Computer Networks

By Ihsan Ul Haq

Lec-1

Prerequisites

- **Required:**
  - An undergrad level course on computer networks
  - Good knowledge of C language, preferably in Unix/Linux
- Recommended:
  - C Programming experience in **Linux** environment
  - Understanding of computer architecture
  - Basic operating system concepts
  - Knowledge of Opnet IT Guru

Assignment/Mailing List

http://groups.yahoo.com/group/cn_fall2008

Group email: cn_fall2008@yahoogroups.com

Text Book

- **Computer Networks: A Systems Approach,4th Edition (The Morgan Kaufmann Series in Networking)** by Larry L. Peterson and Bruce S. Davie
- **Unix Network Programming, Vol. 1: The Sockets Networking API, Third Edition** -by W. Richard Stevens
- Computer Networks BY Natalia Olifer and Victor Olifer.

Instructions

- Class Timing must be observed.
- Office Location
  - Adjacent to Lab-2
- Office Timing
  - Available
  - Must be observed please

Foundation Course in Network Stream

- This Computer Networks course is a foundation course for “Networks” as the Area of Specialization
- It is a **required** course for the following advanced level courses in networking
  - Performance Analysis of Communication Networks
  - Integrated Services over Packet Networks
  - Computer Network Security
  - Mobile Networking
- It is a recommended for the course:
  - Network and System Programming

Tentative Grading Policy

- Assignments 7%
- project 10%
- Midterm exam 25%
- Final exam 50%
- Quiz 8%

Academic Honesty

- Your work in this class **must** be your own

Expectations

- What do you want (or expect) to learn from **this** course

Expectations

- This course **IS** about …
  - Network principles and concepts
  - General purpose computer networks
  - Internet perspective
- Major components of the Internet protocol suite
  - Network software
  - Designing and building a system

Expectations

- This course **IS NOT** about …
  - Survey of existing protocol standards
  - Specialized networks (e.g. CATV, telephone)
  - OSI perspective
- Network hardware
  - Data transmission on physical layer

Expectations

- We will learn

  why

  networks are like they are

Objectives: Principles and Concepts

- At the end of this course, you should be able to:
  - identify the **problems** that arise in networked communication
  - explain advantages/disadvantages of **existing solutions** to these problems in different networking scenarios
  - evaluate **novel approaches** to these problems
  - understand the components of **Internet protocol** suite
  - understand the implications of a given solution for **performance** in various networking environments

Objectives: Programming

- At the end of this course, you should be able to:
  - identify and describe the **purpose** of each component of the TCP/IP protocol suite
  - develop client-server **applications** using TCP/IP
  - understand the impact of **trends** in network hardware on network software issues
  - understand over 1000 useful (or useless) **VUAs**

Course Contents

- Overview
- Introduction to network programming
- Direct link networks
- Packet switching
- Internetworking

Introduction

- Outline
- Statistical Multiplexing
- Inter-Process Communication
- Performance Metrics
- Network Architecture

What is Your Over-ambitious Goal ?

- Build a computer network which
  - Can grow to global proportions
  - Support diverse applications
- Then … think about
  - Underlying building blocks
    - Which available technologies to use
  - Integrating the blocks to **communicate**
    - Which software architecture to use

Network Design

- Before looking inside a computer network, first agree on **what** a computer network is?

Computer Network ?

- Set of serial lines to attach terminals to mainframe ?
- Telephone network carrying voice traffic ?
- Cable network to disseminate video signals ?

Specialized to handle:

- Keystrokes
- Voice
- Video

What Distinguishes a Computer Network ?

- Generality
- Built from general purpose **programmable** hardware
- Supports wide range of applications

Applications – Users' Contact with the Network

- Most people know the Internet through its applications
  - Web, email, streaming audio and video, chat, …
- Applications present an intuitively simple interface
  - Textual and graphical objects
  - Simple "clicks" to maneuver the application
- However, users are not aware of what happens in the network with their simple "clicks" !!!

Applications – Consumers of Networks

- On a simple click, several messages may be exchanged over the Internet
- In a web browser, 17 messages may be exchanged
  - up to six messages to translate the server name
  - three messages to set up a TCP connection
  - four messages to send HTTP “get” request + response
  - four messages to tear down the TCP connection
- Moreover, **millions of messages** are exchanged each day by Internet nodes to make their presence and services known

Applications – the Driving Force

- Streaming audio and video is an emerging application
  - Source generates and sends the video stream in messages across the Internet
- Video-on-demand: reads a preexisting movie
  - One-way data transfer
- Videoconferencing: interactive session
  - Very tight timing constraints
- **Diversity** of applications that can be built on top of the Internet hint at the **complexity** of the Internet design

Our Road Map …

- Fortunately, we are not the first to build a computer network
- Lets start exploring the path that others have already dig deep
- By asking (and answering) **why** networks are designed the way they are

Network Overview

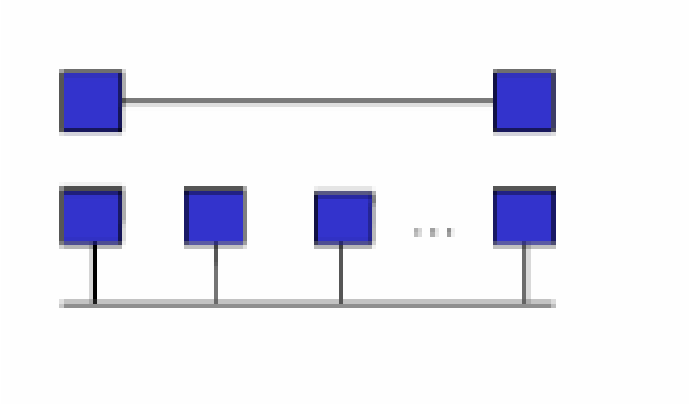
- What must a network provide ?
  - connectivity
  - cost-effective sharing
  - functionality
  - performance
- How are networks designed and built ?
  - layering
  - protocols
  - standards

Perspective

- For network user
  - connectivity: for services required; error free delivery within acceptable time limits
- For network designer
  - efficiency: cost-effective design, fair allocation and efficient use of resources
- For network operator
  - maintenance: easy to administer, fault localization & isolation, usage accounting

Building Blocks

- Nodes: PC, special-purpose hardware…
  - hosts
  - switches
- Links: coax cable, optical fiber…
  - point-to-point
  - multiple access

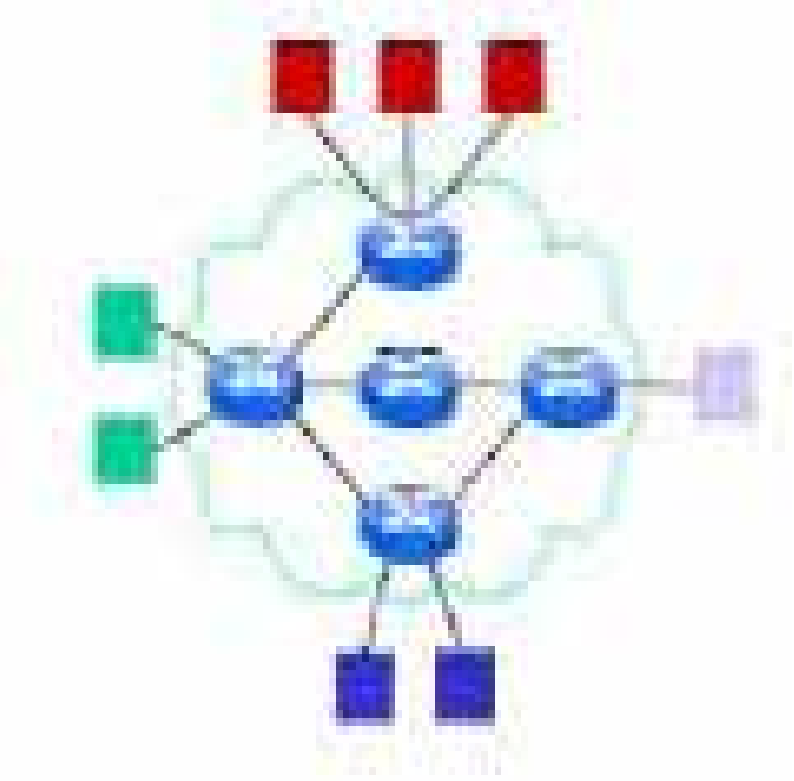


Why not connect each node with every other node ?

- Number of computers that can be connected becomes very **limited**
- Number of wires coming out of each node becomes **unmanageable**
- Amount of physical hardware/devices required becomes very **expensive**
- **Solution**: indirect connectivity using intermediate data forwarding nodes

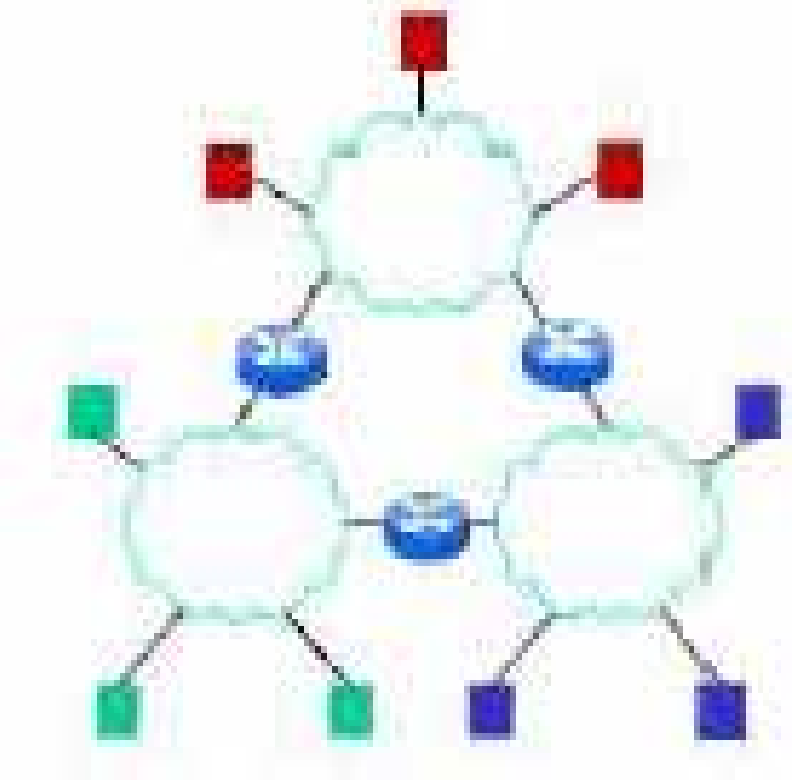
Switched Networks

- A network can be defined recursively as...
  - two or more nodes connected by a link
  - circular nodes (switches) ***implement*** the network
  - squared nodes (hosts) ***use*** the network



Switched Networks

- A network can be defined recursively as...
  - two or more networks connected by one or more nodes: internetworks
  - circular nodes (router or gateway) ***interconnects*** the networks
  - a ***cloud*** denotes “any type of independent network”



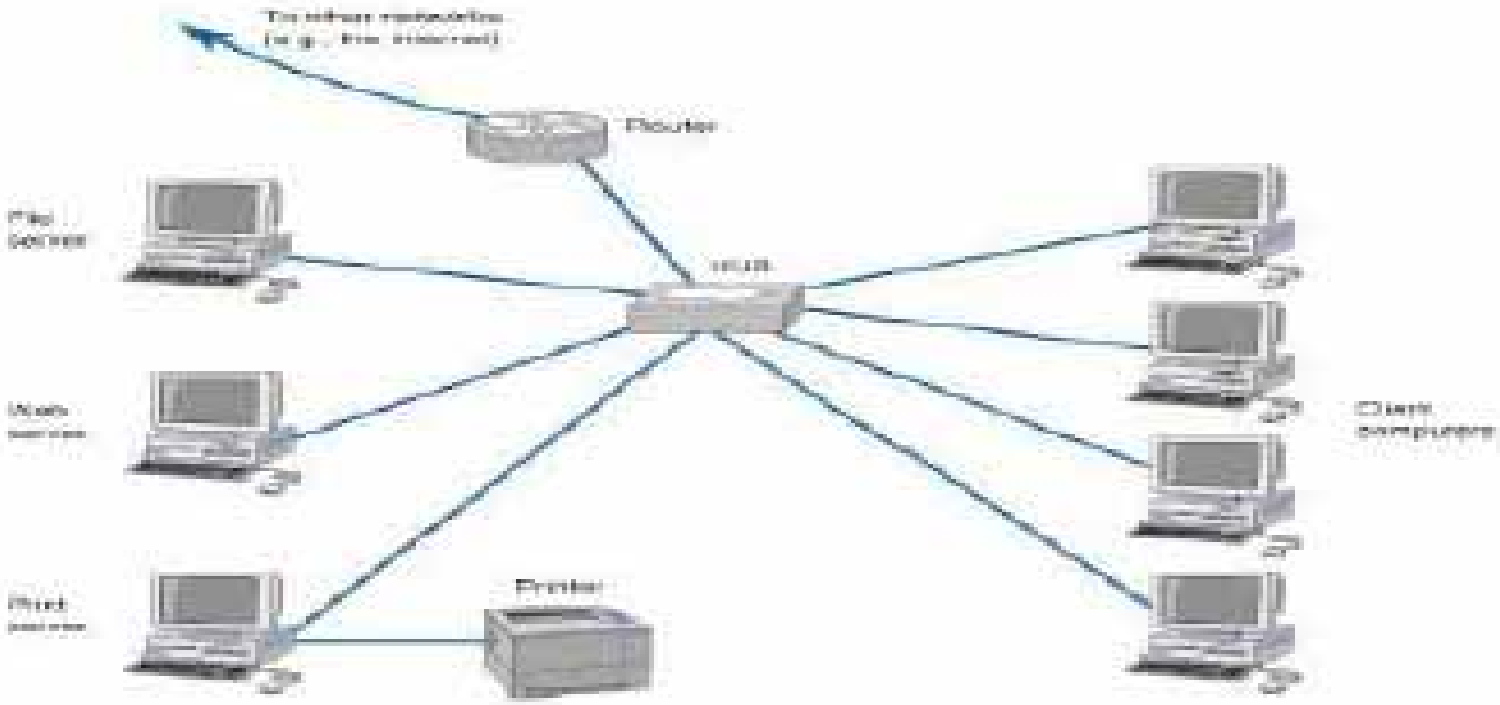
A Network

- A network can be defined recursively as two or more nodes connected by a physical link

OR

- two or more networks connected by one or more nodes

Components of a Network



Switching Strategies

- Circuit switching: carry bit streams
  - establishes a dedicated circuit
  - links reserved for use by communication channel
  - send/receive bit stream at constant rate
  - example: original telephone network
- Packet switching: store and-forward messages
  - operates on discrete blocks of data
  - utilizes resources dynamically according to traffic demand
  - send/receive messages at variable rate
  - example: Internet

What next ?

- Hosts are directly or indirectly connected to each other
- Can we now provide host-host connectivity ?
- Nodes must be able to say **which** host it wants to communicate with

Addressing and Routing

- Address: byte-string that identifies a node
  - usually unique
- Routing: forwarding decisions
  - process of determining how to forward messages to the destination node based on its address
- Types of addresses
  - unicast: node-specific
  - broadcast: all nodes on a network
  - multicast: some subset of nodes on a network

Wrap-up

- A network can be constructed from ***nesting*** of networks
- An ***address*** is required for each node that is reachable on the network
- Address is used to ***route*** messages toward appropriate destination