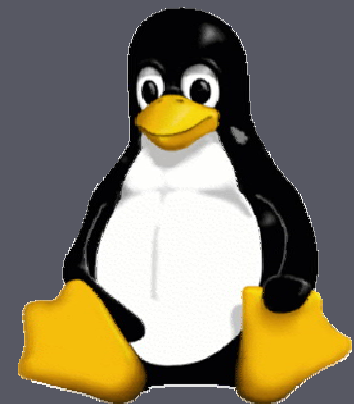


Linux in Engineering Education

Dr. Alexei Kotelnikov
Professor Doyle Knight
School of Engineering, Rutgers Univ.

Presented at RITE conference 05/13/2004



Overview

Linux in Engineering Computing

Linux in Undergraduate Education

Linux in Graduate Education and
Research

Prospective for Future Development

Discussion

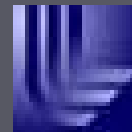
What is the role of Linux in Engineering Computing?

Engineering analysis and design



Smaller companies: ELS, OTEC ...

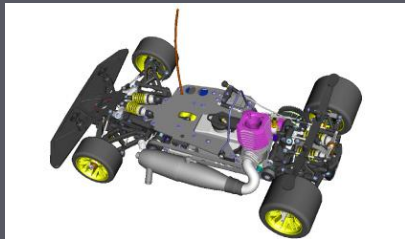
Research



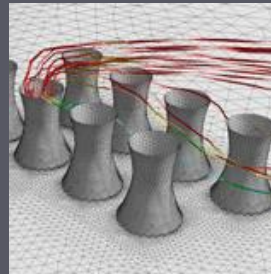
Engineering Design

Examples of software used by engineers for analysis and design:

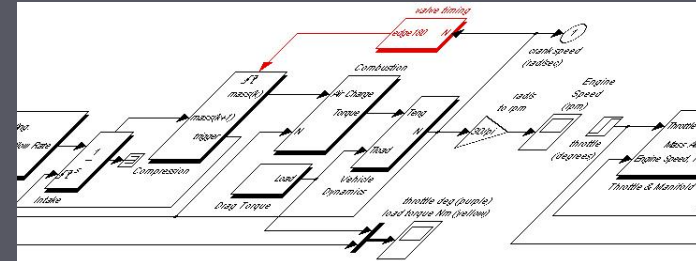
ProEngineer



Fluent



Matlab



Point: Commercial engineering design codes run under Linux ...

Research

Need for High Performance
Computational



Great Performance
high maintenance cost



Good performance
low maintenance cost

Engineer in Computational or IT field needs to know

At a minimum:

Graduate engineers need to know how to effectively use Linux system

But more importantly:

Graduate engineers need to know how to configure and administer Linux desktops servers and high performance computational clusters

Why? ~40% of new jobs are in small companies (< 50 employees)

Researcher in Engineering needs to know

Your work will be done on a cluster

You may have to assemble your own
cluster

Undergraduate Education

§ Unisys Scholars Program

Linux course, Linux for Engineering
and IT applications,

<http://linuxcourse.rutgers.edu>

Summer Governor School

Unisys Program of Excellence

Year 2001: Prof. D. Knight submitted proposal to Unisys Corporation.

Objective: Select talented MAE and ECE students to learn IT over the junior or senior year; financial support from Unisys Corporation. In 2003, we had 27 applications for 4 positions.

AY 01/02: the first Unisys Scholar, JB Kim

AY 02/03: two Unisys Scholars, Christopher Lilgeberg and Mike Miller

AY 03/04: four Unisys Scholars, Malik Khan, Paul Arias, Lucas Machado, Diane Palla

Unisys Program

Fall semester:

- Learn advanced Linux Administration

Spring semester:

- Final Project
- TA for the Linux course

Seniors are qualified for J.J. Slade scholars nomination

Unisys Laboratory, Engineering D112

Built in January 2002

16 desktops

16 cluster nodes

Private network

Servers

DHCP, NFS, Apache



Unisys Projects

2002:

- VPN implementation in cluster computing by JB Kim (posted in Linux Journal, <http://www.linuxjournal.com/article.php?sid=6142>)

2003:

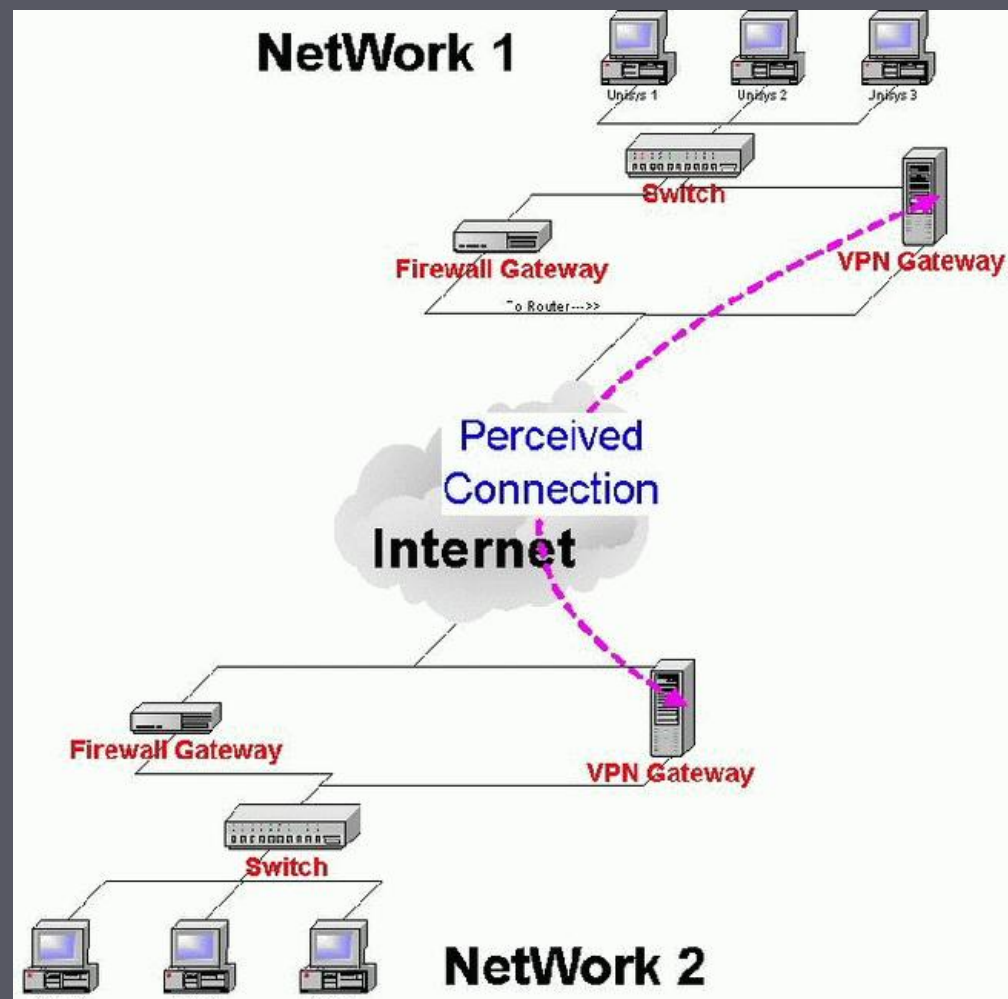
- Windows/Linux Unified Authentication by Mike Miller;
- Parallel Computing with Matlab by Chris Lilgeberg

2004:

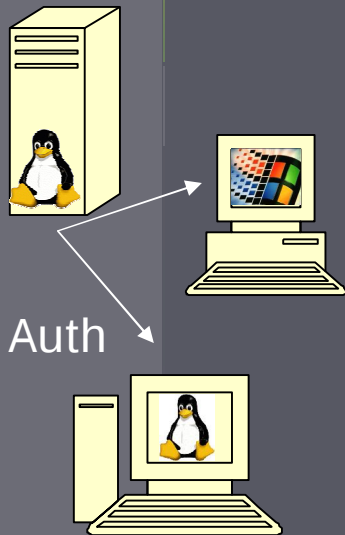
- Centralized Departmental Printing by Malik Khan;
- Web Interface of Linux Print Server by Diane Palla;
- Parallel Numerical Simulations with MPI and SGE by Paul Arias;
- Centralized Linux Security Server by Lucas Machado

JB Kim: VPN implementation in cluster computing

FreeS/WAN
Private
subnets
SGE cluster



Mike Miller: Windows/Linux unified authentication



Software	User Information	Login (Auth)		File Sharing		Print Sharing
		Win	Linux	Win	Linux	
Samba		P		P	1/2	P
NFS				1/2	P	
Kerberos		P	P			
YP/NIS(+)	P		P			
LDAP	P	P	P			

P = Secure

P = Insecure

Malik Khan: Centralized Departmental Printing

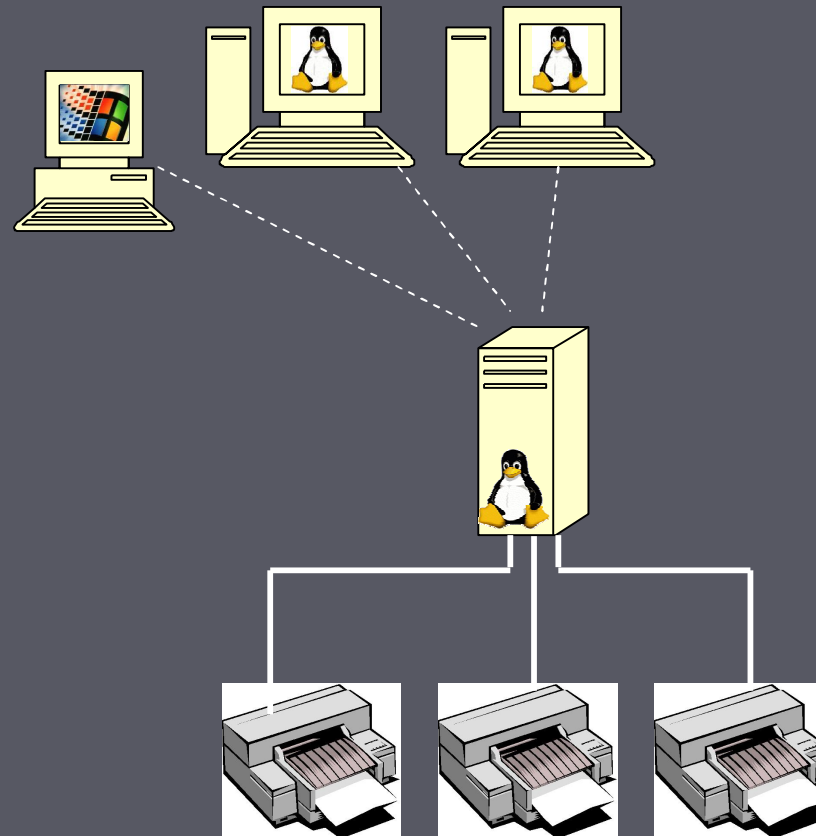
TCP/IP

LPRNG

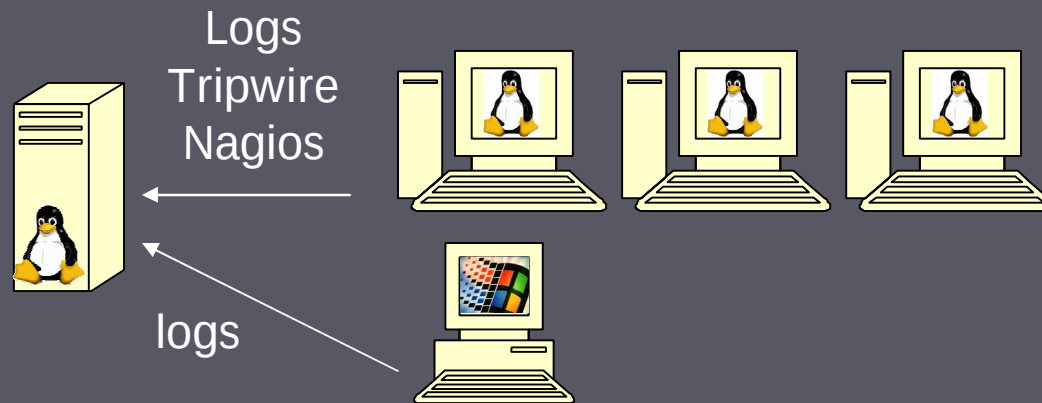
BOOTP

TFTP (ACL)

Printbill



Lucas Machado: Centralized Linux Security Server



Linux and Windows system logging;
send logs to the server

Log analysis with logwatch

Linux IDS with LANTrip

System status monitoring with Nagios

Linux Course

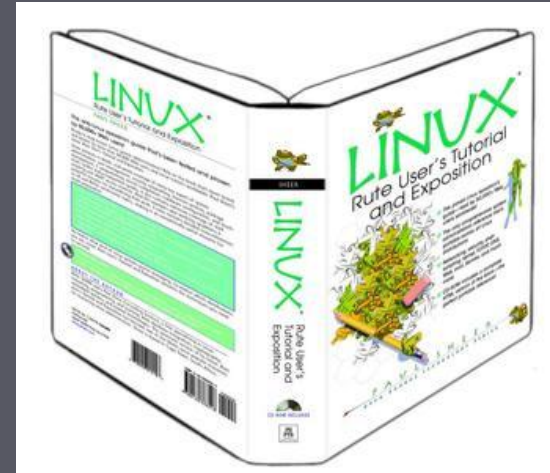
Linux for Engineering and IT applications,
<http://linuxcourse.rutgers.edu>, taught in
Spring Semester 02, 03 and 04

16 students in the class

Special topics in Mechanical and Computer
Engineering curriculum

Attracted ECE and MAE students with
interest in server administration and High
Performance Computing

Course topics

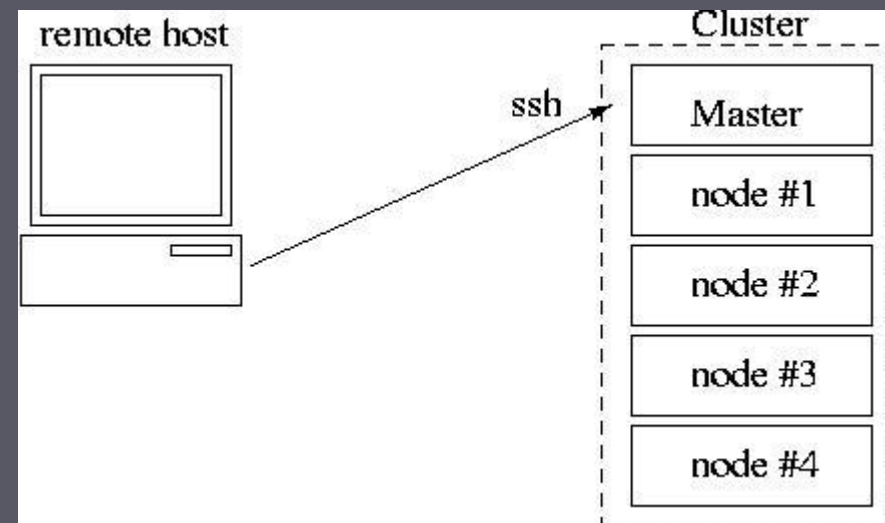


- Week 1:** Basic concepts of the operating system
- Week 2:** System installation configuration and upgrade
- Week 3:** Linux Networking
- Week 4:** Network File System (NFS)
- Week 5:** Network Information Service (NIS)
- Week 6:** Integrating Linux and Windows (Dual boot, Samba)
- Week 7:** Shell scripting, startup/shutdown, run levels, scheduled jobs, logging
- Week 8:** LDAP
- Week 9:** Security
- Week 10:** Midterm exam
- Week 11:** Linux clusters
- Weeks 12, 13:** Final Projects (LVS and HPC)

Course Final Projects

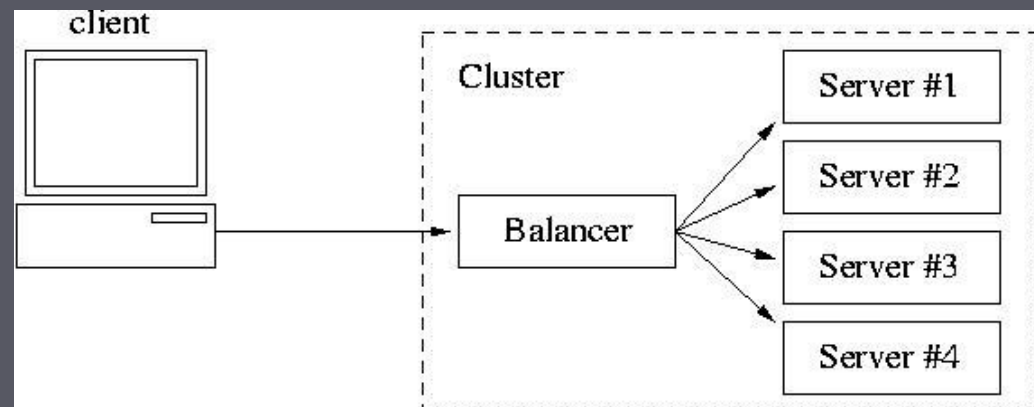
Computational Cluster

NIS, NFS, MPI,
Sun Grid Engine (SGE)



Linux Virtual Server

Apache, ipvsadm,
monitoring tools



Rutgers Governor School of Technology

Summer 2002 and 2003

Linux Web Applications by JB Kim
Amit Freeman, and Hun Yi

<http://remnant.rutgers.edu/gs>

- Linux basic commands
- HTML
- PHP
- MySQL

Future Plans in Undergraduate Programs

Extend the Unisys Program to larger number of students; Involve more juniors.

Modify the Linux course material to include Linux Professional Institute (LPI) certification program.

Switch from Red Hat to Debian



Graduate Education and Research

High Performance Computing on a Linux cluster

MPI, OpenMP

MATLAB

GASP

FLUENT

AMBER

NAMD



Cluster parameters

Deployed 2002



44 dual AMD MP 1.6 GHz

8 AMD Athlon 1.2 GHz

8 dual P-III 866 MHz

100 MBit private network

Red Hat 7.3

Sun Grid Engine queue
system

MPI, OpenMP, commercial
and open source software

deployed 2001



<http://linuxcluster.rutgers.edu>

Future Development in Graduate Research

High Performance Computing Project (HPCP) courses and workshops for students and faculty: MPI, Globus Toolkit, proposals for NSF PACI.

Cluster upgrades – AMD Opteron nodes

New clusters for research labs

Plans for Linux in continuous education courses

LPI level I (exams 101 and 102); includes 14 topics:

- Unix commands
- Devices, File systems
- Bootup, shutdown, run levels
- Documentation
- Administrative tasks
- Hardware and Architecture
- Installation, pkg management
- Kernel
- Text editing, processing, printing
- Shell scripting
- X11
- Networking fundamentals
- Network services
- Security



Concluding remarks and Discussion

The engineering graduates find the Linux education at SOE very helpful;

- JB Kim became a Unix engineer at Deutsche bank

Graduate students take advantage of the Linux computational cluster

In the future, we plan to offer LPI certification program to undergrads and within Rutgers continuous education

Acknowledgements

Dr. David Gardner (Unisys Corporation)

JB Kim (Deutsche bank)

Amit Freeman (ECE senior)

Unisys Scholars:

- Mike Miller
- Chris Lilgeberg
- Malik Khan
- Lucas Machado
- Paul Arias
- Diane Palla

Linux class graduates 02, 03, and 04

MAE department