

## **Network Layer, Part 3**

### **Miscellaneous Internet Topics**

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## **Address Resolution Protocol (ARP)**

- ❑ Consider that a packet arrives at its destination network, say an Ethernet network.
  - precisely, the packet arrives at a router attached to the network
  - the packet carries the destination “IP” address
  - however, the router needs the destination “Ethernet” address to deliver the packet to the destination.
- ❑ ARP is also used when two hosts connecting to the same network communicates with the TCP/IP protocol suite.

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## ARP Operations

- ❑ Host X wishes to send an IP datagram to a Host Y on the same LAN.
- ❑ X knows only the IP address of Y.
- ❑ X broadcasts an ARP request message for the IP address in question.
- ❑ Y responds with its Ethernet address in an ARP reply message.
- ❑ X transmits the datagram using Y's Ethernet address as the destination address in the Ethernet frame.

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## ARP Packet Format

### Ethernet Frame Header

Source Ether addr	Dest. Ether addr	Frame Type
0806		

### ARP Packet (Frame data)

Hard Type	Prot Type		OP	Sender Ether addr	Sender IP addr	Target Ether addr	Target IP addr
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→ Prot Size  
 → Hard Size

### Ethernet Frame Tail

CRC Checksum
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- ❑ Dest. Ethernet Addr (6)
- ❑ Frame Type (2) = 0x0806 (indicating ARP)
- ❑ Hard Type (2 bytes): type of hardware address
  - 1 for Ethernet
  - Other values indicate different LAN technologies (token ring, etc.)
- ❑ Prot Type (2): type of network layer protocol
  - 0x0800 indicates IP
- ❑ The combination of Hard Type and Prot Type enables the use of ARP to resolve the mapping from any type of network layer addresses to any type of LAN addresses, as long as the LAN is broadcast-based.

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- ❑ Hard Size (1): the size of hardware addresses
  - 6 in the case of the Ethernet
- ❑ Prot Size (1): the size of network layer addresses
  - 4 in the case of IP
- ❑ Op (2): type of the ARP operation
  - 1 for ARP request
  - 2 for ARP reply
- ❑ Source Hardware/Network Addresses
- ❑ Target Hardware/Network Addresses
  - Target Hardware Addr is not used in ARP requests

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## Discussion

- ❑ What's the use of the sender's Ethernet addresses in an ARP request ?
  
- ❑ What's the use of the sender's IP address in an ARP request ?

## ARP Caching

- ❑ Each host also maintains a cache of recently seen IP/Ethernet address mappings.
- ❑ Combined with the broadcast of all ARP requests, caching greatly reduces the volume of ARP traffic.
- ❑ To allow changes in IP/Ethernet address mappings, a cached mapping is purged after 20 minutes.

## Routing at Hosts

- Direct Delivery
  - sender determines that destination is on the same local network by checking the netid in its IP address against the netid of the destination
  - ARP is then used to obtain the physical address of destination
  - a data-link frame is composed and transmitted
- Indirect Routing
  - sender forwards the packet to a router that is attached to the network
  - the router is responsible for forwarding the packet toward its destination

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## The Address Depletion Crisis

- We are running out of IP addresses.
- However, it is not that we have used up all  $2^{32}$  addresses.
  - it is class B addresses that are in shortage
  - Class A networks are too large and class C too small; large portions of the address space are not used

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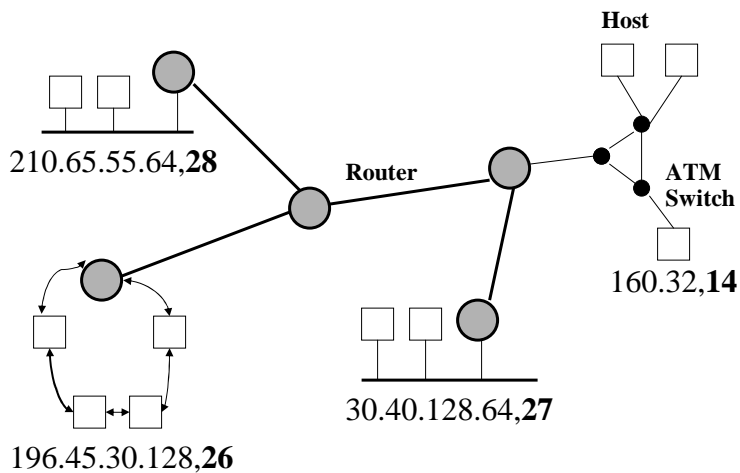
❑ Solutions:

1. dynamic address assignment
2. classless interdomain routing (CIDR)
3. private addresses and address translation
4. next generation IP

## **Dynamic Address Assignment**

- ❑ Each ISP is allocated a block of IP addresses.
- ❑ An IP address is assigned to your PC only when you dial up to your ISP; the address is released after you hang up
  - By what protocol ?
  
- ❑ This reduces the number of IP addresses to the number of on-line users, rather than all the users of the ISP.

## Network Masks



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- ❑ The idea is to break the boundary between network IDs and host IDs, as defined by class A, B, and C addresses.
- ❑ The length of the network ID in an IP address is specified explicitly, by a **network mask**.
- ❑ A mask is usually written in the decimal notation of IP addresses.
  - The mask 255.255.255.0 specifies a network ID of 24 bits

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## Discussion

- ❑ The new addressing model is said to be **classless**.
- ❑ Thus, several class C net IDs can be merged.
  - 200.0.0, 200.0.1, 200.0.2, and 200.0.3 can be merged to 200.0.0/255.255.252.0, accommodating 1000 hosts.
- ❑ Some owners of Class A networks are “donating back” their net IDs, which can be broken into smaller chunks for more efficient use.
- ❑ The routing infrastructure of the Internet has also been upgraded to handle **Classless Interdomain Routing (CIDR)**

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## Exercises

- ❑ Give the network IDs of
  - 200.64.127.88/22
  
  - 100.195.33.2/10
  
- ❑ Are 192.168.80.45/21 and 192.168.91.70/21 on the same network ?

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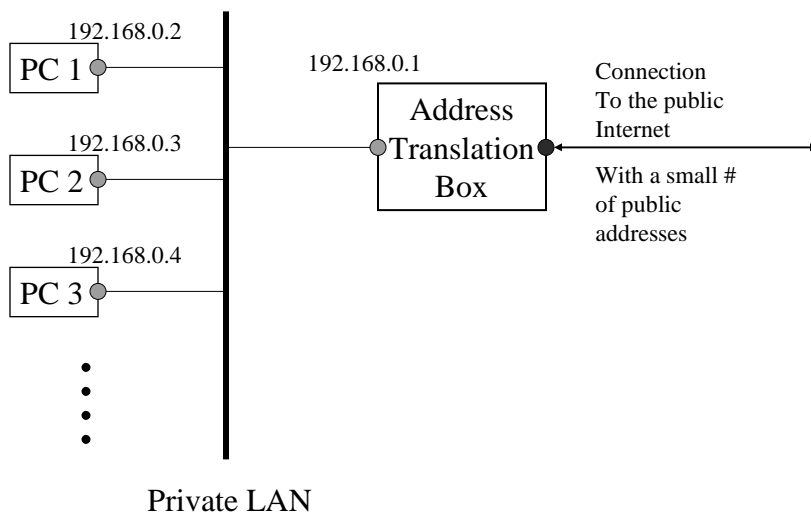
## Private Addresses

- ❑ Some IP addresses, called private addresses, are reserved for internal use in private networks.
  - 10.0.0.0 to 10.255.255.255
  - 172.16.0.0 to 172.31.255.255
  - 192.168.0.0 to 192.168.255.255
- ❑ Public routers will not forward packets using private addresses.
- ❑ A corporation uses private addresses at its own discretion.
  - The same set of addresses can be used by other corporations too.

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## Address Translation



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- ❑ The corporation obtains a small set of public IP addresses.
- ❑ When a machine inside the private network communicates with the outside world, its private IP address is translated to a public address.
- ❑ This binding between private addresses and public addresses is dynamic.
- ❑ This method works well if at any given moment, only a small portion of the machines communicate with the outside world.

## Further Discussions

- ❑ Can we push the technology so that *one* public IP address will do ?
  - Yes, the technique is IP masquerading.
  - However, to appreciate it we need basic understanding of UDP and TCP.
- ❑ Can address translation techniques solve the shortage problem of IP addresses ?

## The Next Generation IP

- ❑ also known as **IPng** or **IPv6**
  - current generation is **IPv4**
- ❑ uses 128-bit addresses
- ❑ practical issues:
  - when will people start using IPv6 ?
  - how do we manage the transition ?