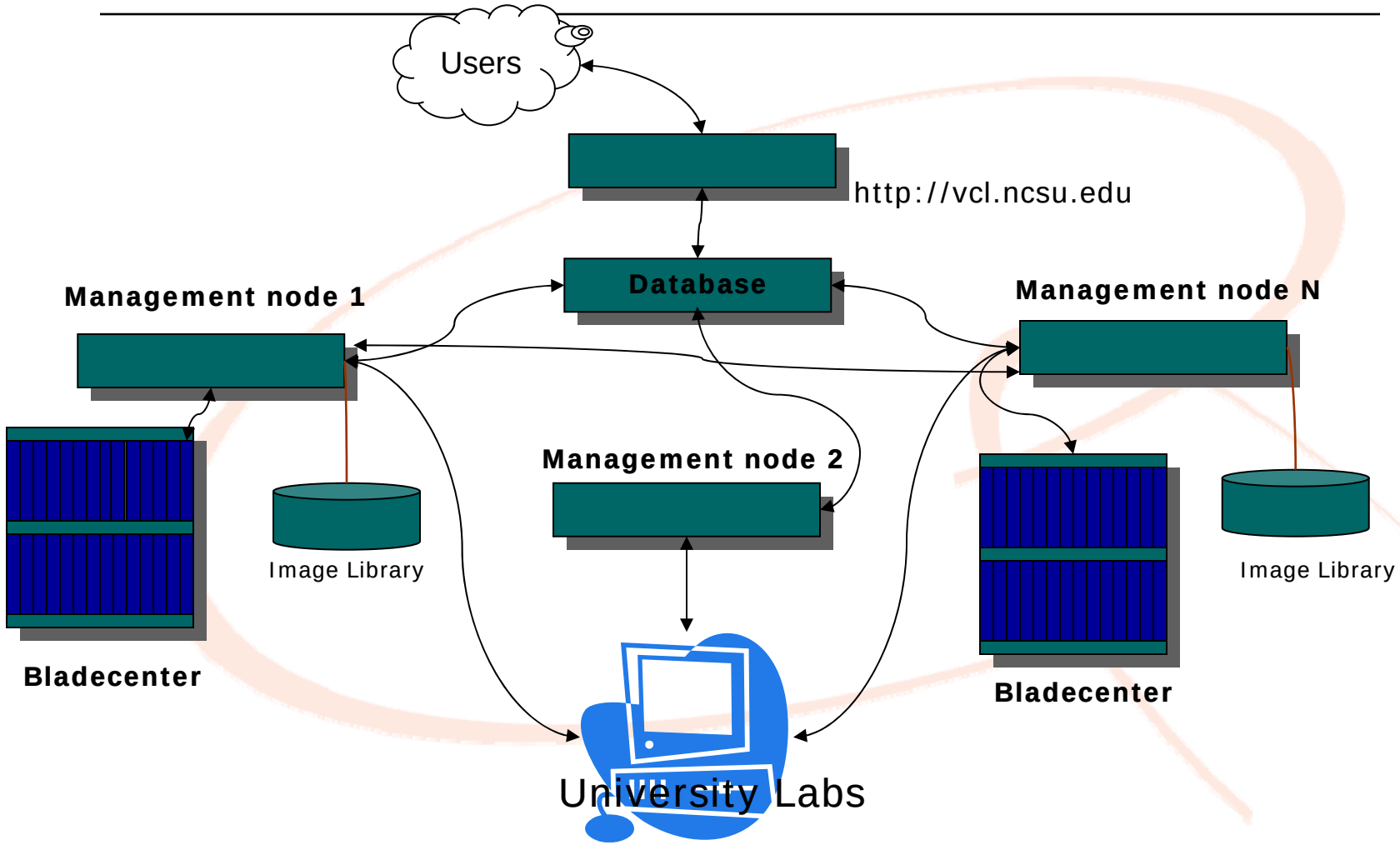
Motivation - Shared Resources / Custom Env.

- **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

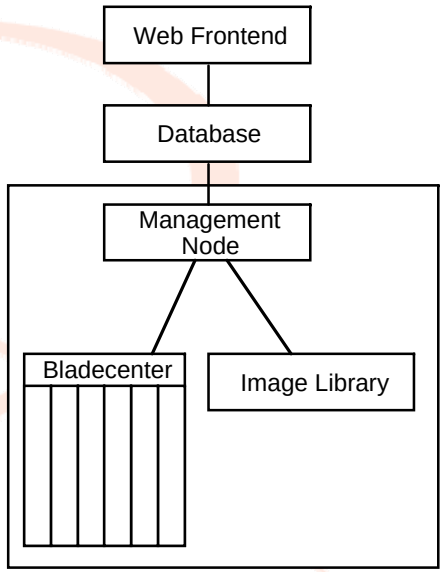
- **Creative** ways to **increase** the compute cycle of a single piece of hardware, while meeting the needs of both **researchers** and **students**.
- **Multi-purpose hardware** - on-demand use, dedicated use. Bare-metal, hyperviser(VMware,KVM,Xen,etc)
- **Switching Blades from VCL to HPC use**
  -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

VCL Infrastructure



VCL Infrastructure

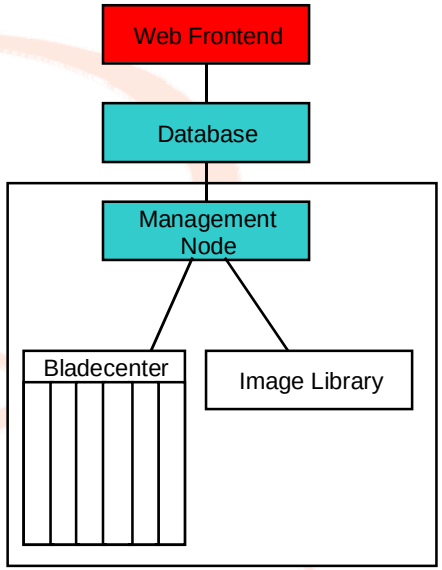
- **Web server** - Linux Host, RHEL
  - Apache
  - PHP
- **Database** - Linux Host, RHEL
  - MYSQL 5.1
- **Management node** - Linux Host, RHEL
  - xCAT
    - DHCP, tftp, PXE, kickstart install server, all run on private network
  - VCLD - perl, calls xCAT commands, process assigned requests



VCL Infrastructure - Web portal

Web server - LAMP,AJAX

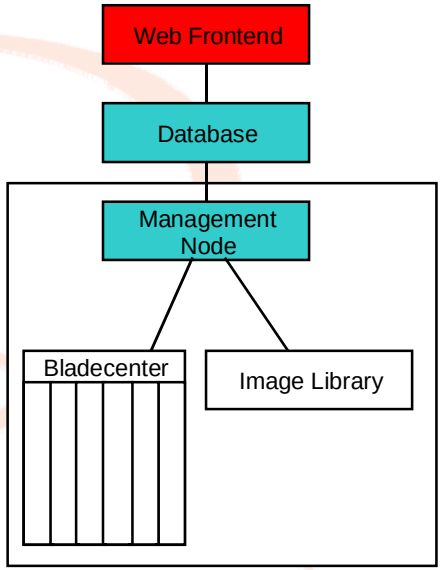
- **Scheduler -** based off user's request provides optimal hardware. Aware of what is running where. Assigns request to a Management node
- **Management interface**
  - **Assign user rights -** what they can use and do
    - Simply check out environments
    - Manage Computers
    - Manage Images
 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



VCL Infrastructure - Web portal

Web server - Management Interface(cont'd)

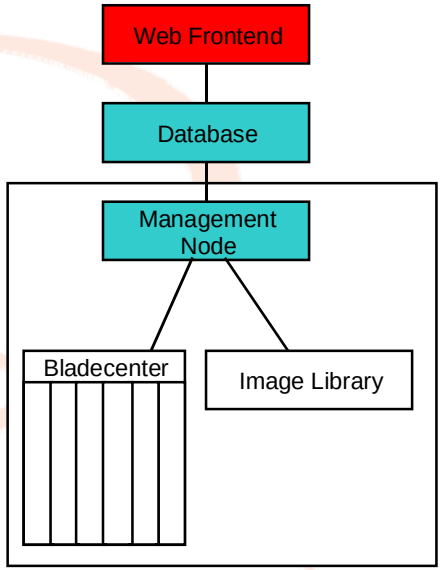
- **Manage Computers**
  - Add / delete computers
  - **Change attributes** about individual computers
    - Change states - available, maintenance
    - Change Schedule
  - **Computer grouping** - change groups individual computers belong to.
  - **Reload** individual or groups of machines



VCL Infrastructure - Web portal

Web server - Management Interface(cont'd)

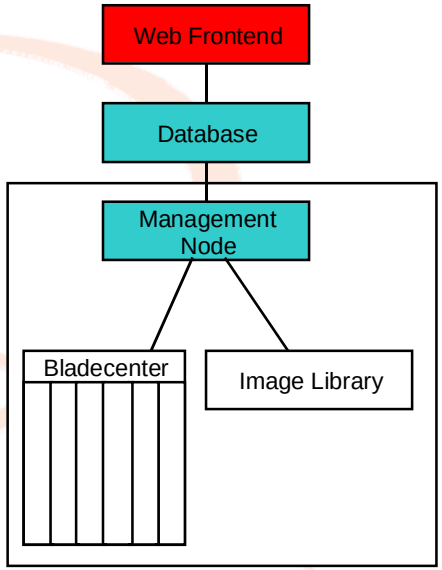
- **Manage Schedules -** used to set times computers are available for use.
  - Add / delete schedules
  - Modify schedules
  - Change ownership of schedules



VCL Infrastructure - Web portal

Web server - Management Interface(cont'd)

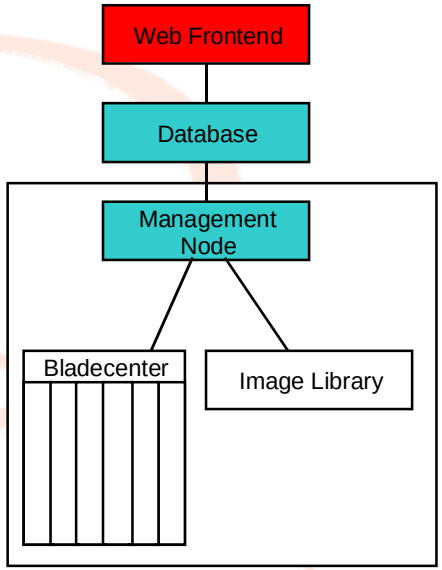
- **Manage Images**
  - **Create -** method to create new images
  - **Image grouping** - put images in specific image groups
  - **Image Mapping** - map image groups to computer groups
  - **Edit image details** - rename, change owner, change minimum requirements (cpu,memory)



VCL Infrastructure - Web portal

Web server - Management Interface(cont'd)

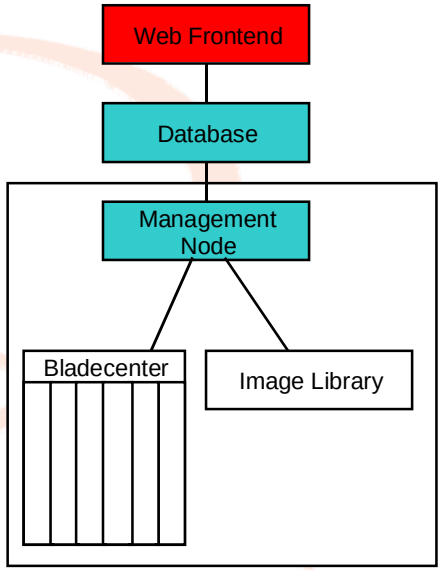
- **Manage Groups**
  - **User groups**
    - Create groups
    - Modify groups - members, owners, names
  - **Resource groups**
    - **Image groups -** groups for images, owner, user groups that can modify or add images to.
    - **Computer groups** - groups for computers, owner, user groups that can modify
    - **Management node groups** - create



VCL Infrastructure - Web portal

Web server - Management Interface(cont'd)

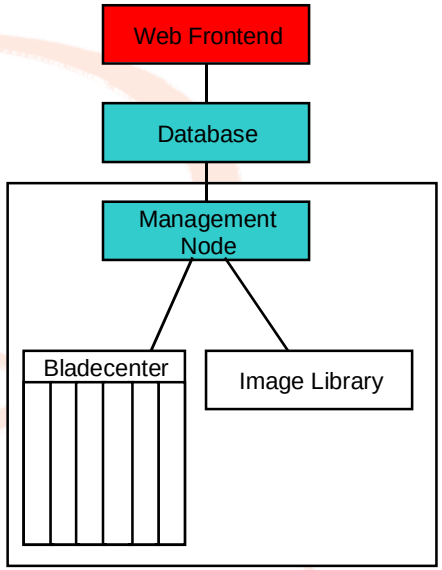
- **Management Nodes**
  - **Edit Management Node info**
    - Hostname, IP address, owner, state
  - **Edit Management Node Grouping**
  - **Edit Management Node Mapping**
    - Map computer groups the management node can control, reload, provision, etc.



VCL Infrastructure - Web portal

Web server - Management Interface(cont'd)

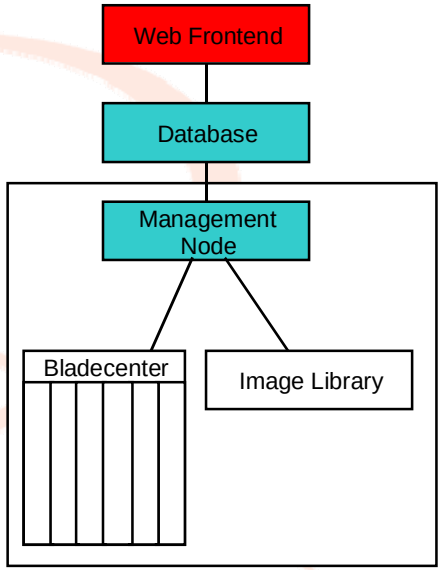
- **Block Reservations** - provision blocks of computes preloaded for workshops or classes.
  - Set schedule to provision X number of computers with a particular environment.
  - Repeating schedule, i.e. every Tu,Th 2-4pm
  - List of dates and duration.
- 30-45 minutes before requested start time, the management node scans all available resources and starts reload process. All selected resources are locked out for the group listed in Block request.



VCL Infrastructure - Web portal

Web server - Management Interface(cont'd)

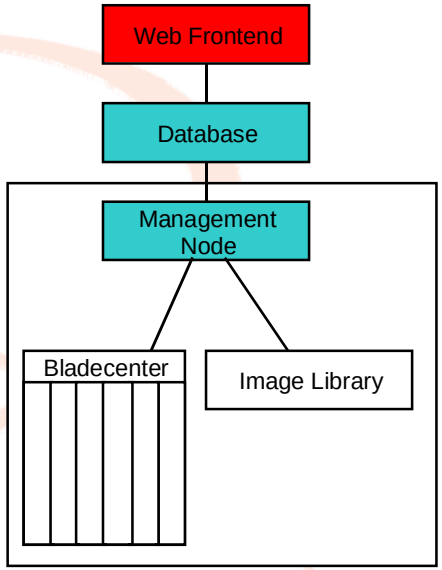
- **User preferences** - set various prefs.
  - Personal Information - set information not pulled from LDAP, preferred, email or IM notifications,etc
  - **RDP File Preferences** - edit all settings related to the remote desktop connection, display, mapped drives, etc.
  - **View Mode** - admin only, change to other users web view for debugging purposes.



VCL Infrastructure - Web portal

Web server - Management Interface(cont'd)

- **Privileges** - privilege tree
  - Based on directory service model
  - Set permissions at privilege node for individuals and user groups
    - Image checkout, Image manage, resource manage, node manage, user grant, schedule manage
  - Set resources available for each node.
  - Both permissions and resources can be cascaded to sub nodes.



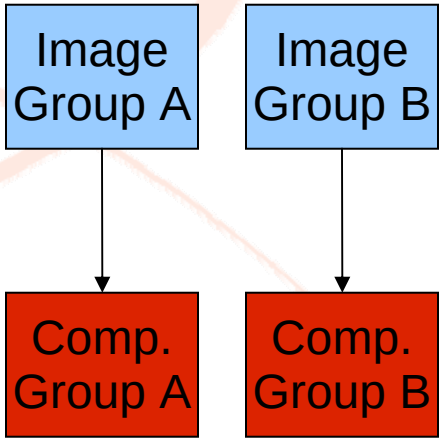
VCL Infrastructure - Web portal

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**

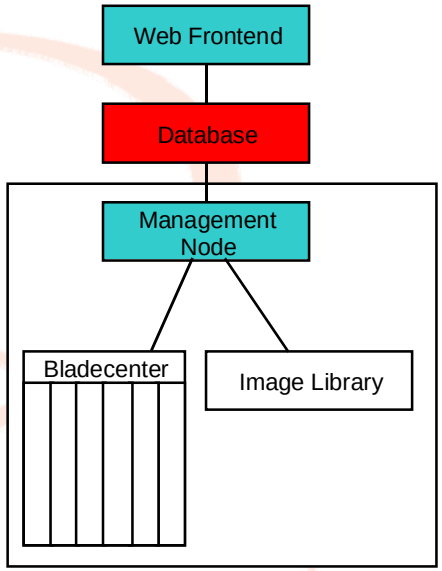


Now, only images in Group A can be run on the computers that are in comp. Group A. If all of the computers in comp. Group B are in use and someone requests an image in image Group B, user must wait until a computer in comp. Group B is available.

VCL Infrastructure - Database

Database - Linux, MySQL 5.X

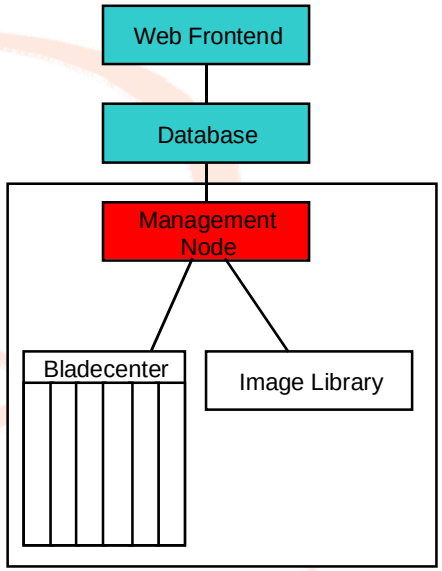
- **Stores all data 46 tables - few examples**
  - Admin levels - determines what users see
  - BlockRequest - workshop course
  - Changelog - log of changes to requests
  - **Computer** - info on machines
  - **Image** - info on images
  - **Imagerevision** - revision control
  - Managementnode - info, 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)

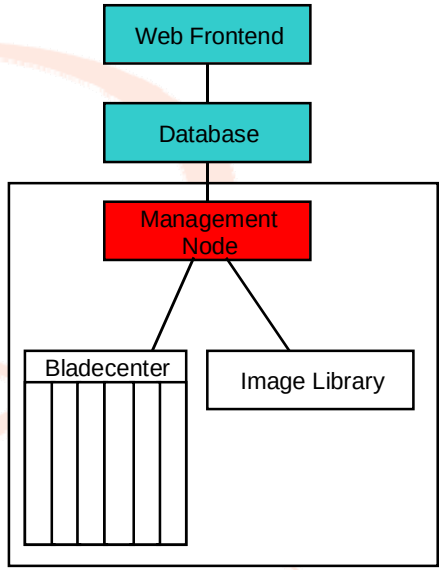
- **State driven**, polls database for assigned tasks
  - **New** - new request, checks assigned blade, confirms or loads image, bare metal or VM
  - **Reserved** - waits for user ACK, moves to inuse/timeout
  - **Inuse** - monitors user connection, notifies user of end time, if user disconnected for 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 hyperviser 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

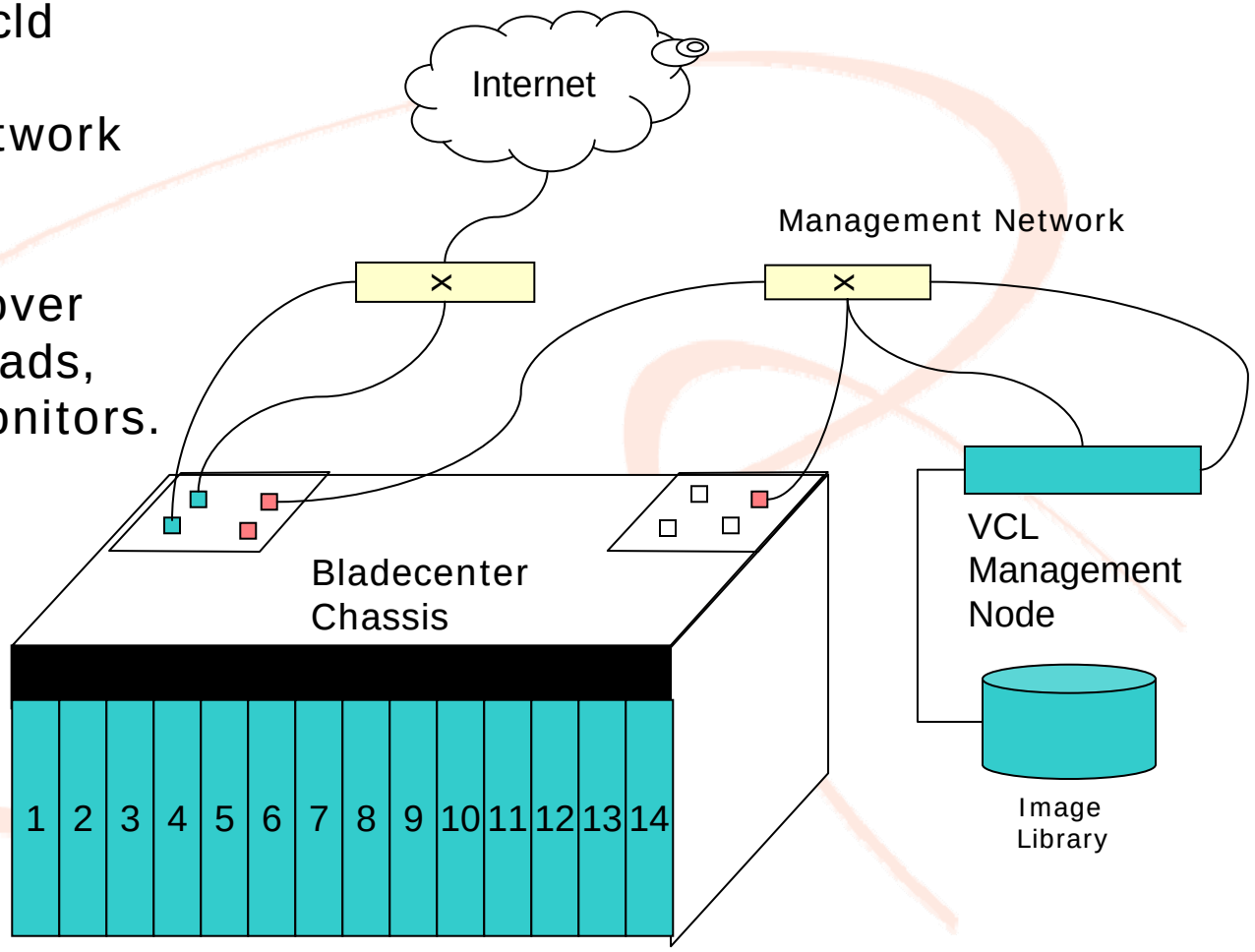
Management Node(MN)

- **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

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



North Carolina State University Virtual Computing Lab Model

User accesses web interface and requests an application

Internet

VCL Manager Software

Web Interface

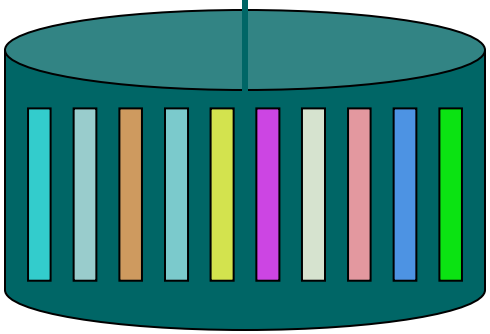
Scheduler

Schedule DB

Scheduler finds a server with the requested application or has management node load requested application on a server

Management Node

Application Image Library



Server with requested application is made available to user

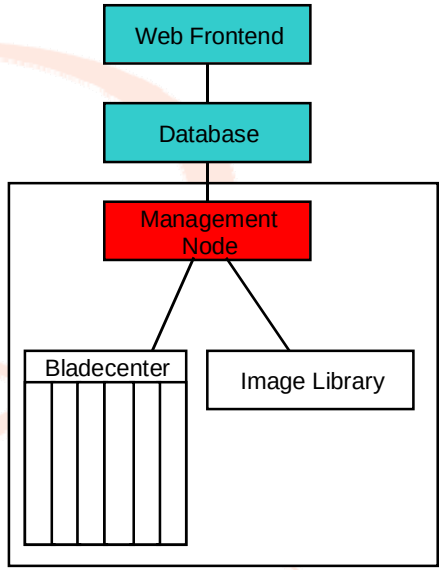
Servers

DEMO

VCL - Image Creation

Image Creation

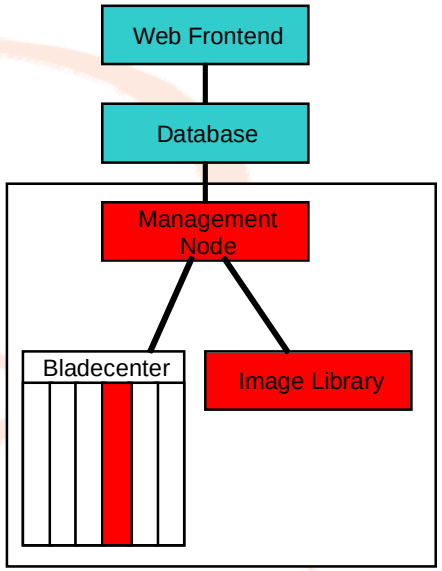
- Similar reservation process - except for users with higher privileges
- **Create** new image from existing image. All images started from base template image. Bare metal or VMWare, Windows or Linux
- **Update** images - version control v0…vN
- Images stored in **Image Library** and are pushed to blade either bare metal or VM host server for hypervisor
- **Bare Metal** images - copied from disk using **Partition Image** (**partimage**) as part of **xCAT**.
- **VM** images - in case of vmware, copy the vmdk files of image to image library.



VCL - Image Creation

Image Creation - process

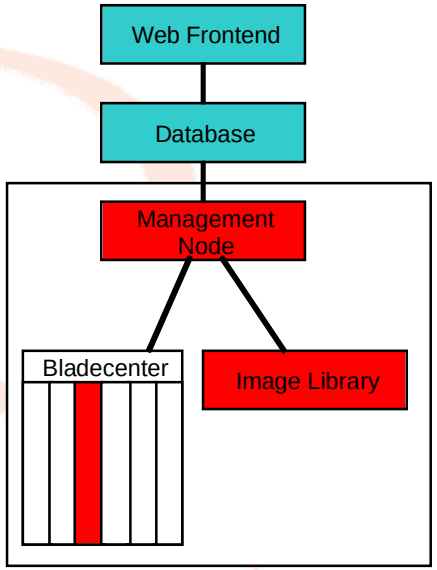
- With higher privileges
  - Select **Manage Images** -> **Create New Image** from the VCL interface.
- Choose an existing image to use as base template, usually base image is a No Apps image for either Windows XP,Windows 2003, or Linux RHEL4
- Reserve and Connect to the assigned machine, make changes or add software packages.
- Ready to image - return the VCL site under Current Reservations simply click “Create Image”.
- Options - **update** or a **create new image**.
- **Update** image - simply creates the next version of the image, v1,v2,v3…etc
- **Create** image - new name, min requirements(cpu,mem,etc) check for user connections, etc.



VCL - Image Creation

Image Creation - process (behind the scenes)

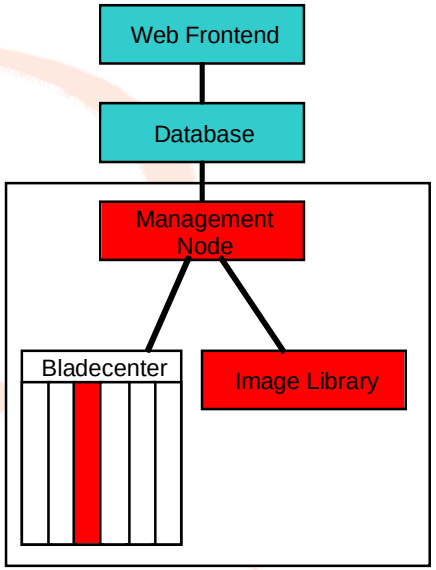
- Depending on the OS, and type (bare metal or VM) and even the profile of the base image, different steps take place during the image creation process.
- **Common checks / tasks**
  - **Confirm naming for version control**
  - **Defrag -** Win only
  - **Copy** any first boot scripts - to rename, start any services that don't behave well with preparation tools, sysprep.
  - **xCAT -** set any **xCAT** configurations for **node** to be **imaged**
  - **Sysprep** (MS preparation tool) - default, but is optional based on image profile.
  - **Based on profile** - start sysprep or simply reboot to start image capture.



VCL - Image Creation

Image Creation process (Bare Metal and VM)

- **Bare Metal -** uses partimage (www.partimage.org) through xCAT
  - Process to copy image from bare disk can take upwards of 15-20 minutes.
  - Saves disk image file in compressed format.
  - On average image sizes range from 2-4 GB depending on applications installed.
- **VM Virtual Machine**
  - Copies VM disk files to the image library through scp. For example, in case of VMWare the .vmdk files are copied and renamed to match the new image name.
  - Process less than 4-5 minutes.



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

Users

"Images"

"Application" Image Stack

End-User Access | SOA | RDP, VNC, ... | X-Win | Client Apps. | Work Flow Services | Vis Services | Other ...

Apps | e.g., Web Sphere | Middleware e.g. LSF

OS: | Win | Linux | ...

e.g., Web Sphere | Apps | Virtual Layer | e.g., VMWare, XEN, MSVS2500...

OS: | Win | Linux | Other ...

VCL Manager

H/W Resources

Hardware
Blades, servers, desktops, storage

Local or distributed

xCAT | VCL code | IBM TM

WebServer | DataBase | Etc.

Simplicity, Flexibility, Reliability
Scalability, Economy

The Virtual Computing Initiative: Anytime, Anywhere On Demand Computing

Internet

Web Interface

Scheduler

Schedule DB

Application Image Library

Management Node

Institution A Servers

Institution B Servers

Server aggregation in shared VCL Data Center B

Schedule DB

Scheduler

Web Interface

Servers

Management Node

Fully distributed VCL Data Center A

Management Node

Servers

Remotely scheduled

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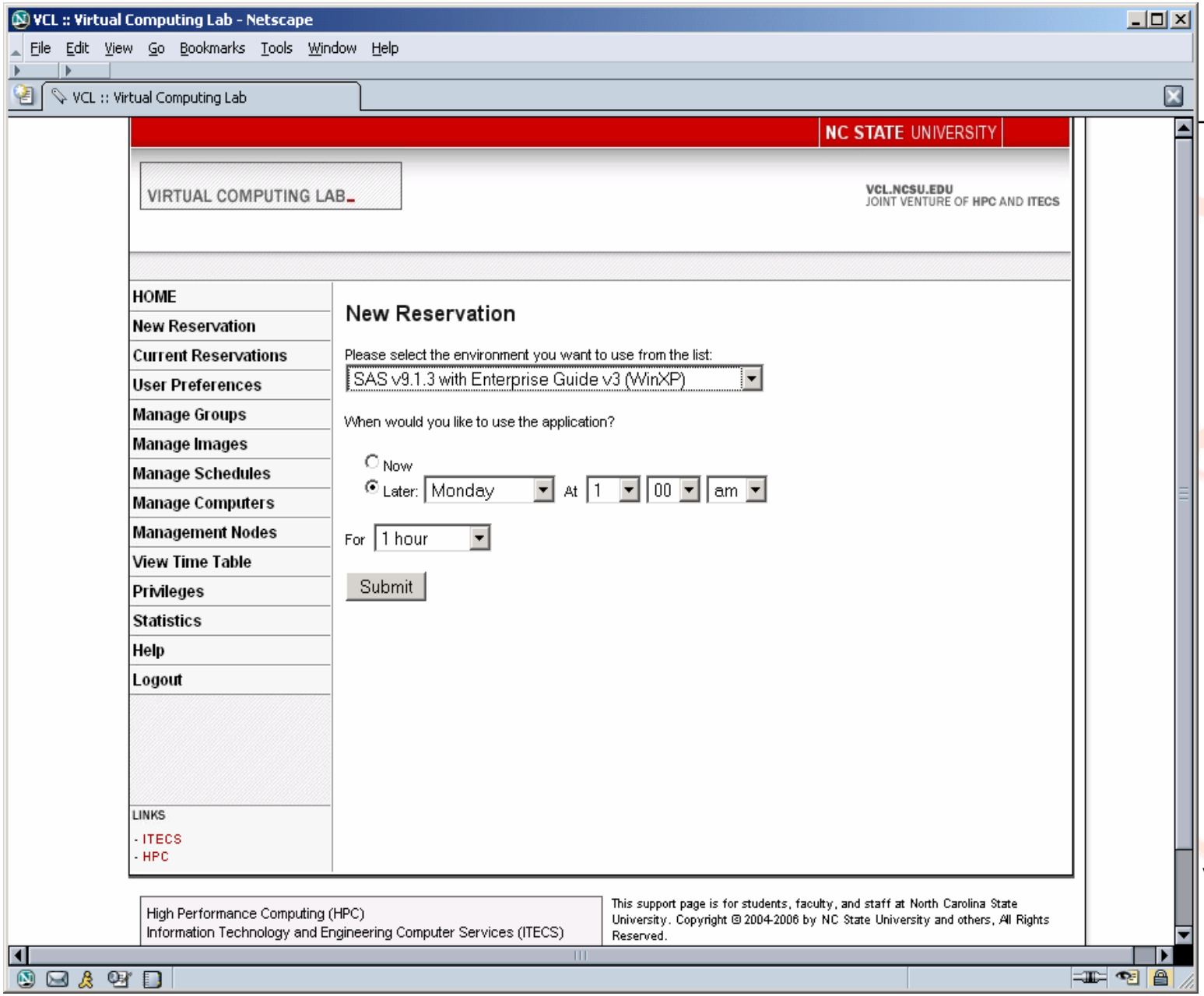

Ongoing:
-Tipping pt.
-Usability
-Availability
-Pedagogy
-…

-Currently scaling to 8000+ users
- N-M-K

vcl.ncsu.edu

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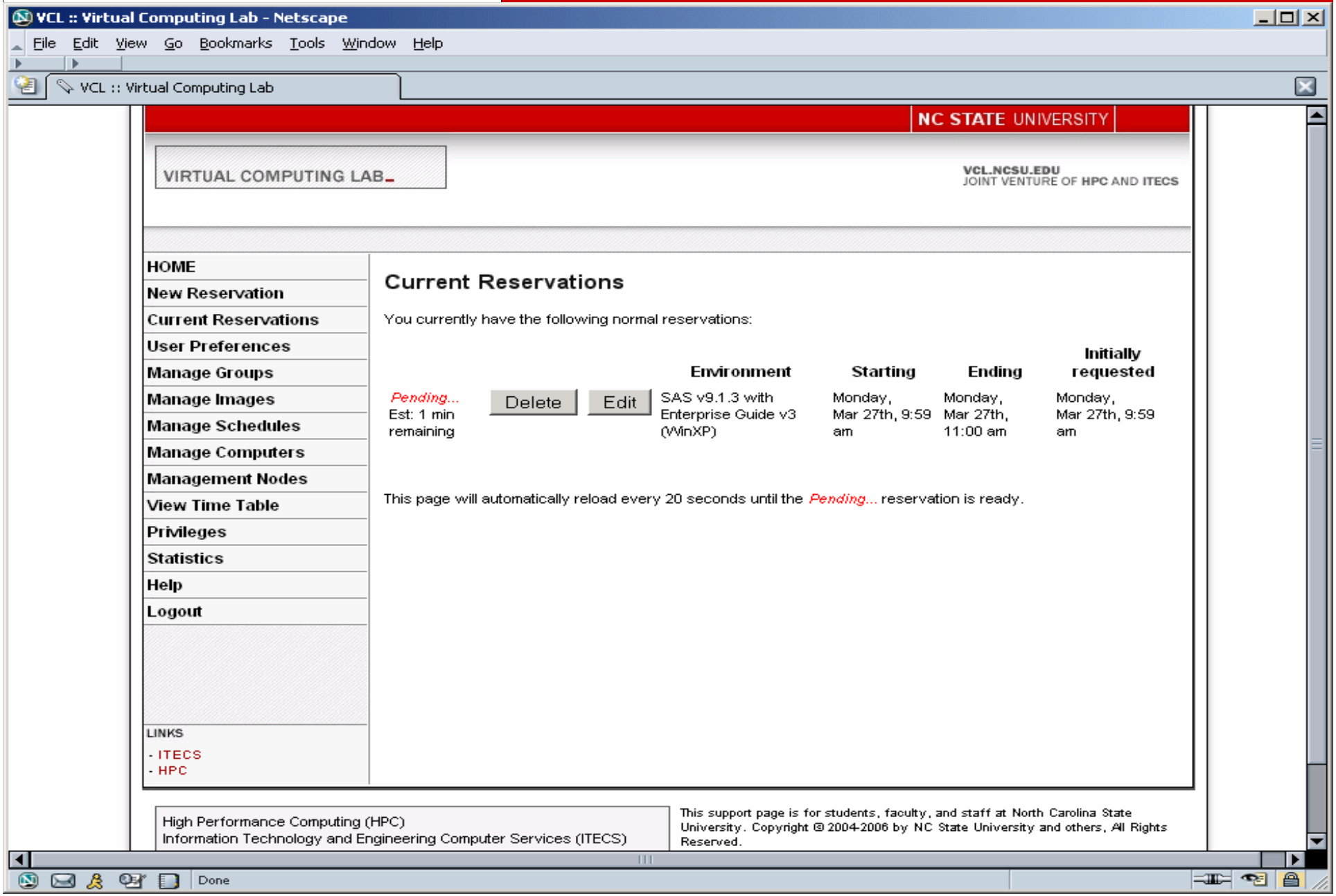

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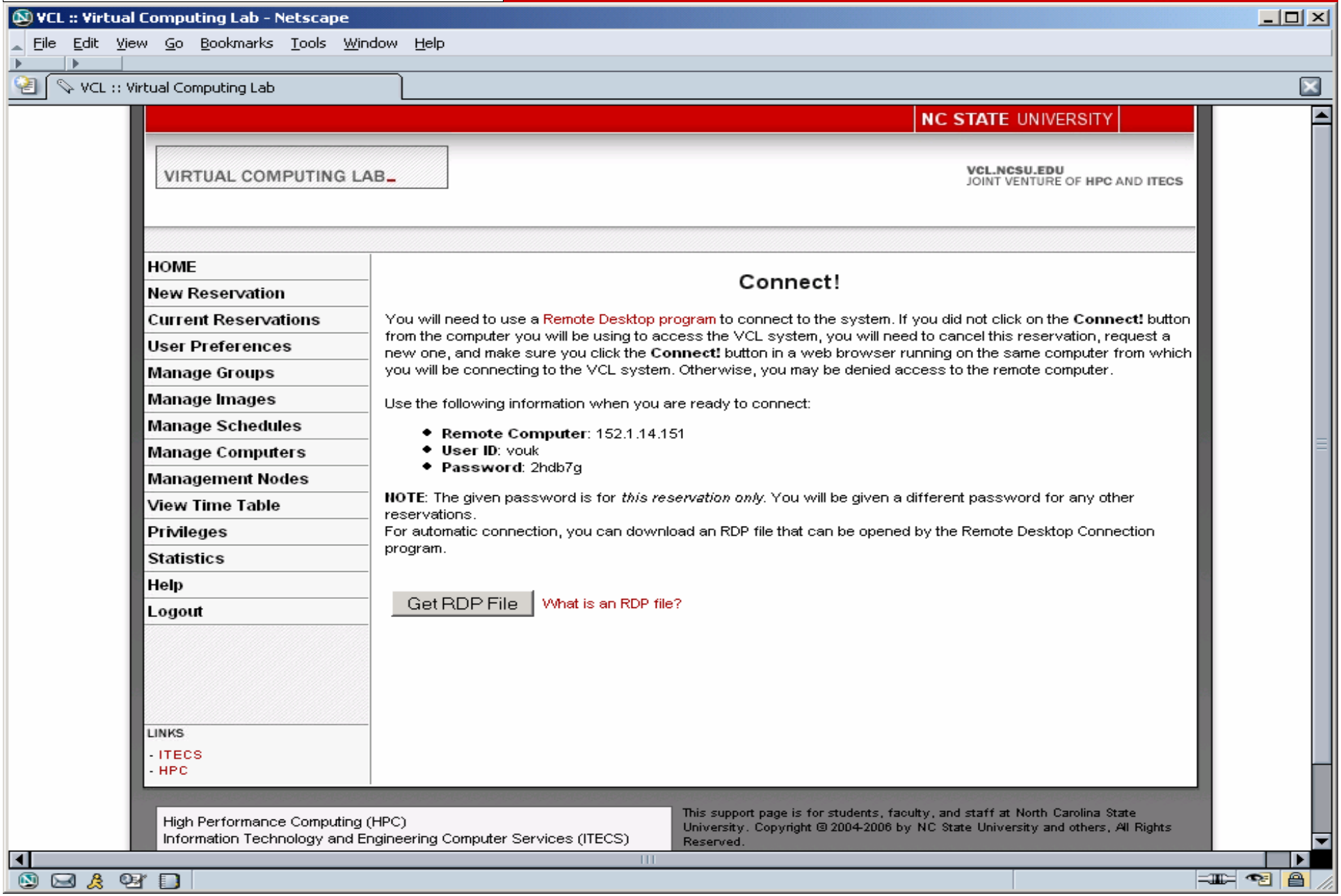

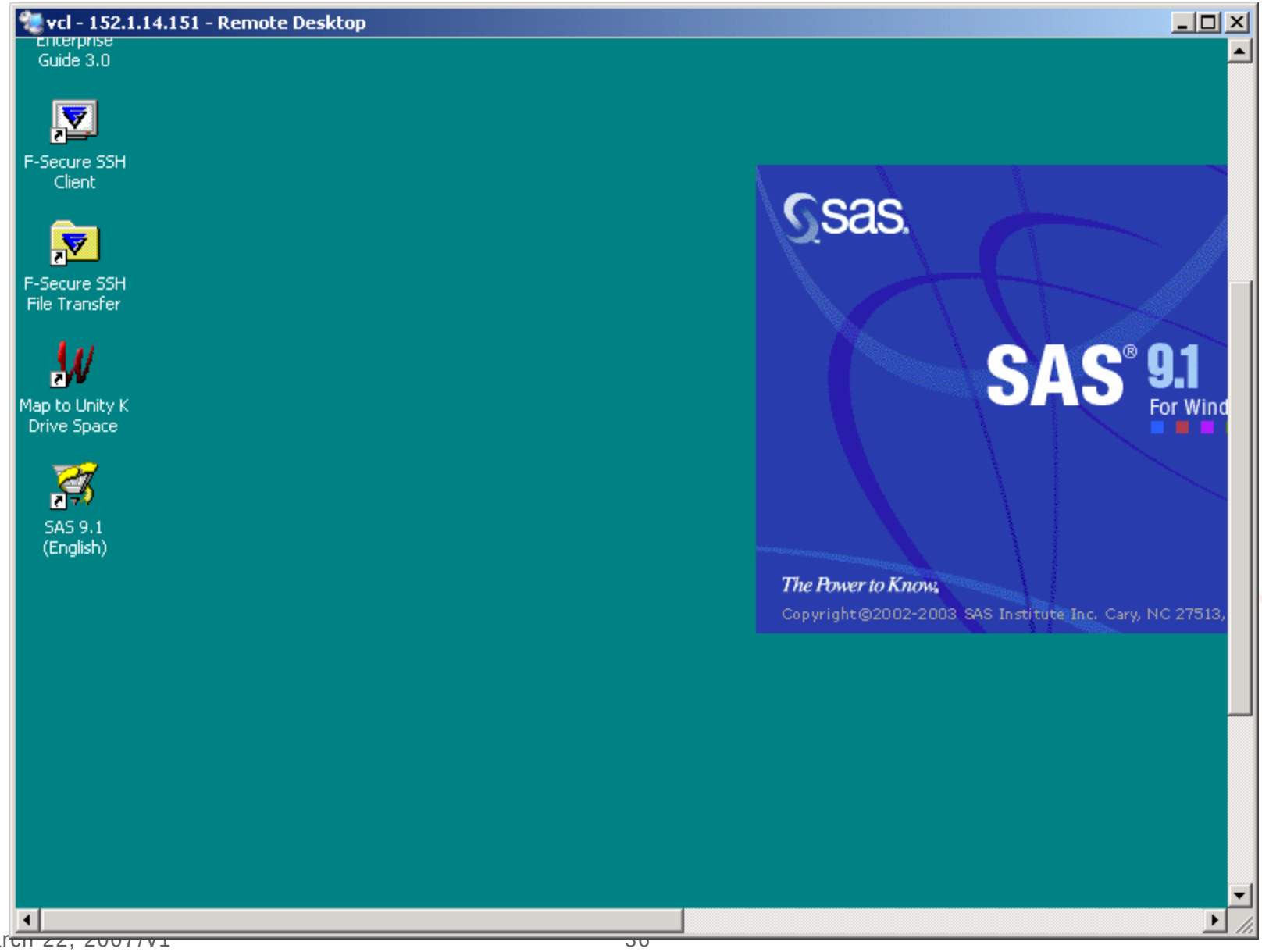
vcl - 152.1.14.151 - Remote Desktop
Guide 3.0
F-Secure SSH Client
F-Secure SSH File Transfer
Map to Unity K Drive Space
SAS 9.1 (English)
sas
SAS® 9.1
For Wind
The Power to Know.
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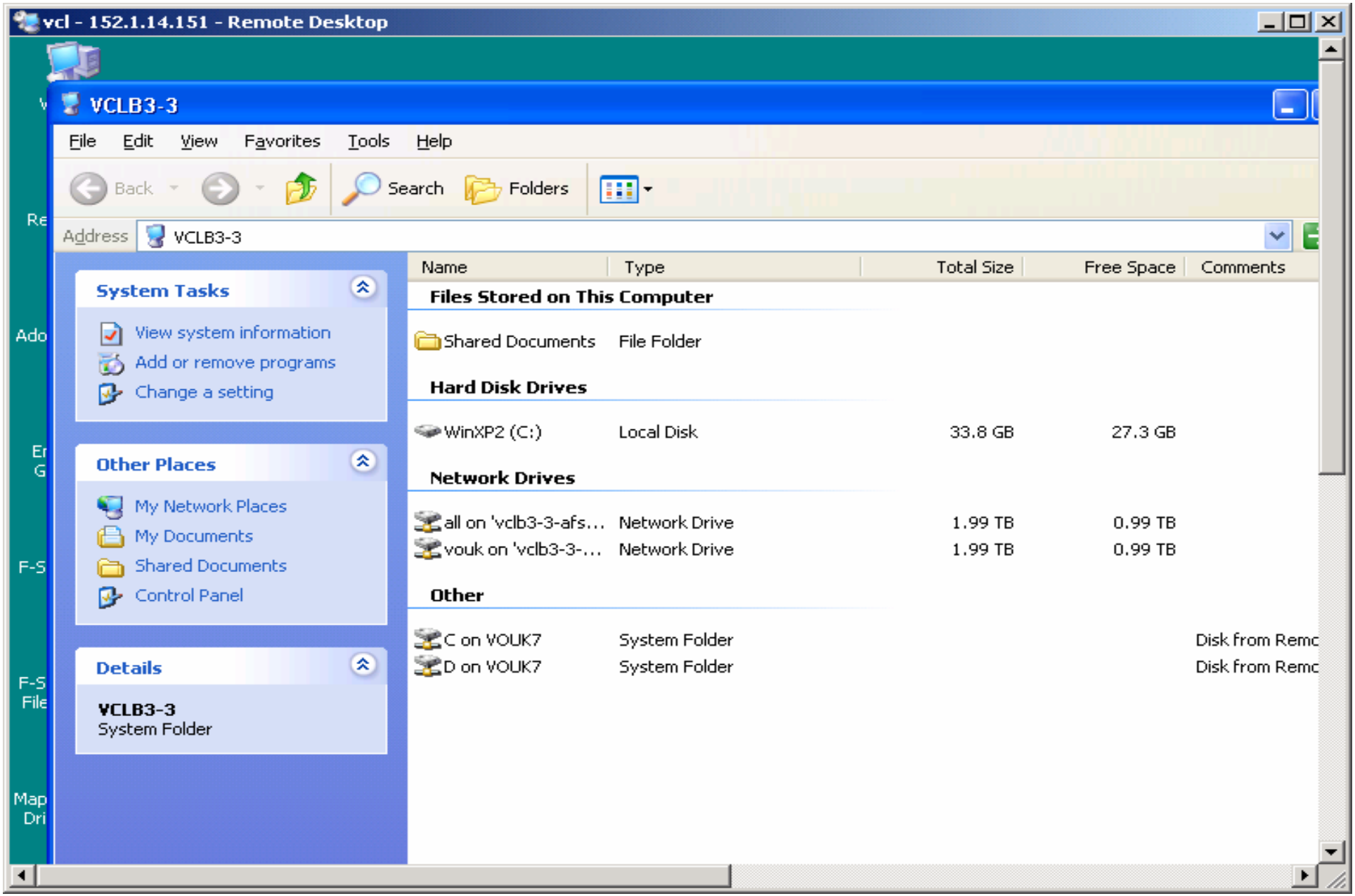

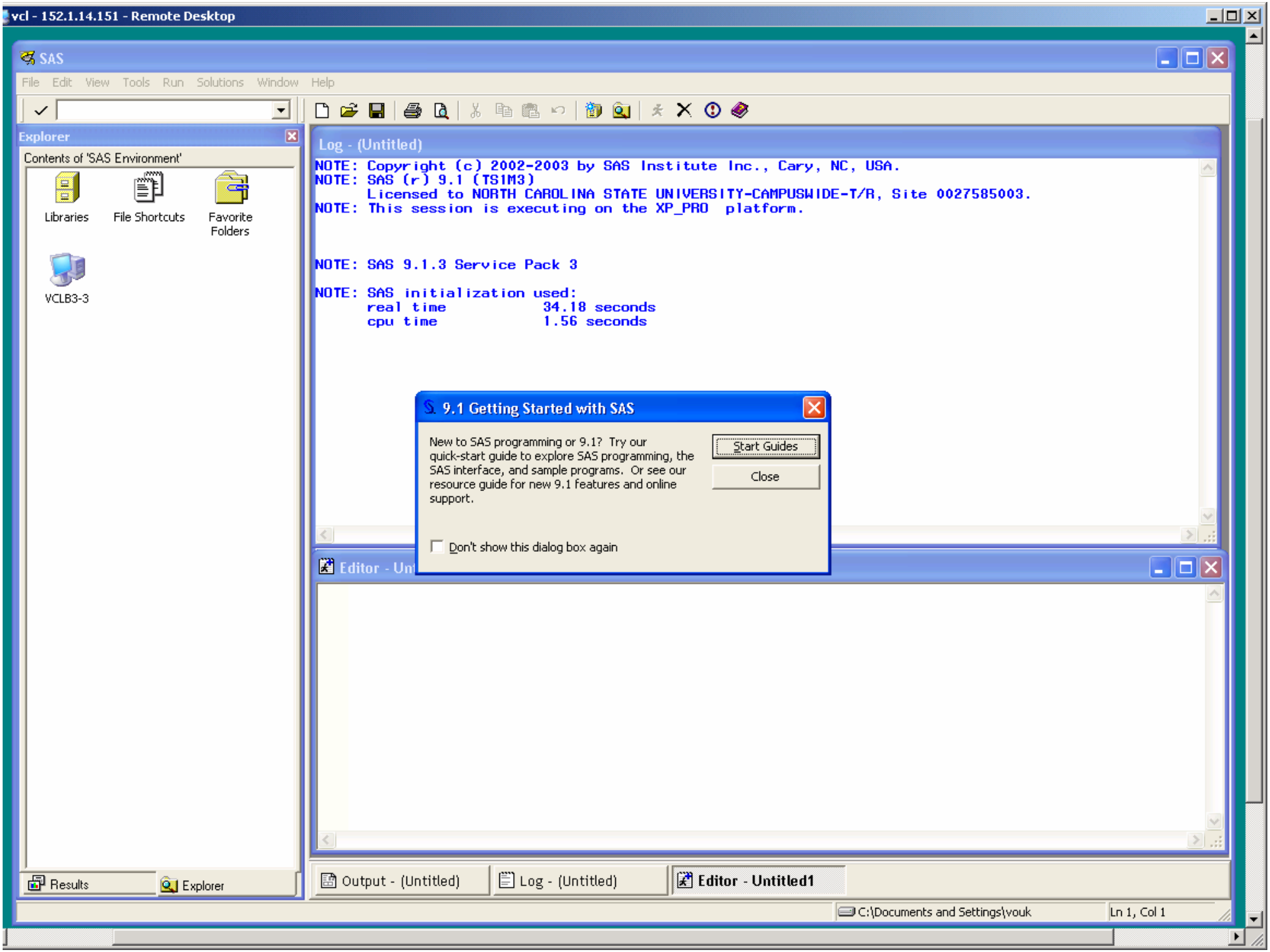
vcl - 152.1.14.151 - Remote Desktop
SAS
File Edit View Tools Run Solutions Window Help
Explorer
Contents of 'SAS Environment'
Libraries
File Shortcuts
Favorite Folders
VCLB3-3
Log - (Untitled)
NOTE: Copyright (c) 2002-2003 by SAS Institute Inc., Cary, NC, USA.
NOTE: SAS (r) 9.1 (TS1M3)
Licensed to NORTH 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
Results
Explorer
Output - (Untitled)
Log - (Untitled)
Editor - Untitled1
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Ln 1, Col 1

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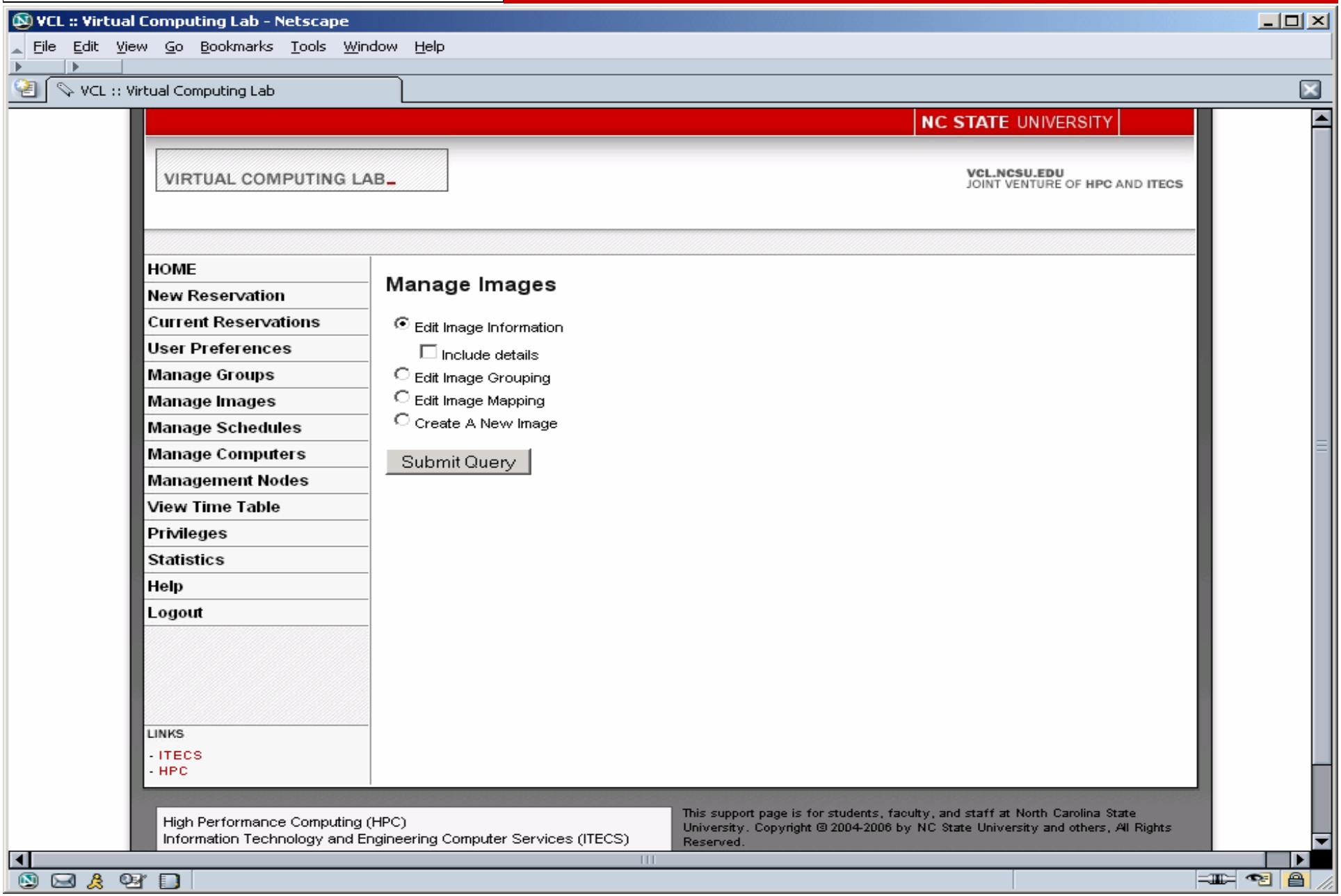

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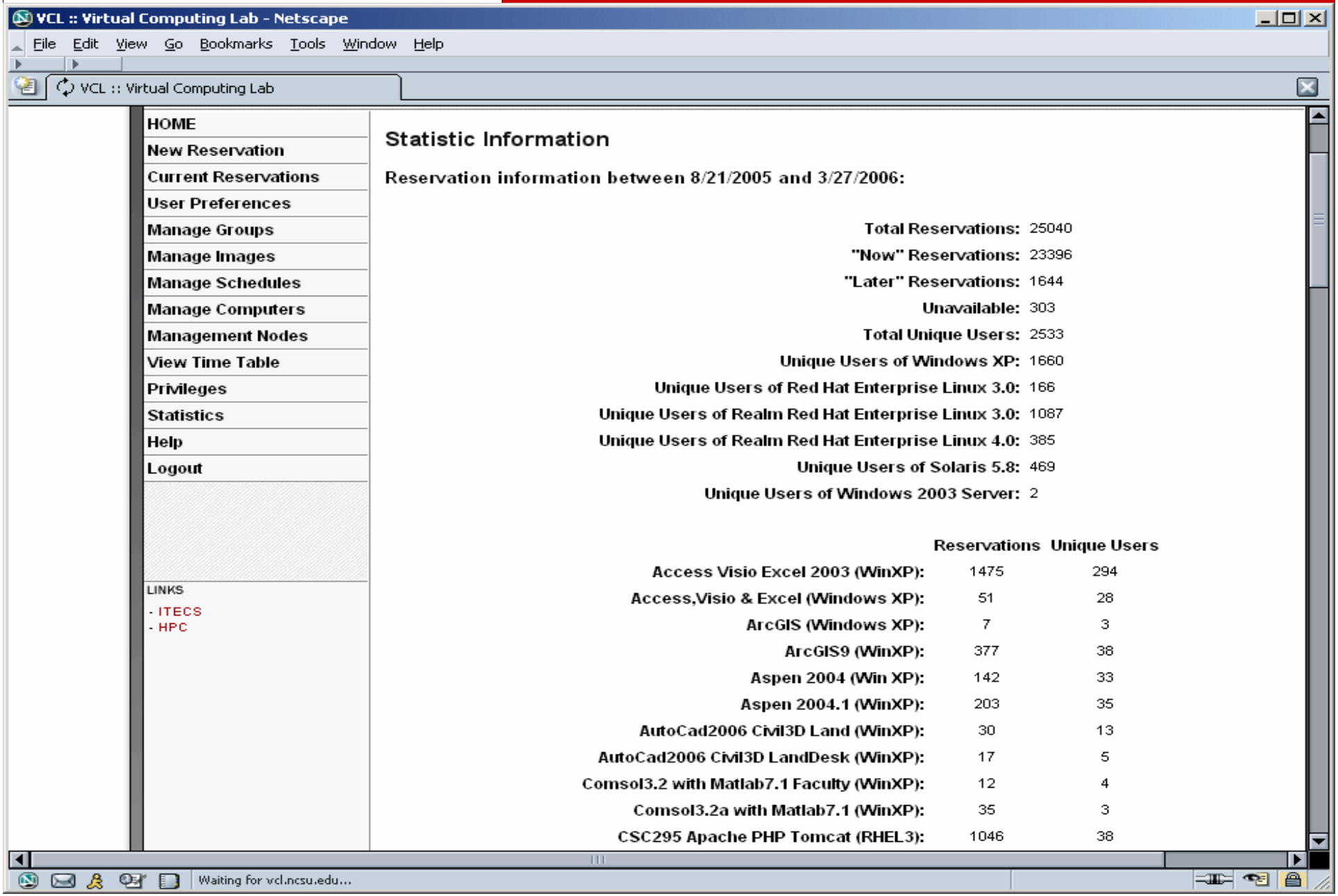

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VCL :: Virtual Computing Lab - Netscape

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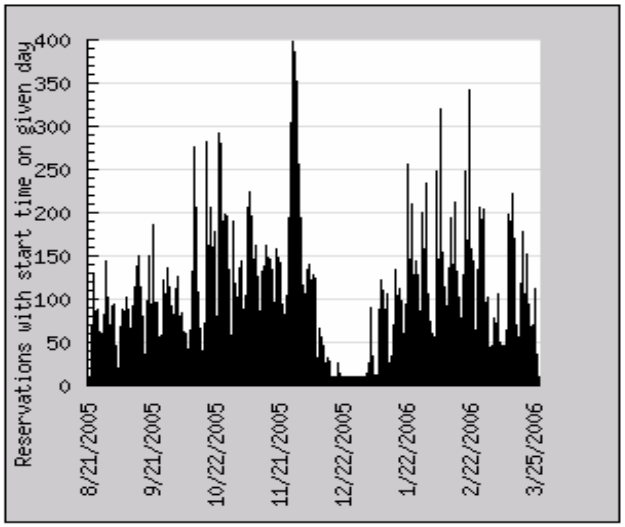
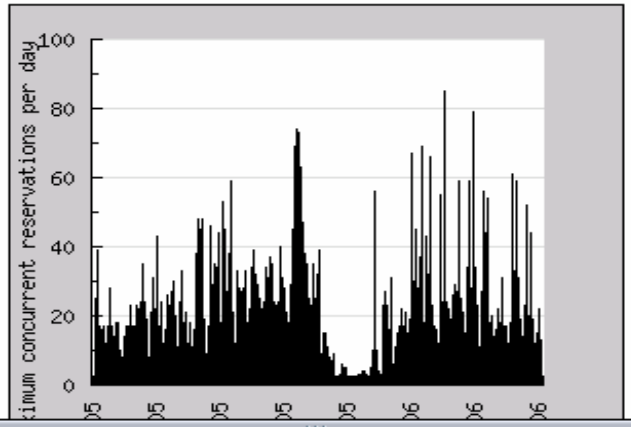
Reservations by Day



Max Concurrent Reservations By Day



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