Introduction
Introduction Outline

- Preliminary Definitions
- Internet Components
- Network Application Paradigms
- Classifying Networks
  - by transmission technology
  - by size/scale
  - by topology
- Summary
computer network ::
[Tan] a collection of autonomous computers interconnected by a single technology.

[LG&W] communications network :: a set of equipment and facilities that provide a service.

[P&D] a network provides connectivity among a set of computers.

Initially, computers were directly connected over a physical medium such as copper, coaxial cable or optical fiber.

Selecting the set of computers involves security and scalability issues.
Physical Connectivity

Figure 1.2 Direct links:
(a) point-to-point
(b) multiple access (MA)
Other Forms of Connectivity

- Indirect connectivity through a set of cooperating nodes.
- Wireless connectivity:
  - WiFi (IEEE802.11)
  - Cellular (3G, 4G LTE)
  - Bluetooth
  - Zigbee (part of IEEE802.15.4)
  - WiMAX
Switched Network

Figure 1.3  Switched network
Figure 1.4 Interconnection of Networks
In a distributed system::

the collection of independent computers appears
to its users as a single coherent system.

Namely, the distinction between a computer network and a distribution system lies in the transparency in assigning tasks to computers.

Examples:

1. NFS is a distributed files system.

2. Computer networks provide host-to-host connectivity by assigning an address to each node.
Figure 1.7 Processes communicating over an abstract channel
Internet Access and Flows

Host A

Host B

Host C

Host D

Host E

Host F

Host G

Host H

Host J

Host M

Host N

Host L

AP

W1

W2

W3

W4

nodes
The Internet: “nuts and bolts” view

billions of connected computing devices: *hosts = end systems*

- running *network apps*

- communication links
  - fiber, copper, radio, satellite
  - transmission rate = capacity

- routers*: forward packets (chunks of data)

* Also referred to as switches or gateways.

K & R
Figure 1.7 • The network core
Student Perspectives

- Application Programmer
  - List the services that an application needs with QoS (Quality of Service) delivery targets.

- Network Designer
  - Design a cost-effective network with fair resource sharing.

- Network Provider/Operator
  - List the characteristics of a system that is easy to administer and manage. Concerns include: quick fault diagnosis, correct configurability, and easy growth.
Figure 1.1  A network with two clients and one server.
Figure 1-2. The client-server model involves requests and replies.
Figure 1.3 In a peer-to-peer system there are no fixed clients and servers.

Tanenbaum
A Closer Look at Network Structure

- **network edge:** applications and hosts
  - access networks, physical media: wired, wireless communication links

- **network core:**
  - interconnected routers
  - network of networks
The Network Edge

- **end systems (hosts)**
  - run application programs
  - e.g. Web, email
  - at “edge of network”

- **client/server model**
  - client host requests, receives service from always-on server
  - e.g. Web browser/server; email client/server

- **peer-peer model**
  - minimal (or no) use of dedicated servers
  - e.g. Skype, BitTorrent
Wireless versus Mobile Applications

- Wireless involves transmissions through the air (type depends on frequency).
  - Residential access networks
    - Residential access points
  - Institutional access networks
    - Institutional and corporate access points or mesh networks
  - Public access networks
    - e.g., Cities, towns, libraries and coffee shops
  - Cellular networks
    - 2.5G, 3G and 4G LTE
Wireless versus Mobile Applications

- Mobile can refer to the Hosts.
  - Laptops can be moveable and wired.
  - Laptops can be moveable and wireless.
  - Cell phones, smart phones and devices in vehicles are mobile and wireless.

- Mobile Ad Hoc NETworks (MANETs):
  - wireless devices are both Hosts and subnet nodes (routers).
  - The distinction is that MANET nodes may relay traffic intended for other nodes (multi-hop traffic).
Network Classifications

Introduction
Classifying by Transmission Technology

**broadcast** :: a single communications channel shared by all machines (addresses) on the network. *Broadcast can be both a logical or a physical concept* (e.g. Media Access Control (MAC) sublayer).

**multicast** :: communications to a specified group. *This requires a group address* (e.g. - multimedia multicast).

**unicast** :: a communication involving a single sender and a single receiver.

**point-to-point** :: connections made via links between pairs of nodes.
Figure 1-6. Classification of interconnected processors by scale.
Classification by Size

PANS {Personal Area Networks}

- Used for communication among computer devices, including smart phones and PDA's in proximity to an individual's body. [Wikipedia].
- Reach up to meters.
- Includes ‘wearable’ devices and protocols such as Bluetooth, Zigbee and UWB (Ultra Wide Band) and BANs (Body Area Networks).
- IEEE 802.15 Working Group for Wireless PANs (WPANs).
PANs

[Brunei University West London]
Classification by Size

- **LANs {Local Area Networks}**
  - Wired LANs: typically physically broadcast at the MAC layer (e.g., Ethernet, Token Ring)
  - Wireless LANs (WLANs)
  - Wireless Sensor Networks (WSNs)

- **MANs {Metropolitan Area Networks}**
  - campus networks connecting LANs logically or physically.
  - often have a **backbone** (e.g., FDDI, ATM or a mesh) to connect campus networks.
Wired LANs

- Ethernet bus
  - Transceivers

- Ethernet hub

Leon-Garcia & Widjaja: Communication Networks
Figure 1-35. (a) Wireless networking with a base station. (b) Ad hoc networking.
Wireless Sensor Networks (WSNs)

WSNs can have mobile or fixed nodes but require a routing algorithm and normally have power concerns.
Metropolitan Area Networks (MANs)

Figure 1-8. A metropolitan area network based on cable TV.
Metropolitan network $A$ consists of access subnetworks: $a, b, c, d$.

National network consists of regional subnetworks: $\alpha, \beta, \gamma$.

Metropolitan network $A$ is part of regional subnetwork $\alpha$. 

Leon-Garcia & Widjaja: Communication Networks
Network Classification by Size

- **WANs** {Wide Area Networks}
  - also referred to as "point-to-point" networks.
  - ARPANET → Internet
  - usually hierarchical with a backbone.
  - Enterprise Networks, Autonomous Systems (ASs)
  - VPNs (Virtual Private Networks).
ARPAnet circa 1972

A point-to-point network

Leon-Garcia & Widjaja: Communication Networks
Figure 1-10. A stream of packets from sender to receiver.
A network of networks

G = gateway

Leon-Garcia & Widjaja: Communication Networks
Network Classification by Topology

Bidirectional flow

Default is baseband cabling

Bus Topology
Network Classification by Topology

Note - *A ring implies unidirectional flow.*

Ring Topology
Network Classification by Topology

Tree Topology
WSN end-to-end routing often employs a spanning tree for routing.
Network Classification by Topology

Star Topology

hub, switch or repeater

Computer Networks
Introduction
Network Classification by Topology

Wireless Infrastructure

Star Topology
Wireless Mesh Network

IEEE 802.11a/g or IEEE 802.16 Mesh Backbone

IEEE 802.11b Local Footprint

Mesh Node Client

Computer Networks Introduction
Define: network, distributed system, subnet, host, node, flow, channel and link.

Paradigms: Client-Server, Peer-to-Peer, Wireless and Mobile.

Classifications and Acronyms:
- Broadcast, multicast, unicast
- PAN, LAN, MAN, WAN, WLAN, WSN
- The Internet versus an internet
- Hierarchical, bus, ring, tree, star and mesh topology