

Internet Architecture and Protocols

By Farooq Javed

Lecture No. 1

Significance and Rationale of course

- Networks and telecommunication is getting more and more importance
- Future telecomm networks will be more oriented toward “networks” rather than “communication”
- Widespread Internet, diffused in our daily life is a ground reality; its beneficial to understand it
- Its fun to play with protocols (software) and able to design exciting new type of networks

Foundation Course in Network Stream

- This Computer Networks course is a foundation course for “Internet Architecture” the Area of Specialization
- It is a **required** pre-requisite course for the following advanced level courses in networking
 - Computer Network Security
 - Mobile Networking
 - System And Network Administration
 - Mobile Network and System Design

Course Material

- Reference books
 - Many textbooks on Networking may be consulted
- RFCs and Internet drafts
 - Related to TCP/IP suite and other protocols
- Web resources
 - Tutorials, white papers, reports, etc.

Text Books

- *TCP/IP Protocol Suite: by Behrouz A. Forouzan*
 - *Fourth Edition, McGraw-Hill.*
- Computer Networks: A system approach
by Larry peterson

Prerequisites

- **Required:**
- Comprehensive Knowledge of DCN
- Understanding of Layered Architecture
- Solid Concepts of Circuit and Packet switching

Course Evaluation

- Assignments
- Quizzes
- Research Activities
- Term Projects / Reports
- Midterm exam
- Final exam

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** about ...
 - Survey of existing protocol standards
 - Specialized networks (e.g. CATV, telephone)
 - OSI perspective
 - Network hardware
 - Data transmission on physical layer
 - Queuing theory (we do survey, if time permits)

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:
- Understand the design of internet and basic architectural components
- The Role and components of Internet Service Providers
- Understand major internet technologies
- To strengthen concepts of TCP/IP protocol suite
- Provide comprehensive knowledge and implementation of routing protocols and switching

Course Contents

- Overview
- Internet Architecture
 - Basics, History, ISP's, Internet Backbones
- Internet Technologies
 - Dial up, Frame Relay, ATM, ISDN, DSL, Cable Modem
- TCP/IP Protocol suite
 - IPv4, IPv6, ARP, ICMP, TCP, UDP, SMTP, FTP
- Routing Protocols:
 - RIP, IGRP, OSPF, BGP
- Others
 - DHCP, RSA, VPN, NAT, CIDR

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

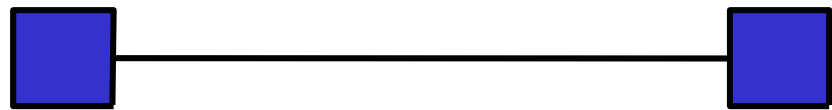
Perspective

- 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

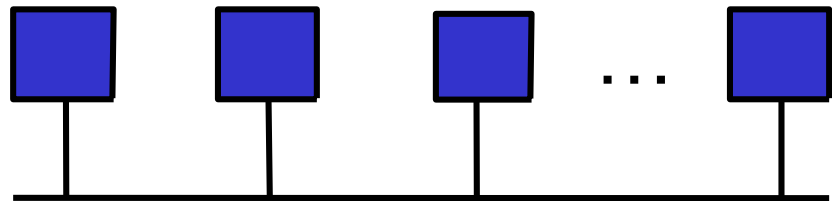
Building Blocks

- Nodes: PC, special-purpose hardware...
 - Hosts
 - Switches
- Links: coax cable, optical fiber...

– Point-to-point



– Multiple access

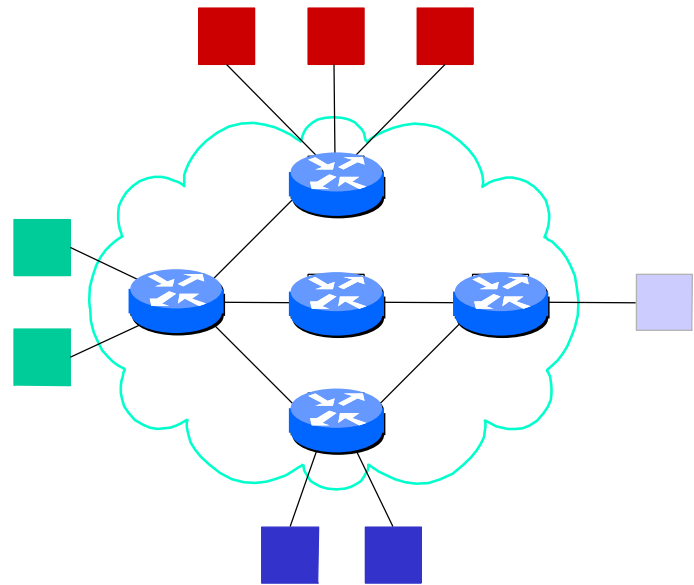


Why not connect each node with every other node ?

- 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**

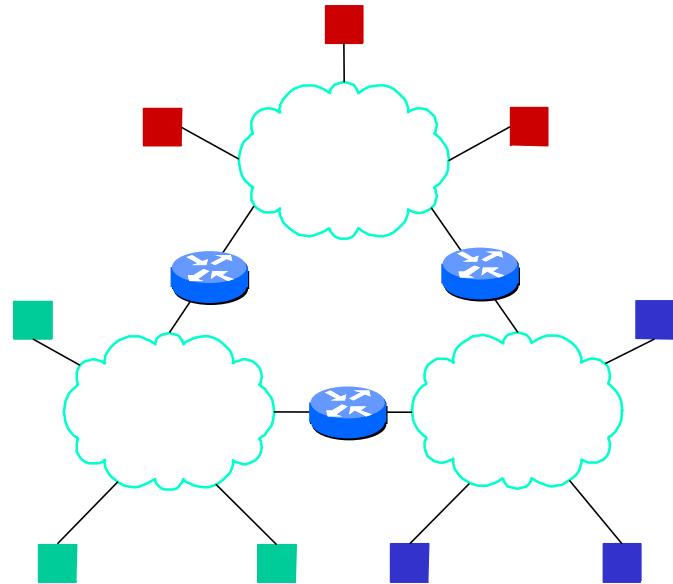
Switched Networks

- 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

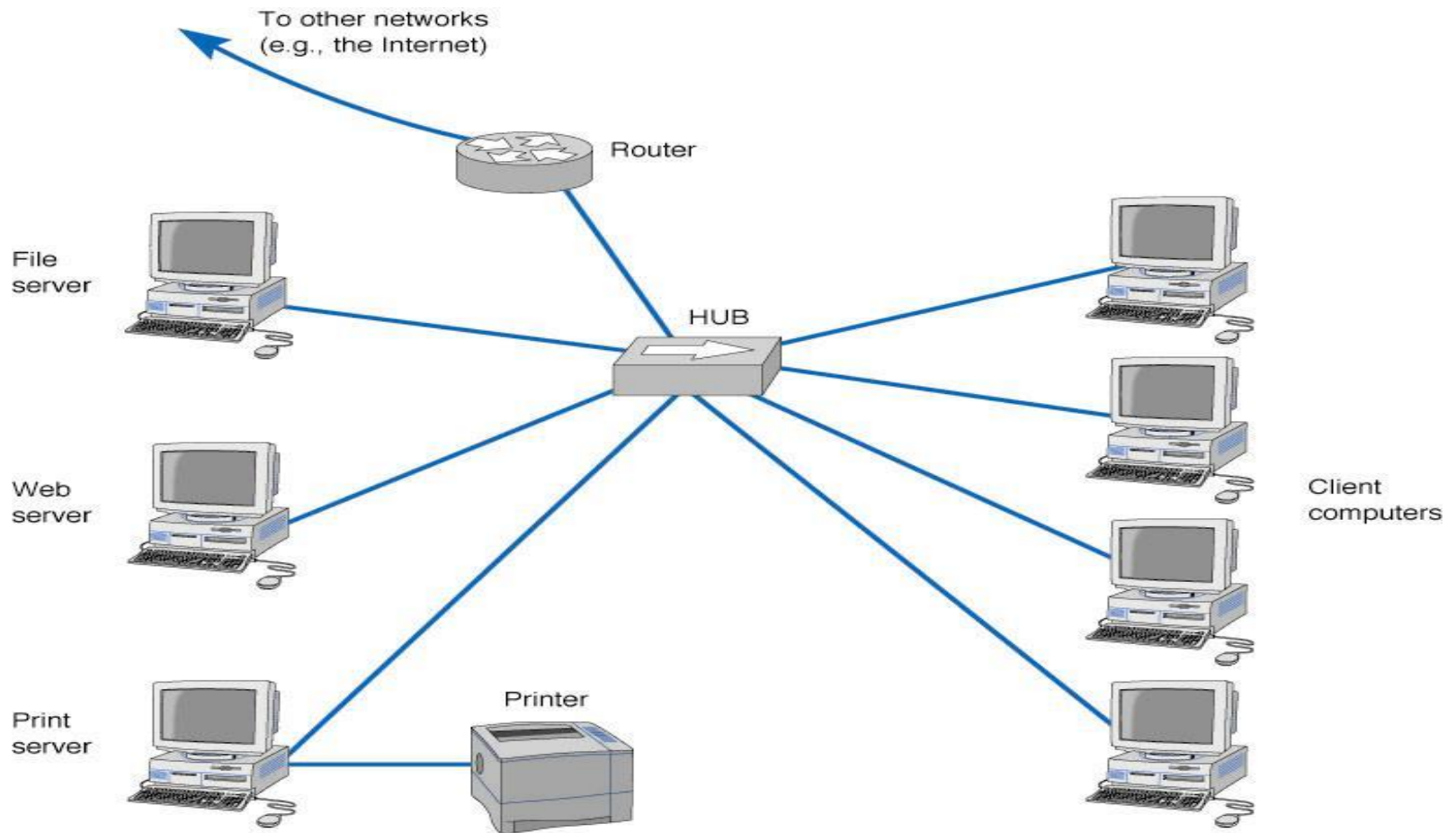
A network can be defined recursively as

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