Computer Networks: Overview

Operating Systems
CS 571

Network types
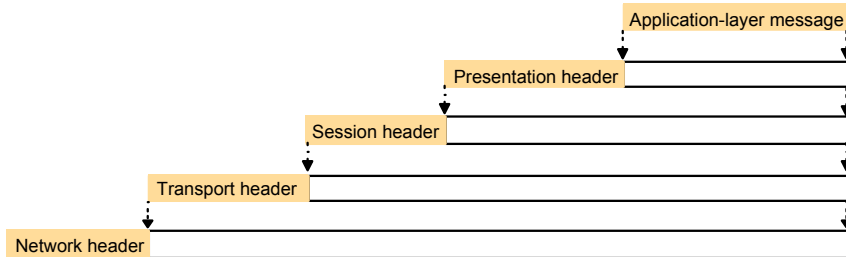
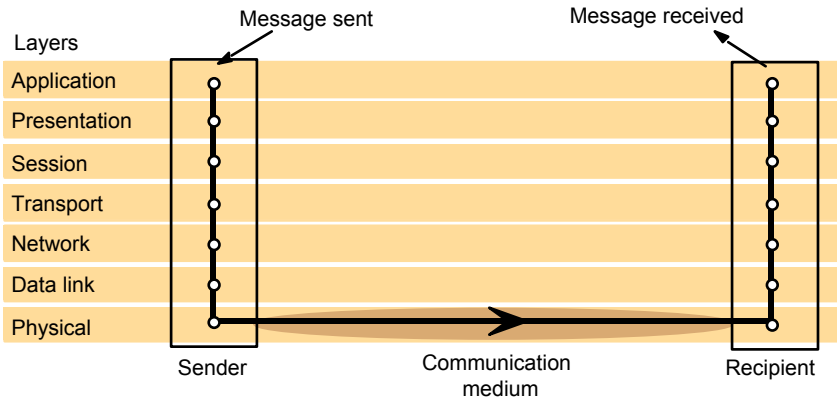|	Range	Bandwidth (Mbps)	Latency (ms)
LAN	1-2 kms	10-1000	1-10
WAN	worldwide	0.010-600	100-500
MAN	2-50 kms	1-150	10
Wireless LAN	0.15-1.5 km	2-11	5-20
Wireless WAN	worldwide	0.010-2	100-500
Internet	worldwide	0.010-2	100-500

2

Conceptual layering of protocol software

Message sent · Message received

Layer n
▪
▪
Layer 2
Layer 1

Sender · Communication medium · Recipient
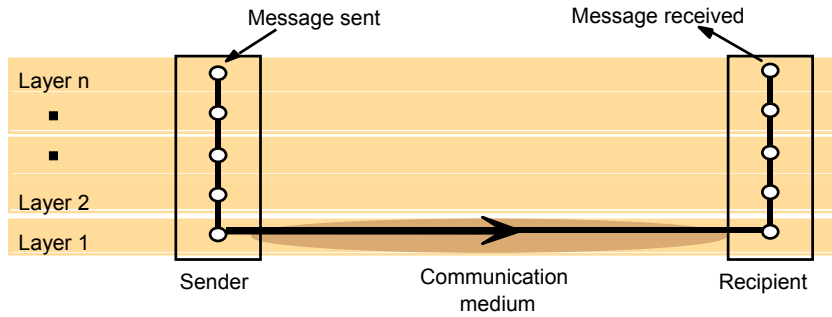
3

Encapsulation as it is applied in layered protocols

Application-layer message

Presentation header

Session header

Transport header

Network header

4

Protocol layers in the ISO Open Systems Interconnection (OSI) model

Message sent   Message received

Layers

| Application |
| Presentation |
| Session |
| Transport |
| Network |
| Data link |
| Physical |

Sender   Communication medium   Recipient

5

OSI protocol summary

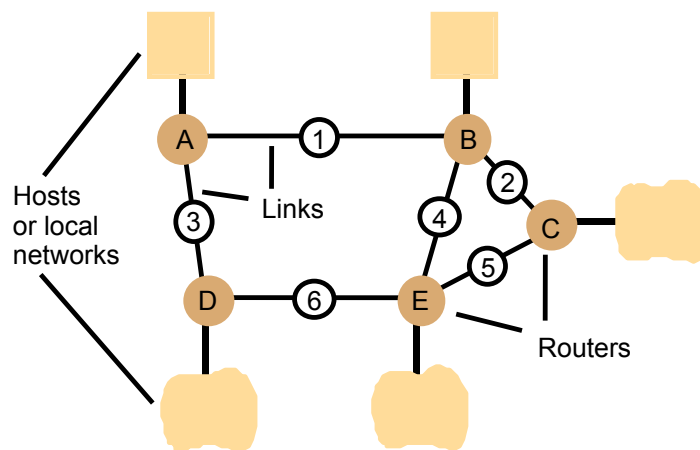| Layer	Description	Examples
Application	Protocols that are designed to meet the communication requirements of specific applications, often defining the interface to a service.	HTTP,FTP, SMTP, CORBA IIOP
Presentation	Protocols at this level transmit data in a network representation that is independent of the representations used in individual computers, which may differ. Encryption is also performed in this layer, if required.	Secure Sockets (SSL),CORBA Data Rep.
Session	At this level reliability and adaptation are performed, such as detection of failures and automatic recovery.	
Transport	This is the lowest level at which messages (rather than packets) are handled. Messages are addressed to communication ports attached to processes, Protocols in this layer may be connection-oriented or connectionless.	TCP, UDP
Network	Transfers data packets between computers in a specific network. In a WAN or an internetwork this involves the generation of a route passing through routers. In a single LAN no routing is required.	IP, ATM virtual circuits
Data link	Responsible for transmission of packets between nodes that are directly connected by a physical link. In a WAN transmission is between pairs of routers or between routers and hosts. In a LAN it is between any pair of hosts.	Ethernet MAC, ATM cell transfer, PPP
Physical	The circuits and hardware that drive the network. It transmits sequences of binary data by analogue signalling, using amplitude or frequency modulation of electrical signals (on cable circuits), light signals (on fibre optic circuits) or other electromagnetic signals (on radio and microwave circuits).	Ethernet base- band signalling, ISDN

6

Internetwork layers

Layers

Message

| Application |
| Transport |
| Internetwork |

Internetwork protocols

Internetwork packets

| Network interface |
| Underlying network |

Network-specific packets

Underlying network protocols
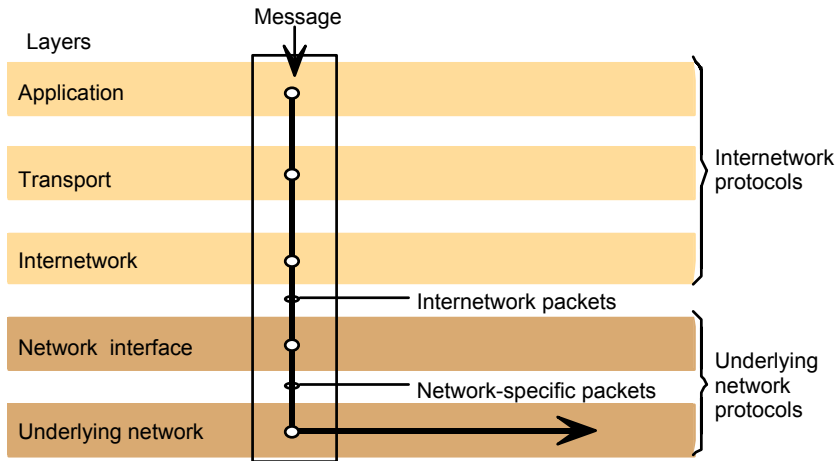
Routing in a wide area network

A — 1 — B

Hosts or local networks

Links

3   4   2

C

D — 6 — E   5

Routers

TCP/IP layers

Layers   Message

Application

Messages (UDP) or Streams (TCP)

Transport

UDP or TCP packets

Internet

IP datagrams

Network interface

Network-specific frames

Underlying network
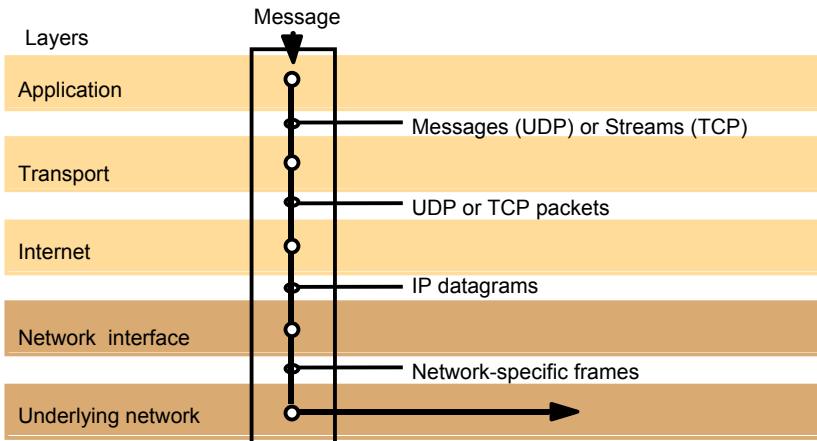
9

Encapsulation in a message transmitted via TCP over an Ethernet

Application message

TCP header   port

IP header   TCP

Ethernet header   IP

Ethernet frame

10

5
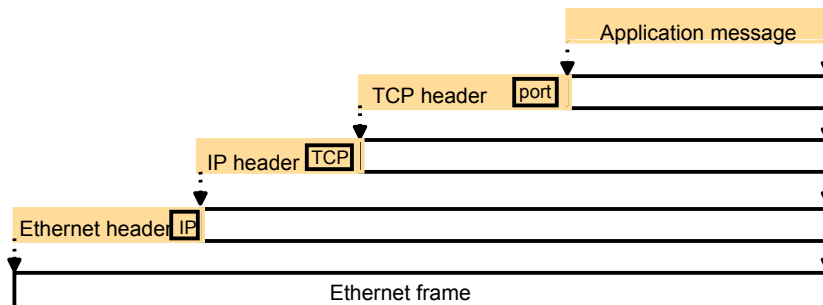
The programmer's conceptual view of a TCP/IP Internet

Application		Application
TCP		UDP
IP		
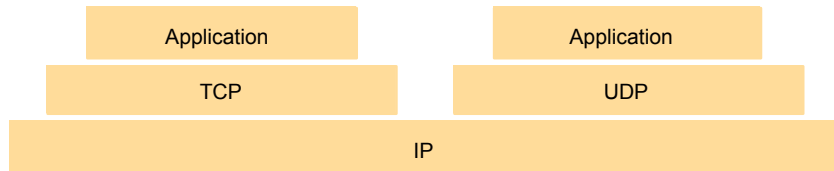
Internet address structure, showing field sizes in bits

Class A:
```
|0| Network ID (7) |        Host ID (24)        |
```

Class B:
```
|1|0| Network ID (14) |       Host ID (16)      |
```

Class C:
```
|1|1|0|   Network ID (21)    | Host ID (8) |
```

Class D (multicast):
```
|1|1|1|0|      Multicast address (28)      |
```

Class E (reserved):
```
|1|1|1|1|0|         unused (27)            |
```
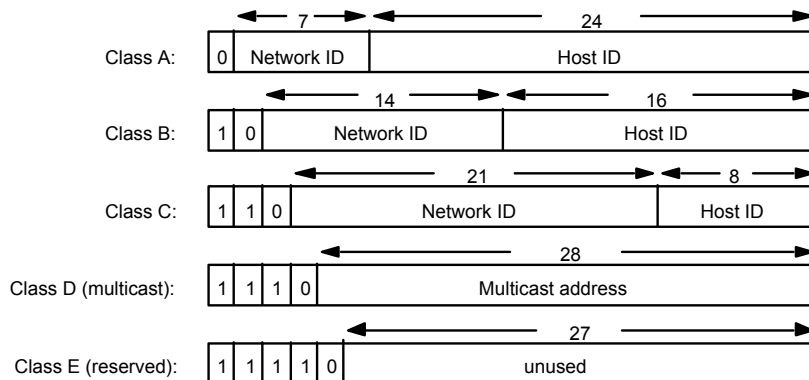
Decimal representation of Internet addresses

	octet 1	octet 2	octet 3		Range of addresses
	Network ID		**Host ID**		
Class A:	1 to 127	0 to 255	0 to 255	0 to 255	1.0.0.0 to 127.255.255.255
		Network ID		**Host ID**	
Class B:	128 to 191	0 to 255	0 to 255	0 to 255	128.0.0.0 to 191.255.255.255
			Network ID	**Host ID**	
Class C:	192 to 223	0 to 255	0 to 255	1 to 254	192.0.0.0 to 223.255.255.255
			Multicast address		
Class D (multicast):	224 to 239	0 to 255	0 to 255	1 to 254	224.0.0.0 to 239.255.255.255
Class E (reserved):	240 to 255	0 to 255	0 to 255	1 to 254	128.0.0.0 to 247.255.255.255

13

DNS: Domain Name System

People: many identifiers:
  ○ SSN, name, Passport #

Internet hosts, routers:
  ○ IP address (32 bit) - used for addressing datagrams
  ○ "name", e.g., markov.cs.gmu.edu - used by humans

<u>Q:</u> map between IP addresses and name ?

Domain Name System:
❑ *distributed database* implemented in hierarchy of many *name servers*
❑ *application-layer protocol* host, routers, name servers to communicate to *resolve* names (address/name translation)

14

DNS name servers

Why not centralize DNS?

❒ single point of failure

❒ traffic volume

❒ distant centralized database

❒ maintenance

doesn't *scale!*

❒ no server has all name-to-IP address mappings

local name servers:

○ each ISP, company has *local (default) name server*

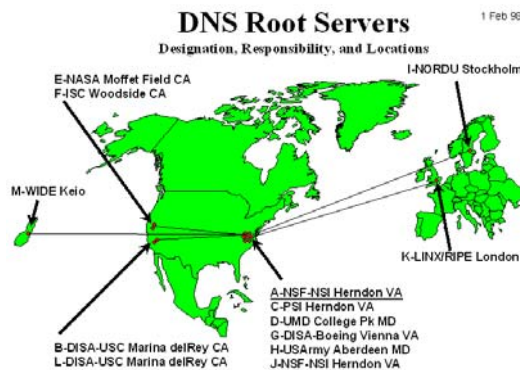○ host DNS query first goes to local name server

authoritative name server:

○ for a host: stores that host's IP address, name

○ can perform name/address translation for that host's name

15

DNS: Root name servers

❒ contacted by local name server that can not resolve name

❒ root name server:

○ contacts authoritative name server if name mapping not known

○ gets mapping

○ returns mapping to local name server

❒ ~ dozen root name servers worldwide

DNS Root Servers 1 Feb 98
Designation, Responsibility, and Locations

E-NASA Moffet Field CA
F-ISC Woodside CA

I-NORDU Stockholm

M-WIDE Keio

K-LINX/RIPE London

A-NSF-NSI Herndon VA
C-PSI Herndon VA
D-UMD College Pk MD
G-DISA-Boeing Vienna VA
H-USArmy Aberdeen MD
J-NSF-NSI Herndon VA

B-DISA-USC Marina delRey CA
L-DISA-USC Marina delRey CA

16

Simple DNS example

root name server

host `surf.eurecom.fr` wants IP address of `gaia.cs.umass.edu`

1. Contacts its local DNS server, `dns.eurecom.fr`
2. `dns.eurecom.fr` contacts root name server, if necessary
3. root name server contacts authoritative name server, `dns.umass.edu`, if necessary

2
5
4
3

local name server
`dns.eurecom.fr`

authoritive name server
`dns.umass.edu`

1
6

requesting host
`surf.eurecom.fr`

`gaia.cs.umass.edu`

17

9