

The Internet Layer

Hour 4

In This Lecture

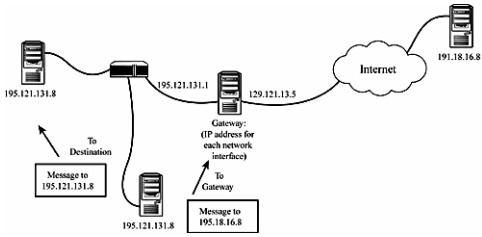
- Explain the purpose of IP, ARP, and ICMP
- Explain what a network ID and host ID are
- Explain what an octet is
- Convert a dotted decimal address to its binary equivalent
- Convert a 32-bit binary IP address into dotted decimal notation
- Describe the contents of an IP header
- Explain the purpose of the IP address
- Identify the network ID and host ID fields for Class A, B, and C addresses

IP Layer

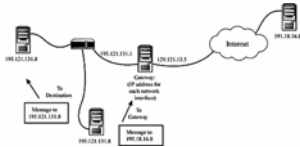
- Allows for routable addresses
- Logical (IP) instead of physical address
- Hierarchical address scheme

- ARP (Address Resolution Protocol) maps physical to IP Addresses.

Routed Network

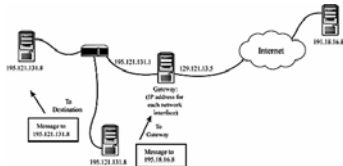


Routed Network



- If the destination address is on the same network segment as the source computer, the source computer sends the packet directly to the destination. The IP address is resolved to a physical address using ARP, and the data is directed to the destination network adapter.

Routed Network



- If the destination address is on a different segment from the source computer, the following process begins:
 - The datagram is directed to a gateway. A gateway is a device on the local network segment that is capable of forwarding a datagram to other network segments. The gateway address is resolved to a physical address using ARP, and the data is sent to the gateway's network adapter.
 - The datagram is routed through the gateway to a higher-level network segment (refer to Figure 4.1) where the process is repeated. If the destination address is on the new segment, the data is delivered to its destination. If not, the datagram is sent to another router.
 - The datagram passes through the chain of routers to the destination segment, where the destination IP address is mapped to a physical address using ARP and the data is directed to the destination network adapter.

IP Layer Functions

- Identify any computer on the network.
- Provide a means for determining when a message must be sent through the gateway.
- Provide a hardware-independent means of identifying the destination network segment so that the datagram will pass efficiently through the routers to the correct segment.
- Provide a means for converting the logical IP address of the destination computer to a physical address so that the data can be delivered to the network adapter of the destination computer.

IP Addresses

- Just like a street address that tells you
 - State
 - City
 - Street address
- IP Addresses indicate
 - Network ID
 - Subnet
 - Host ID

IP Addresses

- IP Addresses are made up of 32 bits
- The 32 bits are subdivided into 4 8bit segments call octets.
- Each octet is a number from 0 – 255
- Most common form is “Dotted decimal address”
- Eg: 131.95.117.212

Network ID

- Part of the IP address is used for the network ID.
- The network ID indicates the size of the network.
- There are five classes of networks: Class A, Class B and Class C
- Class D and Class E are special purpose networks.

Host ID

- Part of the IP address is used for the Host ID
- The host ID identifies the individual computer on the network
- It is the part of the IP address NOT used by the Network ID

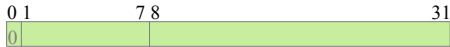


Class A Networks

- **Class A** - This is a class for very large networks, such as IBM which holds IP addresses in the range - 9.0.0.0 - 9.255.255.255. (126 networks, 16,777,214 host addresses).
- **First Octet** - - The first octet is between 1 to 126. (Starts with binary bit - 0).
- **Network Address** - The n/w address is denoted by first 8 bits or first octet.
- **Host/Node Address** - Host address is denoted by last 24 bits or last 3 octets.
- This Network-Host IP configuration for class A can be shown as - **network.host.host.host.**

Classful IP Addressing

Class A



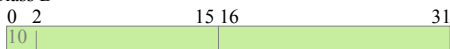
- Class A network has an 8-bit network prefix with the highest order bit set to 0 and a seven-bit network number, followed by a 24-bit host-number
- A maximum of 126 ($2^7 - 2$)/8 networks can be defined

Class B Network

- **Class B** - This is a class for medium-sized networks (16384 networks with 65534 host addresses)
- **First Octet** - - The first octet is between 128 to 191. (Starts with binary bits - 10).
- **Network Address** - The n/w address is denoted by first 16 bits or first 2 octets.
- **Host/Node Address** - Host address is denoted by last 16 bits or last 2 octets.
- This Network-Host IP configuration for class B can be shown as - **network.network.host.host**.

Classful IP Addressing

Class B



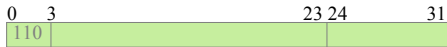
- Class B network has a 16-bit network prefix with the 2 highest order bit set to 1-0 and a 14-bit network number, followed by a 16-bit host-number
- A maximum of 16,384 (2^{14})/16 networks can be defined with up to 65,534 ($2^{16} - 2$) hosts/network

Class C Network

- **Class C** - This is a class for small-sized networks (2097152 networks with 254 host addresses)
- **First Octet** - - The first octet is between 192 to 223. (Starts with binary bits - 110).
- **Network Address** - The n/w address is denoted by first 24 bits or first 3 octets.
- **Host/Node Address** - Host address is denoted by last 8 bits or last octet.
- This Network-Host IP configuration for class C can be shown as - **network.network.network.host**

Classful IP Addressing

Class C



- Class C network has a 24-bit network prefix with the 3 highest order bit set to 1-1-0 and a 21-bit network number, followed by a 8-bit host-number
- A maximum of 2,097,152 (2^{21})/24 networks can be defined with up to 254 ($2^8 - 2$) hosts/network

Special IP Addresses

- 127.0.0.0 to 127.255.255.255 are for loopback (internal testing on a local machine).
- 127.0.0.1 is your NIC card

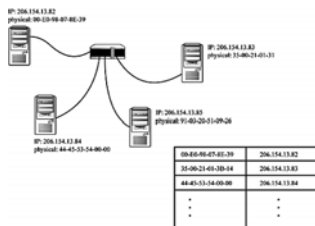
Private Networks

- Used for Private Networks behind a router or proxy server
- Each class has its own Private Network Range
- Class A: 10.0.0.0 to 10.255.255.255
- Class B: 172.16.0.0 to 172.31.255.255
- Class C: 192.168.0.0 to 192.168.255.255

Address Resolution Protocol

- Logical (IP Address) to Physical (NIC Address) Translation
- Invisible to user
- ARP Table
- IP Address Resolution
- Lifetime of ARP table entry

ARP Table



RARP

- Reverse Address Resolution Protocol
- Used when IP is known but NIC address is unknown
- Used for BOOTP (boot on Lan)
- Empty socket on NIC Card
 - BOOT Prom for diskless workstations

IP Header Fields

Version		IHL		Type of Service		Total Length	
Identification		Flags		Fragment Offset			
Time to Live		Protocol		Header Checksum			
Source IP Address							
Destination IP Address							
IP Options (optional)				Padding			
Data							
More Data..?							

As seen in Lecture 2 in Ethereal

Internet Control Message Protocol (ICMP)

- Used by routers to notify source IP of problems.
- Common ICMP messages include:
 - Echo Request / Echo Reply (Used for testing)
 - Source Quench – request for sender IP to slow down (too much for the router to handle)
 - Destination Unreachable – datagram cannot be delivered.
 - Time Exceeded (Time To Live exceeded)

Bibliography

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- <http://www.geocities.com/technofundo/tech/misc/abcofip.html>, ABC of an IP Address, 8/29,2004
- Addressing (PPT), Tamanna Sait & Aneesha Deo
