Introduction
Introduction Outline

- Preliminary Definitions
- Internet Components
- Network Application Paradigms
- Classifying networks
  - by transmission technology
  - by size/scale
  - by topology
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.

In a distributed system the collection of independent computers appears to its users as a single coherent system.
Internet Access and Flows

[Diagram of a network with nodes labeled from 1 to 17, connected by lines, and hosts labeled A to M, including Host A, Host B, Host C, Host D, Host E, Host F, Host G, Host H, Host J, Host W1, Host W2, Host W3, and Host W4.]
The Internet: “nuts and bolts” view

- millions 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.
Figure 1.7 ♦ The network core
Networking
Application
Paradigms

Introduction
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.
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 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
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, PDAs 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
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.
## Classification by Size

<table>
<thead>
<tr>
<th>Interprocessor distance</th>
<th>Processors located in same</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 m</td>
<td>Square meter</td>
<td>Personal area network</td>
</tr>
<tr>
<td>10 m</td>
<td>Room</td>
<td>Local area network</td>
</tr>
<tr>
<td>100 m</td>
<td>Building</td>
<td>Metropolitan area network</td>
</tr>
<tr>
<td>1 km</td>
<td>Campus</td>
<td>Wide area network</td>
</tr>
<tr>
<td>10 km</td>
<td>City</td>
<td>The Internet</td>
</tr>
<tr>
<td>100 km</td>
<td>Country</td>
<td></td>
</tr>
<tr>
<td>1000 km</td>
<td>Continent</td>
<td></td>
</tr>
<tr>
<td>10,000 km</td>
<td>Planet</td>
<td></td>
</tr>
</tbody>
</table>

**Figure 1-6. Classification of interconnected processors by scale.**

*Tanenbaum*
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)
- IEEE 802.15 Working Group for Wireless PANs (WPANs).
PANs

[Brunell 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 and mesh) to connect campus networks.
Wired LANs

Ethernet bus

Ethernet hub

Leon-Garcia & Widjaja: Communication Networks
Wireless LANs (WLANs)

Figure 1-35. (a) Wireless networking with a base station.  (b) Ad hoc networking.
WSNs can have mobile or fixed nodes but require a routing algorithm and normally have power concerns.
Figure 1-8. A metropolitan area network based on cable TV.

Tanenbaum
MANs within a Hierarchical Topology

Metropolitan network $A$ consists of access subnetworks: $a$, $b$, $c$, $d$.

Hierarchical Network Topology

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

Metropolitan network $A$ is part of regional subnetwork $\alpha$.
Network Classification by Size

- **WANs {Wide Area Networks}**
  - also referred to as "point-to-point" networks.
  - ARPANET \(\rightarrow\) 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.
internet

A network of networks

G = gateway

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

Bus Topology

Bidirectional flow

Default is baseband cabling
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

hub, switch or repeater

Star Topology
Network Classification by Topology

Star Topology

Wireless Infrastructure

- AP
- W1
- W2
- W3
- W4
• 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, and star topology