OSI Network Layer

Network Fundamentals – Chapter 5
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Objectives

- Identify the role of the Network Layer, as it describes communication from one end device to another end device.
- Examine the most common Network Layer protocol, Internet Protocol (IP), and its features for providing connectionless and best-effort service.
- Understand the principles used to guide the division or grouping of devices into networks.
- Understand the hierarchical addressing of devices and how this allows communication between networks.
- Understand the fundamentals of routes, next hop addresses and packet forwarding to a destination network.

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Network Layer Protocols and Internet Protocol (IP)

Provides services to exchange data over the network between end devices.

4 Processes:
- Addressing
- Encapsulation
- Routing
- Decapsulation

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Network Layer protocols

- Internet Protocol version 4 (IPv4) –most widely used
- Internet Protocol version 6 (IPv6) – future use…soon!
- Novell Internetwork Packet Exchange (IPX)
- AppleTalk
- Connectionless Network Service (CLNS/DECNet)

Network Layer Protocols and Internet Protocol (IP)

- Designed with low overhead
- Provides only functions necessary to deliver packets over the network
- basic characteristics

- Connectionless - No connection is established before sending data packets.
- Best Effort (unreliable) - No overhead is used to guarantee packet delivery.
- Media Independent - Operates independently of the medium carrying the data.

Network Layer Protocols and Internet Protocol (IP)

- Connectionless systems (IP, UDP)
- Receiving host is NOT contacted before the message is sent

The sender doesn't know:

- if the receiver is present
- if the letter arrived
- if the receiver can read the letter

The receiver doesn't know:

- when it is coming

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Network Layer Protocols and Internet Protocol (IP)

- Unreliable? Simply means that IP does not have the capability to manage & recover from missing or corrupt packets.

Depends on TCP to manage the reliability factor. It just gets data from point A to point B

Network Layer Protocols and Internet Protocol (IP)

- Media doesn't matter. IP only is concerned with the maximum size of PDU that each type can transport.

MTU – Maximum Transmission Unit

Network Layer Protocols and Internet Protocol (IP)

- Source/Destination IP addresses get added at the network layer (layer 3).

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Network Layer Protocols and Internet Protocol (IP)

- IP packet looks like this. Now let's break down the 6 key fields.

6 key fields of IP header

- IP source address – 32 bit ip address of the source host
- IP destination address - 32 bit ip address of the destination host – used to forward the packet by the router!
- Time-to-live (TTL) – 8-bit binary that tells the 'remaining life' of the packet. Countdown mechanism at each hop. When is reaches zero (0), packet is dropped to prevent routing loops.
- Type-of-service (ToS) – 8-bit binary used to determine the priority of each packet. Different types of packets get processed at higher priorities.
- Protocol – indicates the data payload type carried in the packet. 01=ICMP, 06=TCP, 17=UDP, etc.
- Fragment Offset – used in case a packet has to be split because of changing media type to re-construct the packet at the destination.

Grouping Devices into Networks

- Divide networks by:
  - Geographic location
  - Purpose
  - Ownership

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Grouping networks

- Purpose
  - Users may share similar software or have similar bandwidth needs
- Ownership
  - Assists in controlling access to devices and data
  - Assists in administration of the network
  - Helps with security issues
- Geographic location
  - Improves management and operation
  - Just the fact of wiring up an entire LAN in a single building makes this a logical place to start

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Why separate hosts in a network?

- Common issues with large networks: performance degradation, security issues, and address management (identifying hosts).

Discuss Broadcast domains.. Be able to identify how many there are!

Replacing the middle switch with a router creates 2 IP subnets, hence, 2 distinct broadcast domains. All devices are connected but local broadcasts are contained.

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Why separate hosts?

- Security…not allowing students to access research records and vice-versa.
- Done with routers and firewalls.

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Why separate hosts?

- Address management. Identifying host and using default gateways.

Hierarchical Addressing

- Each host is uniquely identified. Has levels that assist in forwarding packets..much like mailing addresses.

Hierarchical Addressing

- Routers use the network portion…switches use the host portion.

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Device parameters

- If a host needs to communicate ANYWHERE that isn't on the local LAN, you must use an intermediary device (router).

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Default Gateway

- Necessary if you are going to communicate with the outside world. You have to key this in on the host device
- If not configured, can only communicate locally on your LAN
- The host and the default gateway MUST be on the same network.
- Use ***ipconfig*** to view ip address, subnet mask, and default gateway information.
- May also use ***netstat –r***, or ***route print*** to view routing details on your PC (stop and do this now…look at your default gateway.
- For any given host, it is the NEAR-SIDE Router interface.

  What is the first router interface a packet would encounter if it left your PC? The IP address of that interface on the router becomes your default gate in the PC.

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Packet Forwarding

- Decisions have to be made at each DEVICE along the path until the packet reaches its final destination

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Routing packets

Routers and routing tables

- 3 main features: Destination network, next-hop, and the metric. Discuss the routing table below.

Discuss routing table information – know these !

Functions of a router

- Select the 'Best Path' for data delivery
- Switch packet out the proper port
- Routers use the *Network portion* of the IP address to forward packets.
- They don't care about the EXACT host, just the EXACT network.
- If broadcast storms arise, network admins can replace layer 2 devices (switches) with layer 3 (routers) or subnet the network into smaller components.

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Default Route?

- A default route is where the router sends remote data if it does not have the destination network in the routing table.
- Network admin must DEFINE the default route.
- If it exists, the packets will be sent there
- If it doesn't exist, the packets will simply be dropped!

Finding the desirable route

- When a packet enters a router, the router looks at the routing table to decide WHERE to forward the packet.
- Therefore, the precedence of route selection for the packet going to 10.1.1.55 would be:
- 1. 10.1.1.0
- 2. 10.1.0.0
- 3. 10.0.0.0
- 4. 0.0.0.0 (Default route if configured)
- 5. Dropped

Routers job in packet forwarding

- Done packet by packet and at every router
- Router will either forward it to next-hop router, forward it to the destination host, or drop the packet.

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Types of routes

- Static – manually configured by network admin. Can't do this for every route. Becomes too burdensome!

Types of routes

- Dynamic – learned from other routers (RIP, EIGRP, OSPF, etc.) Up-to-date routing tables are exchanged.
- Consumes bandwidth

Ch. 5 is finished!

Study Guide – due on test day –
- Define – pg. 126
- concept questions – pg. 127-128
- Define – pg. 128

Labs –None!

Online test….NOW! Will count as your TEST grade…
NOT a homework grade

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