

Data Communication & Computer Networks - Exam Study Notes

HNDIT2042 - Semester 2

Week 1: Introduction & Internet Evolution

What is Internet?

- **Definition:** Largest network of networks in the world
- Uses TCP/IP protocols and packet switching
- Network of government, university, and private computers
- Infrastructure for email, file archives, databases, hypertext documents

Communication Networks

- **Components:** Links and nodes arranged for message passing
- **Examples:** People-roads, Telephones-switches, Computers-routers
- **Message:** Information being transmitted

Historical Timeline

- **2400 BC:** Courier networks in Egypt
- **550 BC:** Postal service in Persia
- **1837:** Telegraph invented by Samuel Morse
- **1876:** Alexander Graham Bell invents telephone
- **1961:** Kleinrock - packet-switched network concept
- **1969:** ARPANET first installed at UCLA
- **1972:** Email introduced
- **1991:** World Wide Web goes public
- **2007:** iPhone released, mobile internet rises

Key Concepts

- **Circuit Switching:** Resources reserved end-to-end (telephone networks)
 - **Packet Switching:** No connection state, store-and-forward network
 - **Statistical Multiplexing:** High overall utilization
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Week 2: Client-Server Architecture

Client-Server Model

- **Client:** Computer that makes requests to server
- **Server:** Computer that fulfills client requests
- **Architecture:** Computing model where server hosts and manages resources

Components

1. **Workstations:** Client computers that send requests
2. **Servers:** Fast processing devices, centralized repositories
3. **Networking Devices:** Medium connecting workstations and servers

Types of Architecture

- **1-Tier:** All layers combined in single software package
- **2-Tier:** Client and database on server, business logic distributed
- **3-Tier:** Presentation, application, and database layers separate
- **N-Tier:** Multi-tier, each function as isolated layer

Internet vs Intranet vs Extranet

- **Internet:** Globally-connected network for public use
 - **Intranet:** Private internal network within organization
 - **Extranet:** Web portal for organization and external partners
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Week 3: OSI Model & TCP/IP

OSI 7-Layer Model

1. **Physical:** Media, signal, binary transmission
2. **Data Link:** Physical addressing, frame handling
3. **Network:** Path determination, logical addressing
4. **Transport:** End-to-end connections, reliability
5. **Session:** Interhost communication
6. **Presentation:** Data representation, encryption
7. **Application:** Network process to application

TCP/IP Stack

- **Application Layer:** HTTP, FTP, SMTP, DNS, Telnet
- **Transport Layer:** TCP (reliable), UDP (fast, unreliable)
- **Internet Layer:** IP, ICMP, ARP, RARP
- **Link Layer:** Ethernet, FDDI, ISDN

Key Protocols

- **TCP:** Connection-oriented, reliable, error checking
 - **UDP:** Connectionless, fast, no delivery guarantee
 - **HTTP/HTTPS:** Web communication
 - **FTP:** File transfer
 - **SMTP:** Email transmission
 - **DNS:** Domain name resolution
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Week 4: Internet Access Methods

Connection Types

Dial-Up

- Uses analog telephone lines and modem
- Speed: 56 kbps
- **Pros:** Low cost, widely available
- **Cons:** Slow speed, ties up phone line

DSL (Digital Subscriber Line)

- High-speed over copper telephone lines
- **ADSL:** Asymmetric (faster download than upload)
- Speed: Up to several Mbps
- **Pros:** Always on, simultaneous phone use
- **Cons:** Distance limitations, expensive

Cable Modem

- Uses coaxial cables (same as cable TV)
- Speed: Higher than DSL
- **Pros:** High speed, convenient

- **Cons:** Shared bandwidth, security risks

Fiber Optic

- Fastest available connection
- Speed: Up to 1 Gbps or more
- **Pros:** Highest speed, reliable, secure
- **Cons:** Expensive, limited availability

Transmission Media

Guided Media

1. Twisted Pair

- **UTP:** Unshielded, prone to interference
- **STP:** Shielded, better protection
- Categories: Cat 5, Cat 5e, Cat 6

2. Coaxial Cable

- Single copper conductor, braided shield
- Types: Thinnet (10Base2), Thicknet (10Base5)

3. Fiber Optic

- Glass fibers, light pulses
- Types: Single-mode, Multi-mode
- **Pros:** Immune to interference, secure, high bandwidth
- **Cons:** Expensive, difficult installation

Wireless Media

- **Radio Waves:** Multi-directional, long range
- **Microwaves:** Line-of-sight, high frequency
- **Infrared:** Short range, blocked by obstacles

IP Addressing & Subnetting

IPv4 Classes

- **Class A:** 1-126, /8, 16.7M hosts
- **Class B:** 128-191, /16, 65K hosts

- **Class C:** 192-223, /24, 254 hosts

Subnetting

- **CIDR Notation:** /24, /25, /26, etc.
- **Subnet Mask:** Defines network and host portions
- **VLSM:** Variable Length Subnet Masking

IPv6

- 128-bit addressing
 - Hexadecimal notation with colons
 - Solves IPv4 exhaustion problem
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Network Protocols & Services

Email Protocols

- **SMTP:** Sending mail (port 25)
- **POP3:** Receiving mail (port 110)
- **IMAP:** Advanced mail access

Other Services

- **DHCP:** Dynamic IP assignment
 - **DNS:** Domain name resolution
 - **ARP:** IP to MAC address resolution
 - **Telnet:** Remote login
 - **SSH:** Secure remote access
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Mobile & Wireless Communication

Cellular Generations

- **1G:** Analog cellular
- **2G:** Digital cellular (GSM)
- **3G:** High-speed digital (UMTS)
- **4G/LTE:** IP-based multimedia

Multiple Access Schemes

- **FDMA:** Frequency Division
- **TDMA:** Time Division
- **CDMA:** Code Division

Wireless Technologies

- **Wi-Fi:** Local area wireless
 - **Bluetooth:** Short-range personal area
 - **GPS:** Global positioning
 - **RFID:** Radio frequency identification
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Security & Risk Management

Risk Components

- **Threat:** Potential danger/attack
- **Vulnerability:** Weakness in system
- **Impact:** Severity of loss

Security Objectives (CIA Triad)

- **Confidentiality:** Information privacy
- **Integrity:** Data accuracy and completeness
- **Availability:** System accessibility

Access Control Models

- **MAC:** Mandatory Access Control (most restrictive)
- **DAC:** Discretionary Access Control (least restrictive)
- **RBAC:** Role-Based Access Control
- **Rule-Based:** Automated rule-driven control

Malware Types

- **Virus:** Replicates, needs host file
- **Worm:** Self-replicating, network spread
- **Trojan:** Appears legitimate, actually malicious

- **Rootkit:** Hidden system control
 - **Ransomware:** Encrypts data for payment
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Data & Signal Encoding

Signal Types

- **Analog:** Continuous values over time
- **Digital:** Discrete states and values

Encoding Techniques

- **NRZ-L:** Non-return to zero level
- **Manchester:** Transition in middle of bit
- **Differential Manchester:** Transition for clocking

Modulation

- **ASK:** Amplitude Shift Keying
 - **FSK:** Frequency Shift Keying
 - **PSK:** Phase Shift Keying
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Storage & Backup

Backup Types

- **Full:** Complete system backup
- **Incremental:** Changed files since last backup
- **Differential:** Changed files since last full backup

Storage Technologies

- **SAN:** Storage Area Network
- **NAS:** Network Attached Storage
- **RAID:** Redundant Array of Independent Disks

Virtualization

- **Server Virtualization:** Multiple VMs on single hardware
- **Desktop Virtualization:** Centralized desktop delivery

- **Storage Virtualization:** Abstracted storage resources
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Key Formulas & Calculations

Bandwidth & Data Rate

- **Bandwidth:** $f_{\max} - f_{\min}$
- **Bit Rate:** Bits per second (bps)
- **Baud Rate:** Signal changes per second

Network Performance

- **Throughput:** Actual data transfer rate
- **Latency:** Delay in data transmission
- **Utilization:** Percentage of bandwidth used

Subnet Calculations

- **Hosts per subnet:** $2^h - 2$ (where h = host bits)
 - **Number of subnets:** 2^n (where n = borrowed bits)
 - **Block size:** $256 - \text{subnet mask value}$
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Important Port Numbers

- **HTTP:** 80
 - **HTTPS:** 443
 - **FTP:** 21
 - **SSH:** 22
 - **Telnet:** 23
 - **SMTP:** 25
 - **DNS:** 53
 - **POP3:** 110
 - **IMAP:** 143
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Exam Tips

1. **Understand concepts** rather than memorizing

2. **Practice subnet calculations** extensively
3. **Know OSI layers** and their functions
4. **Memorize key protocols** and port numbers
5. **Understand security principles** and access control
6. **Practice network topology** problems
7. **Review historical timeline** of internet development