ITB721/ITN721
Unix Network Administration

Lecture 1

Systems and Networks

Academic Staff

- Unit Co-ordinator & Lecturer
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Consultation

- All student consultation is <u>by appointment only</u> during consultation times, or at some other time as agreed
  - Dr Linda Burnett
    - Wednesdays 7pm – 9pm by appointment only
    - Email ld.burnett@qut.edu.au to arrange an appointment
  - Dr Richard Au
    - Mondays 11am – 1pm by appointment only
    - Email w.au@qut.edu.au to arrange an appointment

Pre-Requisite Knowledge

- ## Pre-requisite Unit
  - You must have successfully completed at least one basic networking unit eg ITB006 (Undergraduates), ITN701 (Postgraduates)

- ## Prior knowledge not expected
  - It is assumed that you have never used a unix operating system before, HOWEVER, you are responsible for rapidly acquiring such generic skills during this unit

What This Unit is About

- Theory and practical aspects of system and network administration and management, using a Unix environment as the platform for the practical tasks

- Development of technical skills and problem solving skills

- Learning various tasks and responsibilities of system and network administration professionals

Week by Week Topics

Week 1:   Systems and Networks
Week 2:   User and System Management
Week 3:   File System Administration and Data
                  Management
Week 4:   Administration of Network Services (1)
Week 5:   Administration of Network Services (2)
Week 6:   Domain Name System (DNS)
Week 7:   Web Management
Week 7:   **Mid-Semester Examination (21 Apr)**
Week 9:   Electronic Mail Management
Week 10:   Network Security (1)
Week 11:   Network Security (2)
Week 12:   Enterprise Network Administration
Week 13:   System and Network Maintenance

Assessment

- ## Compulsory Practical Attendance

  - You must attend at least 10 out of 12 of your weekly allocated practicals in order to receive a passing grade in this unit, regardless of results

  - Please bring your student card to each of your allocated practical sessions

  - A roll will be taken at each practical session

  - You must be present for at least 70 minutes in your allocated practical session in order to satisfy attendance in any week

Assessment

- Mid-Semester Examination
  - Theory and Practical to be conducted in laboratory (Weight 30%)
  - In Week 7: Sat 21 April; time to be advised
- Final Examination
  - Theory and Practical to be conducted in laboratory (Weight 70%)
  - In Final Examination Period

Postgraduates: longer and more complex assessment

Practical Sessions

- You must allocate yourself to a practical session on QUT Virtual

- You must attend your weekly allocated practical session

- The practical session immediately after the lecture is for enrolled part-time students

- A roll will be taken at each practical session

Practical Exercises

- Answers to practical exercise questions are <u>NOT</u> provided
  - It is essential that you test command lines and configurations yourself to see if they are working correctly
    - The majority of questions can be tested
- For the small number of questions which cannot be checked or tested, you may check your answer to those particular questions with your tutor

What is Expected of You

- Attendance at all lectures, and your weekly one and a half hour allocated practical session

- Additional self-managed time to complete practical exercises

- Use of your own initiative to search available resources for help and experiment with potential solutions

- Ensuring you put in the necessary effort to revise and be familiar with all essential pre-requisite knowledge

What is Expected of You

- A constant effort to keep up-to-date with completion of the practicals each week

- To ask your tutor for guidance during your practical class (and/or make consultation appointments, if necessary) if you are struggling with any of the practical exercises

- Demonstration of your prior attempts at answering any practical exercise questions that you are querying

Using Fedora to do Practical Exercises

- Whilst attending your one and a half hour weekly lab practical session

- Use additional lab time as required and available

- Installing Fedora at home (optional) – but only SOME of the practical exercises can be completed outside the lab

Unit Resources

- On-line resources on Blackboard
  http://blackboard.qut.edu.au then click on

ITB721 Unix Network Administration

  - For the Undergraduate students OR

ITN721 Unix Network Administration

  - For the Postgraduate students

Read carefully "Conduct of the Unit" link on Blackboard

- Each week, the lecture and practical will be uploaded sometime on Monday (click on Learning Resources)

  - Unless Blackboard is unavailable for any reason

- A sample test will be placed on Blackboard prior to Week 7

Feedback

Brief discussion on student feedback from the last time this unit was run

Lecture Content

- Revision: Systems and Networks
- System and Network Administration
- The Computer System
- Setting Up a Simple LAN

Revision: Systems and Networks

- Important topics from your previous studies include:

  - Network architectures

  - Hardware components of a network

  - Networking protocols

  - IP addressing

  - Variable Subnetting

  - Packetization and Packet Delivery

  - Routing Concepts

  - Software components of a network

Computer Systems

- Typically refer to single machines

- Include
  - an operating system
  - system and user accounts
  - services to be provided
  - applications

Networks

- Two or more computer systems connected together

- Examples

  – Local Area Networks (LANs)

  – Metropolitan Area Networks (MANs)

  – Wide Area Networks (WANs)

System and Network Administration

- A duty required regularly
- Involves a broad range of tasks
- Required in every organization
- Administrators need special privileges

System Administration

- In large organizations, often a dedicated position

- Involves attending to individual systems

- Involves administration of entire system and all users on that system

- Tasks relate to accounts, services, etc

- Must have superuser privileges to perform system administration

Network Administration

- In large organizations, usually always a dedicated position

- In smaller organizations, often a combined position

- Involves ensuring the security and functionality of the network

- Tasks relate to network connectivity, server and firewall configuration, etc

- Must have superuser privileges to perform network administration

Administrators - Superuser

- Superuser traditionally known as the "root" user

- Do NOT log in as root

- Become the superuser very sparingly
  - Only when a task requires it
  - Revert back to normal user once task completed

- Can be very dangerous to be the superuser for longer than necessary

The Computer System

- Operating Systems

- Maintaining an Operating System

- Unix and Linux

- Interacting with a Linux Operating System

- Key Steps to Using Linux

- Linux Help and Documentation

Operating Systems

- Present day functions include:
  - Standard features for stand-alone systems
  - Networking capabilities
- Examples of Operating Systems include:
  - Unix (various distributions and versions)
  - Microsoft Windows (various versions)
  - Macintosh (various versions)

What Operating Systems Comprise

Include

- A kernel
- Support for file system types
- Accounts
- Programs
- Process management
- Input/output functions
- Device management

Software Packages for Operating Systems

- Applications, additional tools and libraries, utilities, hardware device drivers, updates, etc

- Keeps relevant files together

- Includes information about locations for file distribution, dependencies, etc

Package Distribution Mechanisms

- Download from eg author, manufacturer, distributor web site

- May automatically be sent to registered users or systems

  - Bug fixes and security problem corrections often distributed in this way

Maintaining an Operating System

- Bugs and Security Vulnerabilities
- Patches
- Product Life

Bugs and Security Vulnerabilities

- Are regularly discovered
- Patches and workarounds are released
- Maintenance
  - Monitor problem reports
  - Patch

Patching

- Ensure patches are installed
  - With minimum disruption
  - Common technique to have scheduled maintenance window
- Dangerous to not patch

End-of-Life

- Versions only available for a fixed period of time

- Versions also only supported for a fixed period of time

  - Support includes notice of bugs, patches and security advisories

Unix (and Linux)

- Widely available and used commonly on servers

- Major types: System V and BSD

- Linux: independent implementation

- Full history and timeline

  - http://www.unix-systems.org/what_is_unix/history_timeline.html

The Linux Operating System

- Runs on Intel (iA86 class), Alpha (IA64), Sparc, m68k (Macintosh), PowerPC, SGI, MIPS and other microprocessors

- Common distributions include: Red Hat Linux, Fedora Core, Ubuntu, Mandriva, Debian, Slackware, Tiny Linux, Novell Linux, SUSE

Linux Distributions

- Include one (or more) kernels
- Have an installer eg Anaconda, PGI
- Usually have pre-defined default sets of packages
- Include user selectable optional packages
- Provide relevant documentation

Linux Packages

- Essential packages provide rest of core Linux environment

  - eg bintools, net-tools, glib

- Additional (non-essential) packages may be installed at time of Linux installation or at some later date

Red Hat Linux

- Distributions originally free

- Later introduced commercial "Enterprise Edition" versions, in addition

- Now only supports the commercial distribution

  – Provides Intel (i386) and Alpha (IA64) versions

- http://www.redhat.com

The Fedora Project

- Took over as the free distribution from Red Hat
- What was going to have been Red Hat Linux 10 became Fedora Core 1
- Versions available
  - Fedora Core 1 to 4 (no longer supported)
  - Fedora Core 5
  - Fedora Core 6
- http://fedora.redhat.com

Interacting with a Linux Operating System

- Users interact with operating system
- Interaction can be via
  - Command Line Interfaces
  - Graphical User Interfaces (GUIs)

Command Line Interfaces

- Command lines are submitted to the system
  - text only displays
  - text displays inside windows
- Primary means of remote system and network administration

Graphical User Interfaces (GUIs)

- Emulates Microsoft Windows style "point-and-click" and "drag-and-drop"

- Greater ease of use for novices and Windows-educated users

- A Linux GUI requires X-Windows (X11) libraries, plus Desktop

Desktops

- Provide window control, look and feel, program launchers, taskbars, workspaces/virtual desktops, etc

- Not required for a Command Line Interface

- Essential for a Graphical User Interface (GUI)

- Two common Linux desktops: KDE and GNOME

Key Steps to Using Linux

- Installing Linux
- Logging in
- Some Basic Commands for Command Lines
- Shutting Down Linux

Installing Linux

- Choose Linux distribution
- Before, during and after installation, steps include:
  - Install boot loader
  - Select packages
  - Install kernel and packages
  - Create minimum of 2 accounts (the superuser, 1 normal user)

Logging In

- User authentication on log in, with username and password

- Always log in using your normal user account

- Once successfully logged in, bring up a Command Line Interface

Some Basic Commands for Command Lines

- Used by normal users and Administrators, eg

  man: Display manual page/s

  ls: List directory contents

  mkdir: Make new directory

  rmdir: Remove empty directory

  cp: Copy files or directories

  mv: Move/rename files or directories

  rm: Remove files

  less: Display file contents without editing

Some Basic Commands for Command Lines

- Used by Administrators, eg

  su: temporarily change to a different user

  – "su -"

  useradd: add a new user account

  userdel: delete a user account

  service: controlling service state

  ifconfig: configure network interfaces

  route: configure network routes

Some Search Commands

- which

- whereis

- locate

- find

- grep

Shutting Down Linux

- Critical to shut down Linux cleanly
  - Cached data is written to disk
- Commands include
  - "poweroff", "halt", "reboot" and "shutdown"

Linux Help and Documentation

- Some reliable sources:
  - RFCs
  - HOWTO documents
  - Linux Guides
  - manual ("man") pages
- Reference sources
  - www.redhat.com
  - fedora.redhat.com
  - www.linux.org
  - www.tldp.org

RFCs, HOWTO Documents and Linux Guides

- RFC (Request For Comments)

  - Internet standardization process

  - Provides official details of many protocols, eg HTTP, telnet, SMTP

  - Not all RFCs are "standards"

  - Co-ordinating body is The Internet Engineering Task Force (IETF)

  - Primary source is www.ietf.org

- The Linux Documentation Project (TLDP)

  - Public domain source of Linux documentation

  - www.tldp.org

  - Includes HOWTO documents and Guide books

Manual (man) pages

- Complete, detailed instructions for, eg,
  - specific commands
  - configuration files
  - library functions
- Text based document
- Generally written by the author of the code in question

man pages

- Most "standard" Unix commands have associated man pages

- "man" command accesses these man pages

- Most general form is "man <name>"
  - eg "man ls"

- man pages divided into sections eg
  - Section 1: commands
  - Section 3: library functions
  - Section 5: file formats

man searching

- To view man page when name is known
  - "man <name>"
- To view particular man section
  - "man <section> <name>"

    eg "man 5 passwd"
- -k option (very useful when name is not known)
  - eg "man -k process"
- "whatis" command returns the name description of particular man page/s

Man Pages - Command Line Syntax

- Synopsis provides syntax for command line

  - Command first on command line

  - [ ] indicate options/switches which are optional in the command line

  - Underline indicates necessary parameter to be replaced

  - Order is often important

Setting Up a Simple LAN

- A wired Local Area Network (LAN) typically comprises:

    - Two or more computer systems (with network operating systems installed)

    - One or more communication devices eg hub, switch

    - Appropriate cables

- Appropriate hardware and devices must be physically plugged in to corresponding network components correctly

- Devices must be correctly configured

General Steps for a Simple Wired LAN

1) Connect computer systems to communications device

2) Check appropriate network start-up scripts on each system

3) Configure communication device

4) Configure required interfaces on each system

5) Configure routes on each system, as necessary

6) Configure name service

Additions/Variations to a Simple LAN

- For a wired LAN to also have Internet connectivity, it requires:
  - a suitable router or modem; AND
  - an ISP account
- For a wireless LAN, cables are replaced by wireless access point/s

Network Interfaces and Configuration

- Network Interface Card (NIC) eg Ethernet card (Linux: eth0, eth1, etc)

- To configure, assign IP address to NIC and specify netmask and broadcast address

- If multiple ethernet NICs present, referred to as eth0, eth1, eth2, ...

  - Each connects to a different network

  - Each is configured independently

- Performed manually or via scripts at boot

- Use the "ifconfig" command

- Appropriate activation/deactivation is required

"ifconfig" command

ifconfig <interface> inet <IP address> netmask <netmask> broadcast <broadcast address>

- configures interface with IP address for that network

ifconfig <interface> up

- enables/activates interface

ifconfig <interface> down

- disables/deactivates interface

ifconfig -a

- displays status of all interfaces

Examples of "ifconfig" Command Lines

ifconfig eth0 inet 131.181.119.51 netmask 255.255.255.0 broadcast 131.181.119.255

ifconfig eth0 up

ifconfig eth1 inet 131.181.113.7 netmask 255.255.255.0 broadcast 131.181.113.255 up

ifconfig eth1 down

ifconfig -a

ifconfig eth0

Checking Status of Interface

```
# ifconfig eth0

eth0 Link encap:Ethernet   HWaddr 00:E1:38:2D:DE:F3
     inet addr:10.0.0.50   Bcast:10.0.0.255 Mask:255.255.255.0
     UP BROADCAST RUNNING MULTICAST   MTU:1484   Metric:1
     RX packets:23143 errors:0 dropped:0 overruns:0 frame:0
     TX packets:25394 errors:0 dropped:0 overruns:0 carrier:0
     collisions:399 txqueuelen:100
     RX bytes:2506740 (2.3 Mb)   TX bytes:4578530 (4.3 Mb)
```

Testing Network Connectivity

- "ping" command
  - "ping <IP address>" OR "ping <hostname>"
  - eg "ping 131.181.116.21"
  - "ping -c <count> <IP address>" limits packet count
- Other network diagnostic tools include ifconfig, netstat, tcpdump

Routing

- Packets sent from source to destination, either
  - directly OR
  - via one or more routers
- Local, remote and default routes
- Static routing or dynamic routing
- Relies on information in routing table

The Routing Table

- One for each system
- Entries for
  - Local routes
  - Remote routes
  - Default route
- Updated manually (static)
- Updated automatically (dynamic)

Local Network Routes

- Local route required for local network

- Use the "route" command to add, when necessary

eg # route add -net 131.181.116.0 netmask 255.255.255.0 dev eth0

  – Specifies that the network 131.181.116.0/24 is directly connected to the ethernet interface eth0 on this computer

Testing Local Network Routes

- Use "route" command with appropriate option/s to display routing table contents

- Choose another computer on local network

  eg 131.181.116.95

  – "ping 131.181.116.95"

Adding Remote Network Routes

- Need to know remote network address, netmask and next hop gateway (local)

- # route add -net <remote network address> netmask <netmask> gw <IP address>

- eg

   # route add -net 217.19.22.0 netmask 255.255.255.0 gw 217.19.59.254

   – sends all packets meant for 217.19.22.0/24 to the gateway 217.19.59.254

Testing Remote Network Routes

- Use "route" command with appropriate option/s to display routing table contents

- Choose a computer on remote network

  eg 217.19.22.24

  – "ping 217.19.22.24"

  – "traceroute 217.19.22.24"

Default Route

- All packets that do not match any other route are sent to the default route

- Specified as destination 0.0.0.0 with netmask 0.0.0.0

- Must point to a local gateway

route add default gw <IP address>

Routing Problems

- Identifying source

  - Test routing path, and investigate any identified breaks

- Detecting Routing Failures

  - Regularly monitor network links

  - Use automated scripts to test connectivity

  - Regularly check routing table

- Bypassing Routing Problems

  - If anticipated repair time is long, explore alternate routes

  - Good network design has backup routes already planned

  - Modify routing tables to use alternate routes

General Network Interface and Routing Configuration Steps (1)

1. Collect necessary information for your network/s

    · host IP addresses, network addresses, netmasks, broadcast addresses, gateway addresses, etc.

2. Configure and activate interfaces using "ifconfig"

3. Check status of interfaces using "ifconfig"

4. Check local routes

General Network Interface and Routing Configuration Steps (2)

5. Add any necessary remote routes using "route"

6. Add appropriate default route using "route"

7. Make sure IP forwarding is enabled on gateway machines

   # echo 1 > /proc/sys/net/ipv4/ip_forward

8. Check routing table using "route"

9. Check connectivity and routes using "ping" and "traceroute" respectively

Name Service

- Require name to IP address mapping

- Sometimes possible to use /etc/hosts

- More common to use Domain Name System (DNS)

  - Discuss further in Lecture 6

Virtual Machines

- Includes virtual file system, memory, process management, network interfaces etc

- Each virtual machine runs a separate copy of Linux

- Real computer sometimes called "parent" machine

- Virtual machine sometimes called a "child" machine

Common Administrator Tasks

- Monitoring latest product releases and end-of-life status

- Keeping up-to-date with operating system bugs

- Looking up man pages, HOWTOs and other sources of help and technical information

- If feasible, conduct physical inspection of network connections

- Configuring and monitoring interfaces and routes on machines for connection to network/s