4.4 Subnets

Communication internal, able without router.

Amount of IP bits must match, indicated by /x on address, x is amount of bits for matching in subnet, rest used for host.

Sometimes can be represented using an IP address, in binary all bits that are 1 are the amount for subnet.

4.4 NAT

In routers, has public and private addresses, wraps private address in public NAT.

Private addresses either 10.0.0 or 192.168.1.

NAT makes forwarding table, associates internal IP and port with NAT IP and new chosen NAT port.

Each socket will have its own entry.

4.4 Adressing

Addressing is dotted decimal, a.b.c.d, each decimal separating a byte.

Roughly 2^32 addresses with IPv4.

DHCP, Interfaces, ICMP

DHCP is client/server setup, assigns IP from pool, releases once host is done.

DHCP, Interfaces, ICMP (cont)

Interfaces: a connection with a host/router and link, associated with IP addresses.

ICMP, protocol, error communication, above IP

Forwarding Table

Tells you what link to send to based on destination IP.

Splits the destination IPs into ranges in the forwarding table.

Choose range with longest match.

To make, split destination IP ranges by looking at where bits deviate.

4.5 Types of Routing Algorithms

Global	All routers have the knowledge of the network system. Link state algorithms. Dijkstra's algorithm.
Decentralized	Routers only know information about neighbors. Learns network through neighbors. Distance vector algorithms.
Static	Changes slowly over time.
Dynamic	Changes more quickly.

4.1-4.3

What does network layer do? Transports segments, wraps segments in datagram, in every host, uses IP.

How do routers work? Use routing algorithm to create forwarding table. Move datagrams from input to output, use switching fabric. Works on layer 3.

Key network functions: Routing: Determine the route to dest. Forwarding: Deciding the correct output port to send a packet on. Forwarding tables tell router where to send datagram.

Hierarchical Routing

Divide network into small groups. A router is chosen as gateway to outside networks. All routers in group run same routing algorithm.

4.4 classful IP and CIDR

Class A:	8 bits network, 24 bits host.
Class B:	16 bit network, 16 bits host.
Class C	24 bit network, 8 bits host.
Classless (CIDR):	allows any choice of # bits for network.

4.4 Fragmentation

Break data to fit on link.

Formula for fragmenting datagram: ceiling (datagram – IP header / MTU – IP header)

Formula for fragmenting raw data: ceiling (bytes / MTU – IP header – transport layer header)

4.4 IPv6

Removed fragmentation. Increased address size to 128 bits. 40 byte fixed header.

Version: IP version.

Traffic class: type of traffic.

Payload length: how much data.

Next header: upper layer protocol to deliver to.

Hop limit: how many hops allowed.

Source and dest. addresses: 128 bits.

Data: what data is transported.

4.4 IPv4

Protocol version:	what version running.
Header length:	length of header, fixed 20 bytes + optional field.
Type of the data:	Different types of datagrams exist.
Datagram length:	data + header

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4.4 IPv4 (cont)

Identifier:	identify fragments of IP datagram, data from same datagram has same number
Flags:	indicate beginning of fragmentation or if allowed, uses 3 bits. First bit always 0. Second bit is 0 or 1, 0 means fragment, 1 means can't. Last bit 0 or 1, 0 means no more fragments, 1 means more.
Offset:	used to rebuild fragment.
Time to live:	How many hops before dropped, resets at router, drop at 0.
Upper layer:	upper layer protocol to pass to.
Header checksum:	check for errors
Source and dest. IP:	32 bits.
Data:	data carried.
Options:	allows increase in header.

5.1 Link layer

What is it?	Getting messages from one link to next, one hop communication.
How does info change?	From link to link.
What are transmission units?	Frames.

5.1 Link layer services

Framing: putting datagrams into frames.

Link Access: rules for multiple users accessing link.

Reliable delivery: uses re-transmissions and ACKs. For direct connection links. Only used on error prone links.

5.3 Types of links

Point to ponit

Broadcast: many users share link.

Wireless

5.3 MAC protocols

MAC protocols allow link sharing.

Channel partitioning: No collisions, communicate on time intervals.

Random access: if collisions, randomly choose time to resend.

5.4 MAC addresses

MAC is fixed. IP can change.

MAC 48 bits, in hex

Host has both MAC and iP.

Ethernet Frames

Preamble	Wakes up the receiver for transmission.
Source and Dest MAC	tell you sender and receiver, 48 bits, hex.
Payload	Must be between 46-1500 bytes, data sent.

Error correction

Type	Tells you the upper layer protocol.

Ethernet topology

Bus	hosts connect to same link.
Star	hosts connect to switch, switch moves traffic, reduces traffic to router, forwards within subnet, uses MAC address.

5.4 ARP

Maps MAC to IP

Above link layer, below network layer. ARP packets carried by link layer.

Creates tables to map IP and MAC. Entries last approx. 20 mins.

5.4 ARP sending in subnet

Check ARP table for mapping.

If mapping is there, send frame.

If mapping not there, ARP query.

Broadcast ARP query for who has an IP.

Host with IP responds directly to query host.

Table updated with MAC/IP mapping.

5.4 ARP sending outside subnet

Can't have destionation's MAC.

Use MAC for next hop link (router) as destination MAC.

Source IP and Dest IP stay same. Source MAC and Dest. MAC change.

Switches

Operates on layer 2, link layer device, transparent to host (no IP or MAC).

Self learns by recording interface and MAC of sent frames that cross it. Builds own forwarding table.

If no entry in forwarding table, broadcasts frame to all interfaces. Those with the wrong MAC drop it.

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