Chapter 4 (Final Study Guide)

INPUT PORT FUNCTIONS

decentralized switching:

- using header field values, lookup output port using forwarding table in input port memory ("match plus action")

- destination-based forwarding: forward based only on destination IP address (traditional)

- generalized forwarding: forward based on any set of header field values

LONGEST PREFIX MATCHING

****EXAM PROBLEM****

Longest Prefix Matching: When looking for forwarding table entry for given destination address, use longest address prefix that matches destination address.

Destination Address Range	Link interface
11001000 00010111 00010*** *********	0
11001000 00010111 00011000 *********	1
11001000 00010111 00011*** *********	2
otherwise	3

examples:

DA: 11001000 00010111 00010110 10100001 which interface?

DA: 11001000 00010111 00011000 10101010 which interface?

****EXAM PROBLEM****

- Consider a datagram network using 8-bit host addresses. Suppose a router uses longest prefix matching and has the following forwarding table:

Prefix Match	Interface
00	0
010	1
011	2
10	2
11	3

- For each of the four interfaces, give the associated range of destination host addresses and the number of addresses in the range.

Answer:

Interface 0: 0000 0000 - 0011 1111 = 2^6 = 64

Interface 1: 0100 0000 - 0101 1111 = 2^5 = 32

Interface 2: 0110 0000 - 0111 1111 & 1000 0000 - 1011 1111 = 2^5 + 2^6 = 32 + 64 = 96

Interface 3: 1100 0000 - 1111 1111 = 2^6 = 64

SWITCHING VIA BUS

bus contention: switching speed limited by bus bandwidth

OUTPUT PORTS
Datagram (packets) can be lost due to congestion, lack of buffers

Priority scheduling – who gets best performance, network neutrality

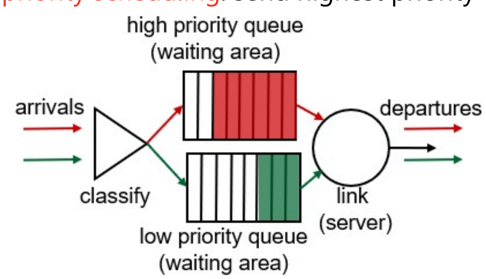
Queuing (delay) and loss due to output port buffer overflow!

Datagram (packets) can be lost due to congestion, lack of buffers

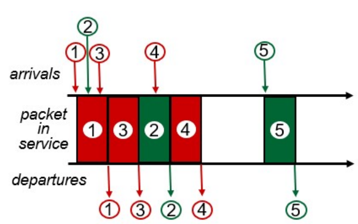
Priority scheduling – who gets best performance, network neutrality

SCHEDULING MECHANISM
scheduling: choose next packet to send on link
FIFO (first in first out) scheduling: send in order of arrival to queue
-real-world example?
-discard policy: if packet arrives to full queue: who to discard?
-tail drop: drop arriving packet
-priority: drop/remove on priority basis
-random: drop/remove randomly

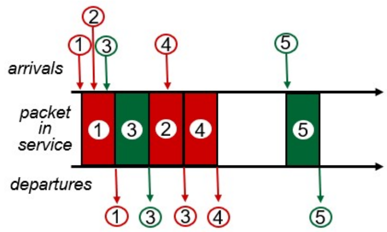
SCHEDULING POLICIES: PRIORITY
priority scheduling: send highest priority queued packet



Non-preemptive priority queuing discipline: the transmission of a packet is not interrupted once it has begun

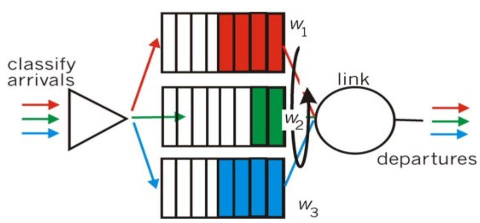


****MORE SCHEDULING****
Round Robin (RR) scheduling:
- multiple classes
- cyclically scan class queues, sending one complete packet from each class (if available)

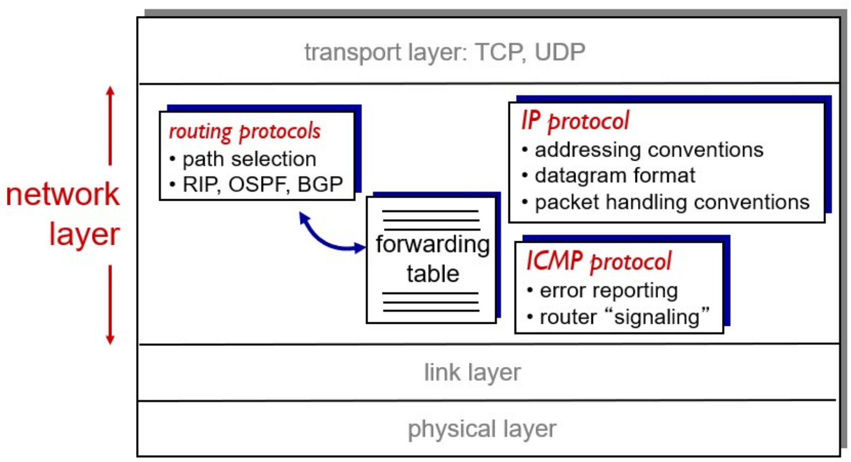


Weighted Fair Queuing (WFQ):

- generalized Round Robin
- each class gets weighted amount of service in each cycle
    - Even if all classes have queued packets, each class will still be guaranteed to receive a certain bandwith



INTERNET LAYER PROTOCOL



IPv4 ADDRESSING

IPv4 address: **32**-bit identifier for host, router interface

interface: connection between host/router and physical link

- router's typically have multiple interfaces
- host typically has one or two interfaces (e.g., wired Ethernet, wireless 802.11)

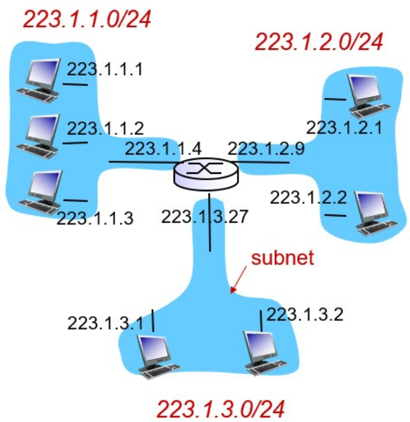
IP addresses associated with each interface

SUBNETS

what's a subnet ?

- device interfaces with same subnet part of IP address
- can physically reach each other without intervening router
- to determine the subnets, detach each interface from its host or router, creating islands of isolated networks

- Each isolated network is called a subnet



subnet mask: /24

IP ADDRESSING: CIDR

CIDR: Classless InterDomain Routing

- address format: a.b.c.d/x, where x is # bits in subnet portion of address
- Broadcast address: 255.255.255.255

Helpful resource: http://eee.guc.edu.eg/Courses/Networks/NETW503%20Internet/Tutorials/Tutorial%209.pdf

EXAM QUESTION SUBNET ADDRESS

ONLINE EXAMPLES (similar to PP questions):

Subnet 1 (60 interfaces)

$2^n - 2 \geq 60$

Notice that we subtract 2 from the total number of available IP addresses because 2 IP addresses are reserved for the network and broadcast addresses.

$2^n \geq 62$

$n = 6$

Number of bits allocated to host part = n = 6

Number of bits allocated to network part = Prefix length = 32 - n = 32 - 6 = 26

The network address of any subnet (that is NOT the first subnet) is obtained by adding one to the broadcast address of its preceding subnet.

Network address of second subnet = 223.1.17.128/26

Broadcast address of second subnet = 223.1.17.10111111/26 =223.1.17.191/26

Subnet E (2 interfaces)

$2^n - 2 \geq 2$
Notice that we subtract 2 from the total number of available IP addresses because 2 IP addresses are reserved for the network and broadcast addresses.
$2^n \geq 4$

$n = 2$
Number of bits allocated to host part = $n = 2$
Number of bits allocated to network part = Prefix length = $32 - n = 32 - 2 = 30$

Network address of subnet E = 219.98.0.4/30

Broadcast address of subnet E = 219.98.0.00000111/30 = 219.98.0.7/30

Subnet F(2 interfaces)

$2^n - 2 \geq 2$
Notice that we subtract 2 from the total number of available IP addresses because 2 IP addresses are reserved for the network and broadcast addresses.
$2^n \geq 4$
$n = 2$
Number of bits allocated to host part = $n = 2$
Number of bits allocated to network part = Prefix length = $32 - n = 32 - 2 = 30$

Network address of subnet F = 219.98.0.8/30
Broadcast address of subnet F = 219.98.0.00001011/30 = 219.98.0.11/30

Lecture Example

Subnet IP address assignment

- Consider a router that interconnects three subnets: Subnet 1, Subnet 2, and Subnet 3. Suppose all of the interfaces in each of these three subnets are required to have the prefix 223.1.17/24. Also suppose that Subnet 1 is required to support 120 interfaces, Subnet 2 is to support 60 interfaces, and Subnet 3 is to support 60 interfaces. Provide three network addresses (of the form a.b.c.d/x) that satisfy these constraints.

-> ANSWER ->

Answer

- Subnet 1: 223.1.17.0/25
- Subnet 2: 223.1.17.128/26
- Subnet 3: 223.1.17.192/26

DHCP DYNAMIC HOST CONFIGURATION
DHCP: Dynamic Host Configuration Protocol: dynamically get address from network server

goal: allow host to *dynamically* obtain its IP address from network server when it joins network

Other uses for DHCP (More than IP Address)
- address of first-hop router for client
- name and IP address of DNS sever
- network mask (indicating network versus host portion of address)

NAT: NETWORK ADDRESS TRANSLATION

motivation: local network uses just one IP address as far as outside world is concerned

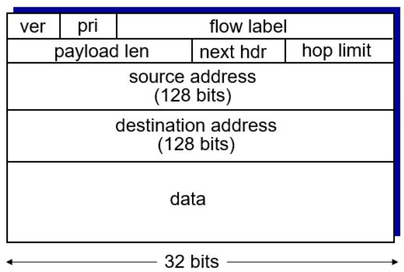
- 16-bit port-number field:
- 60,000 simultaneous connections with a single LAN-side address!

IPV6

initial motivation: 32-bit address space soon to be completely allocated.

-additional motivation:

- header format helps speed processing/forwarding
- header changes to facilitate QoS



Source and Destination Addresses are in 128 bits

-Differences from IPV4 and IPV6

- checksum: removed entirely to reduce processing time at each hop
- options: allowed, but outside of header, indicated by "Next Header" field
- ICMPv6: new version of ICMP

TUNNELING