Data Communications Networks

Text Book Definition

"Movement of *computer information* from one point to another by means of electrical or optical transmission systems"

More Universal Definition (by TF)

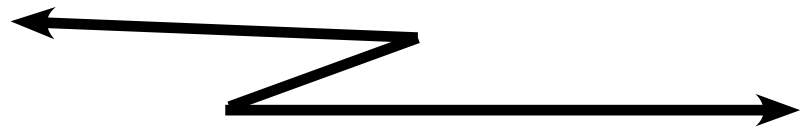
"Movement of *digital information* from one point to another *across a transmission medium*"

Data Communications Network's Three Basic Components

Client

Server

Circuit



Examples

Browser----------WEB Host
E-Mail Client----------POP/SMTP Server
Cash Register----------Store Controller
Microcomputer----------File/Print Server
CC Authorization termial----------Financial Processor

Text Book Definitions

Server

Stores data or software that may be accessed by the client.

(TF Comment: "INCOMPLETE")

Client

The input-output hardware device at the user's end of a communication circuit.

(TF Comment: "INCOMPLETE")

Circuit

The pathway through which messages travel.

(TF Comment: "SATISFACTORY")

Data Communications Network's

Client

Server

Transaction Components

Request Message

Response Message

Examples

Browser----------WEB Host
E-Mail Client----------POP/SMTP Server
Cash Register----------Store Controller
Microcomputer----------File/Print Server
CC Authorization termial----------Financial Processor

Functional Definitions
(as implemented by TCP/IP)

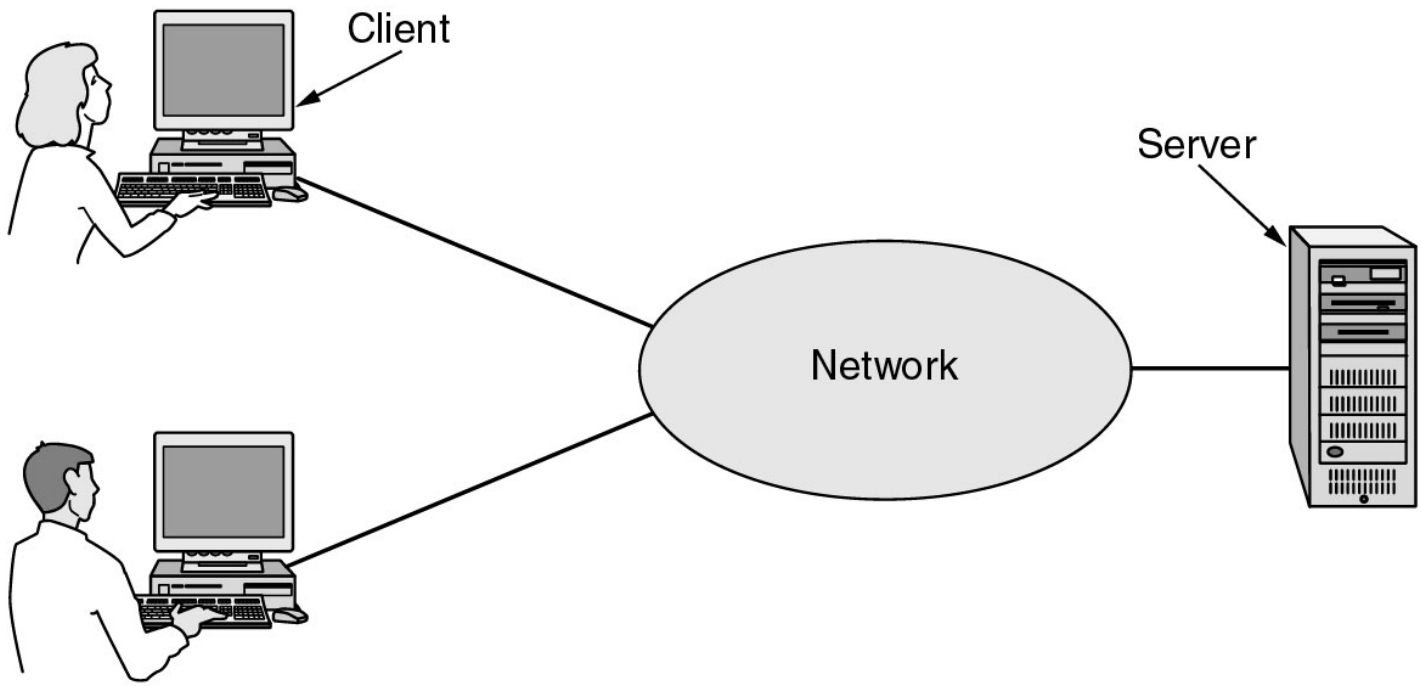
Client

1. Generates Requests
2. Transmits Requests
6. Receives Responses

Server

3. Receives Requests
4. Generates Responses
5. Transmits Responses

A network with two clients and one server.



Types of Networks

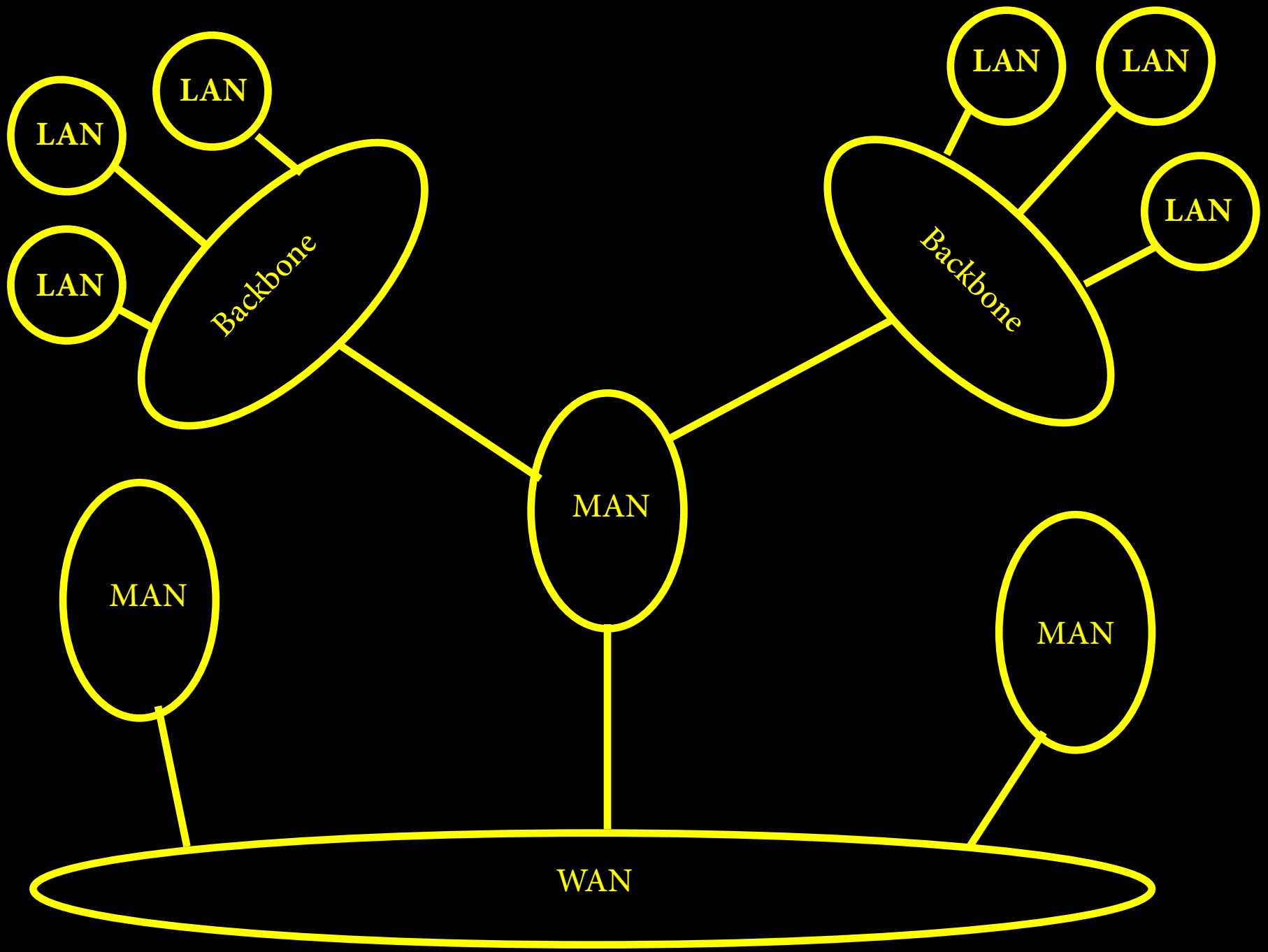
LAN's

Backbones

MAN's

WAN's

"Usually" categorized by geographic scope


LAN
LAN
LAN
LAN
LAN
LAN
Backbone
Backbone
MAN
MAN
MAN
WAN

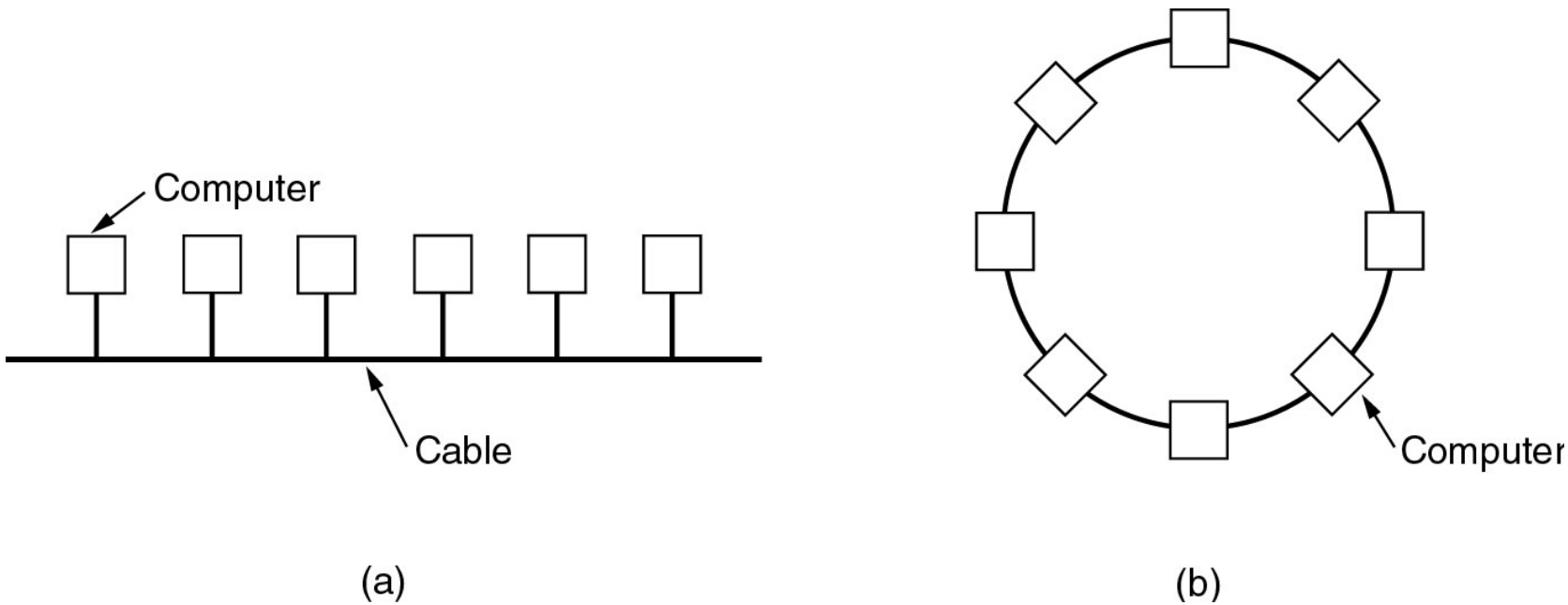
Classification of interconnected processors by scale.

Interprocessor distance	Processors located in same	Example
1 m	Square meter	Personal area network
10 m	Room	Local area network
100 m	Building	
1 km	Campus	
10 km	City	Metropolitan area network
100 km	Country	Wide area network
1000 km	Continent	
10,000 km	Planet	The Internet

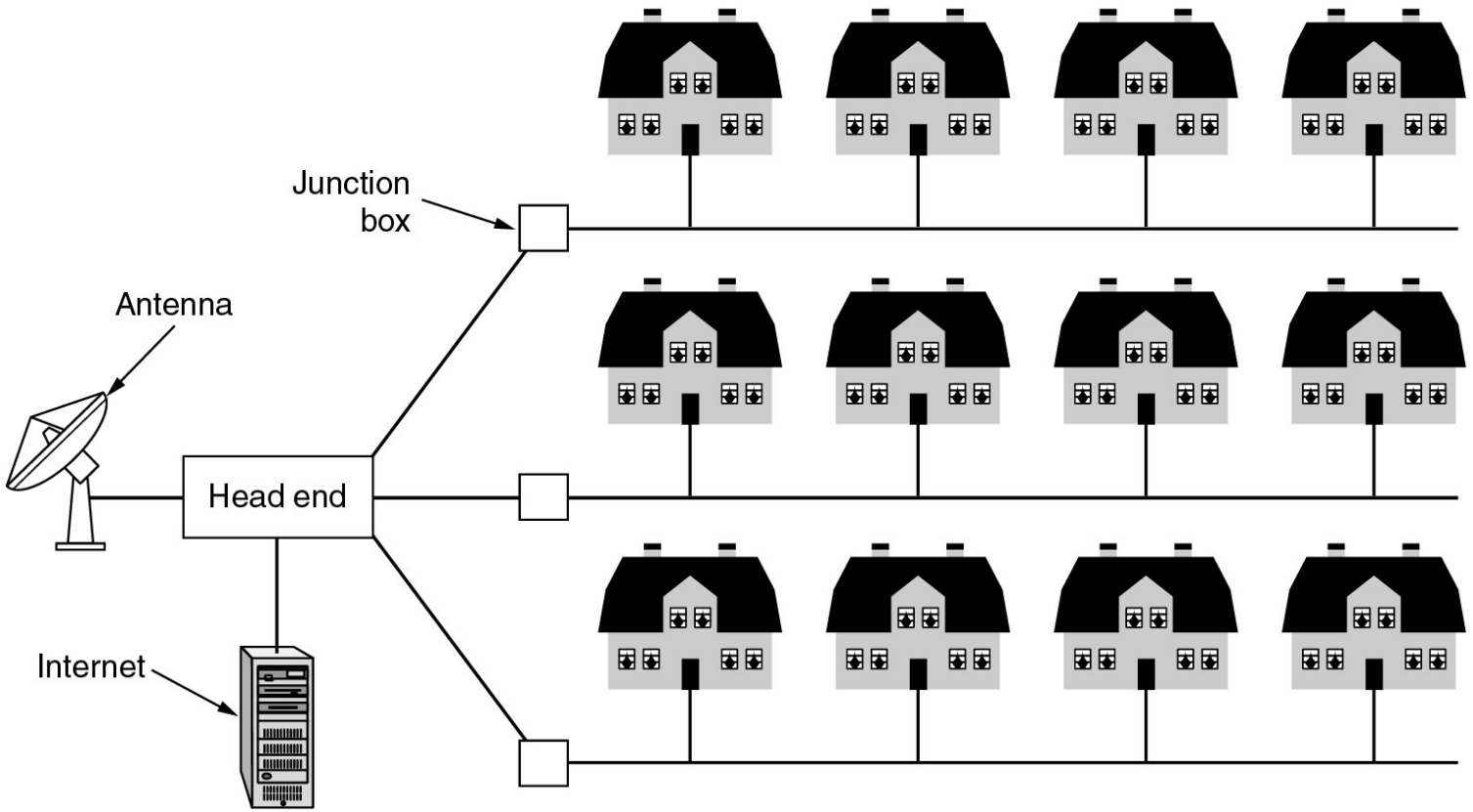
Two broadcast networks

(a) Bus

(b) Ring

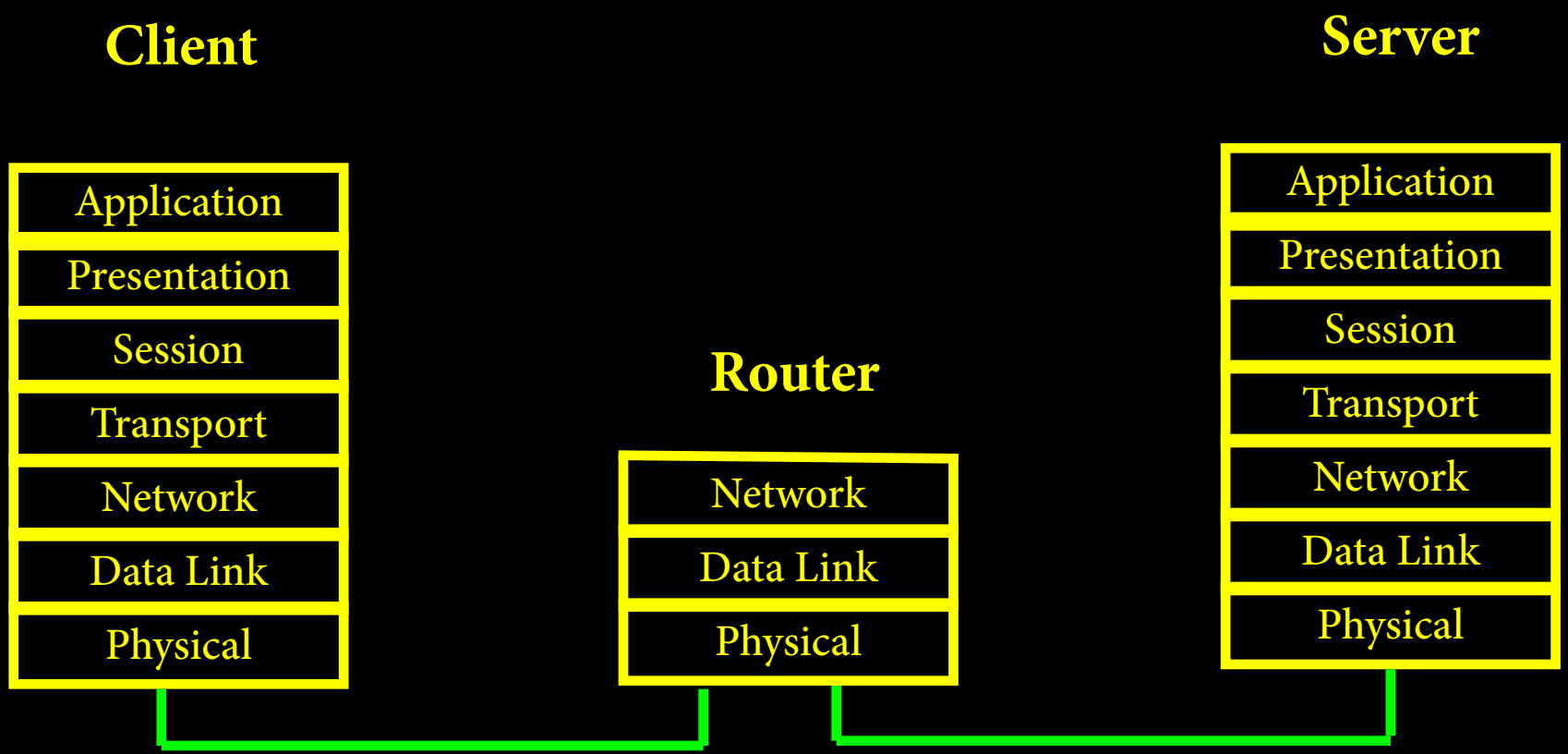


A metropolitan area network based on cable TV.



Open Systems Interconnection (OSI) Reference Model

(by the ISO)



Physical Layer 1:

Provides the path for transmission between end points. Defines the rules by which binary ones and zeros are transmitted, including the speed (bps).

Example standard: IEEE 802.2, RS232

Data Link Layer 2:

"Manages" the physical transmission of layer 1, and provides protection against transmission errors. (Detail in chapter 4).

Example standard: LLC, LAPB, LAPD, HDLC, SDLC

Network Layer 3:

Performs routing. Joins together concatenated subnetworks and links to provide a path for the end-to-end transfer of data.

Example standard: IP, ISDN, X.25, MPLS, ARP

Transport Layer 4:

Manages the end-to-end transfer of data over the path provided by the Network Layer, including:, error detection and correction, retransmission, and block sizes.

Example standard: TCP, UDP

Session Layer 5:

Manages a transmission session set-up and tear-down, accounting, and other end-system application specific coordination requirements.

Typical example: Login and logout, “Transaction” routing, “Stand-in” processing, session hits and advertising billing

Presentation Layer 6:

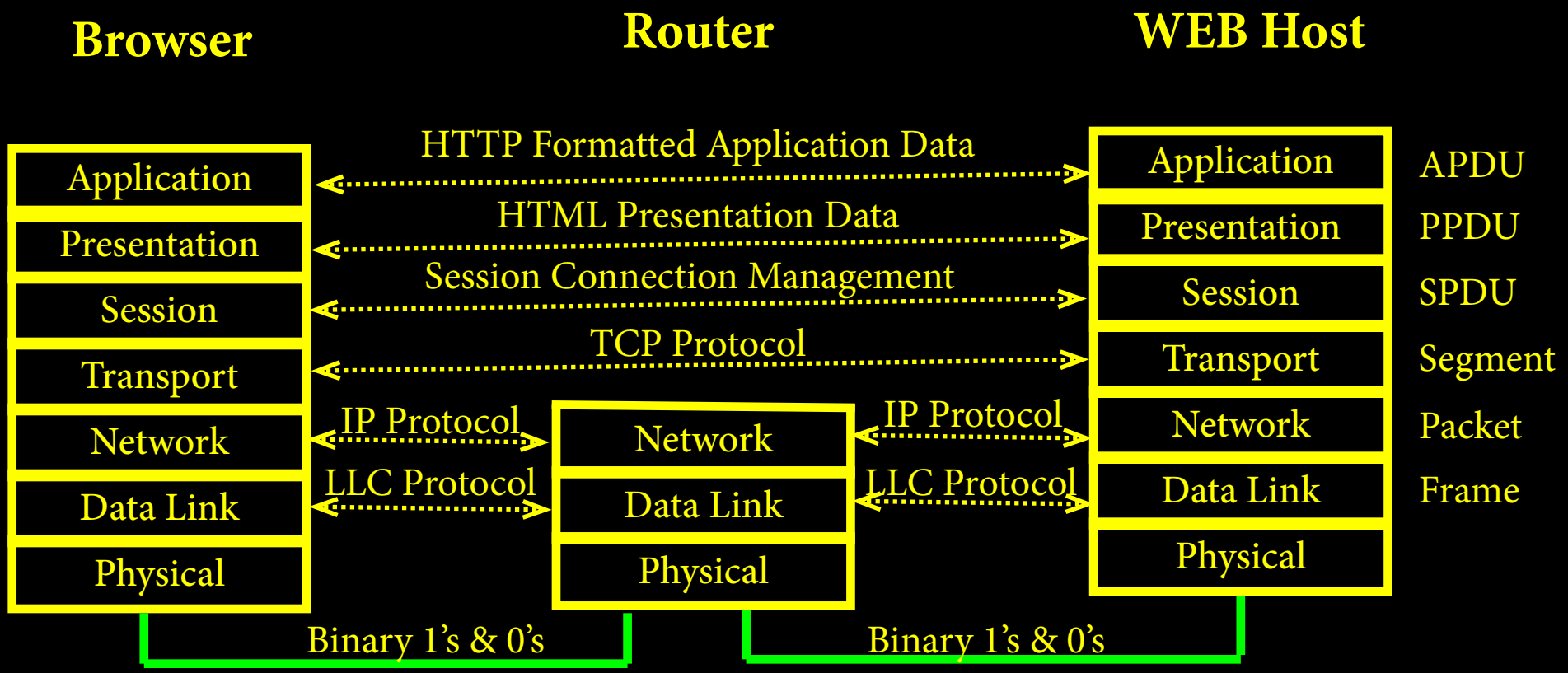
Defines Request/Response message formats and structures.
(When using TCP/IP, then correlates to a well defined service port)

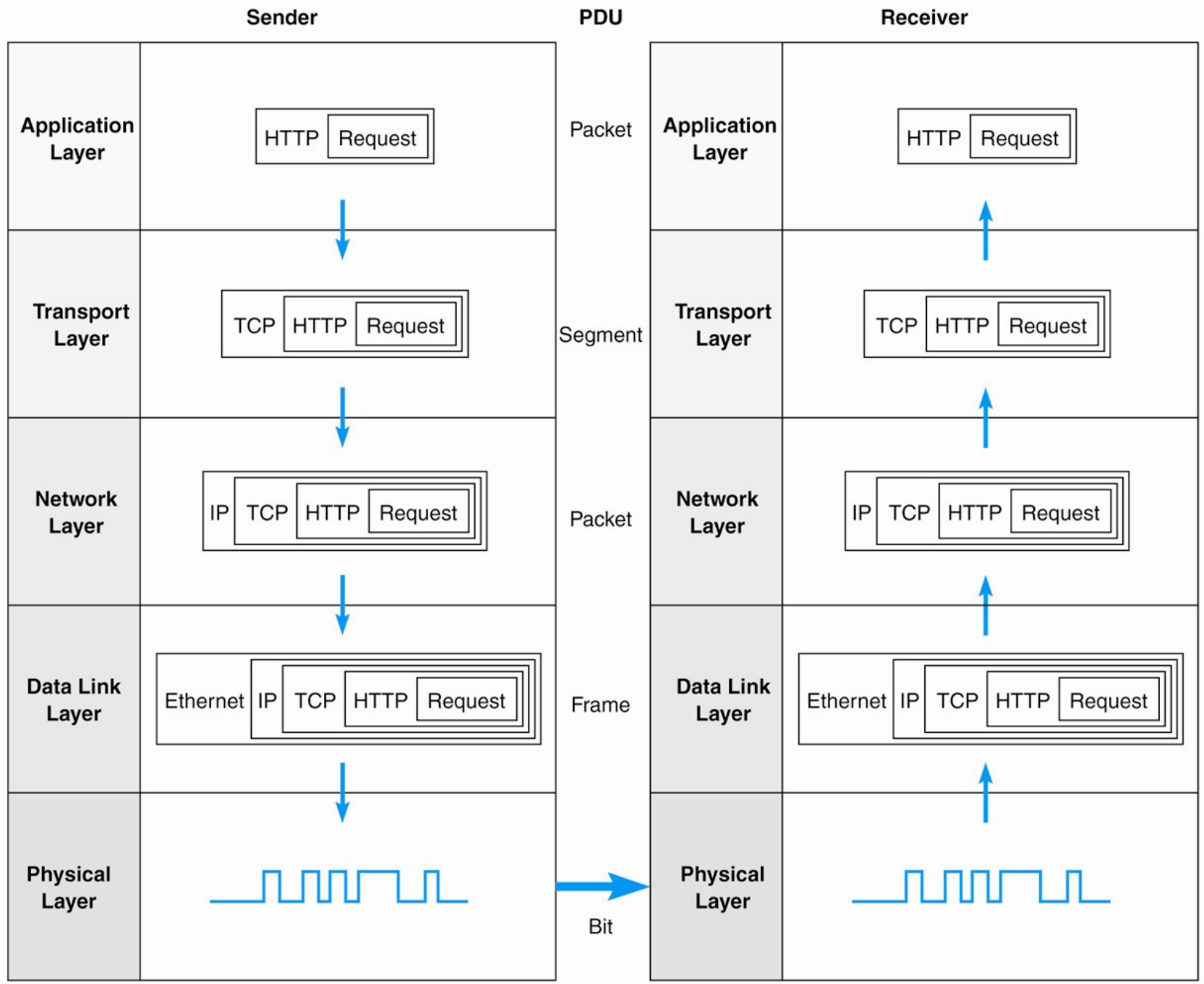
Example standard: HTML

Application Layer 7:

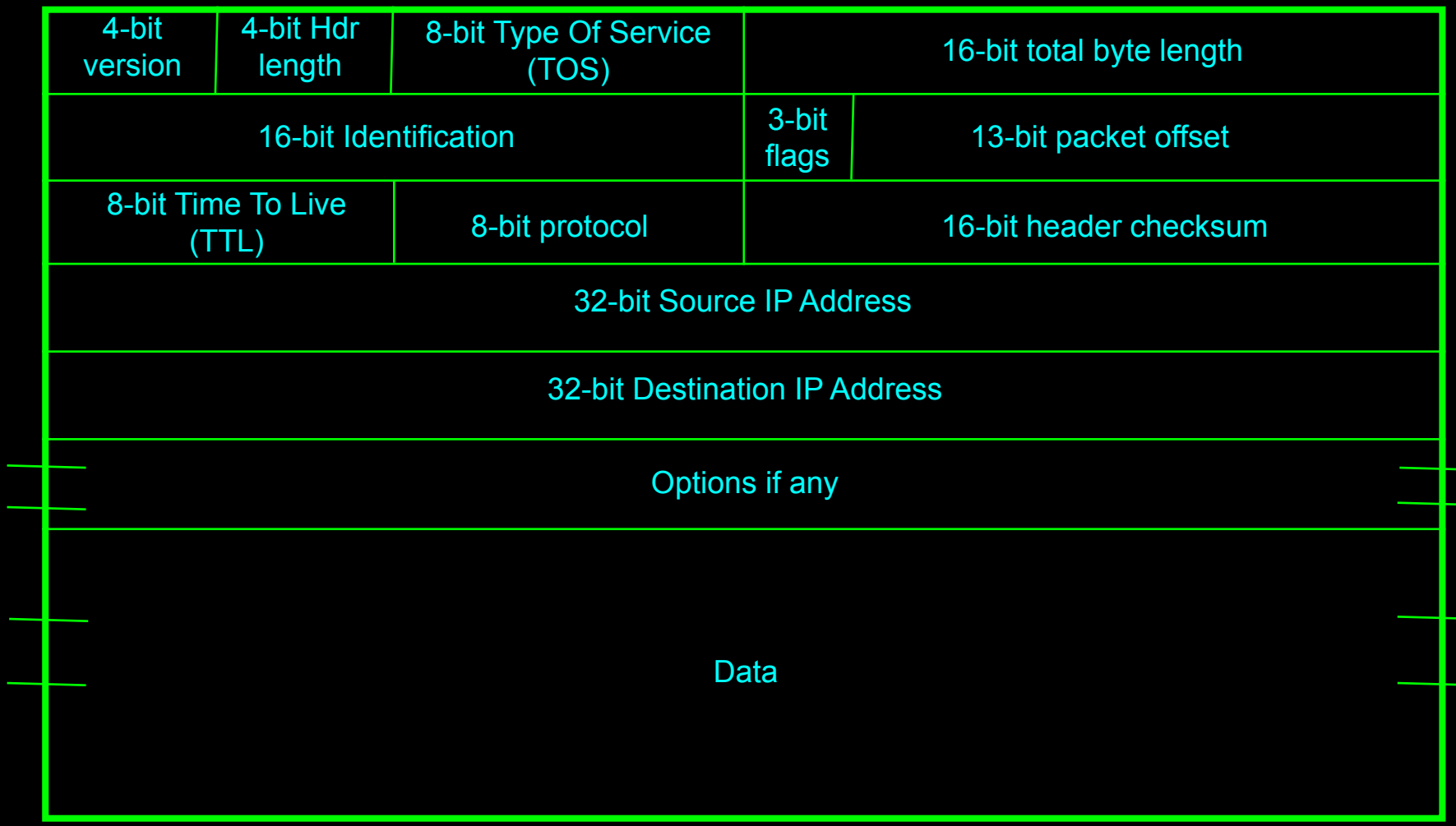
Provides services to end users.
Example standard: HTTP, DNS, POP, IMAP, SMTP, FTP, Telnet

OSI Reference Model
Typical WEB Client/Server Session

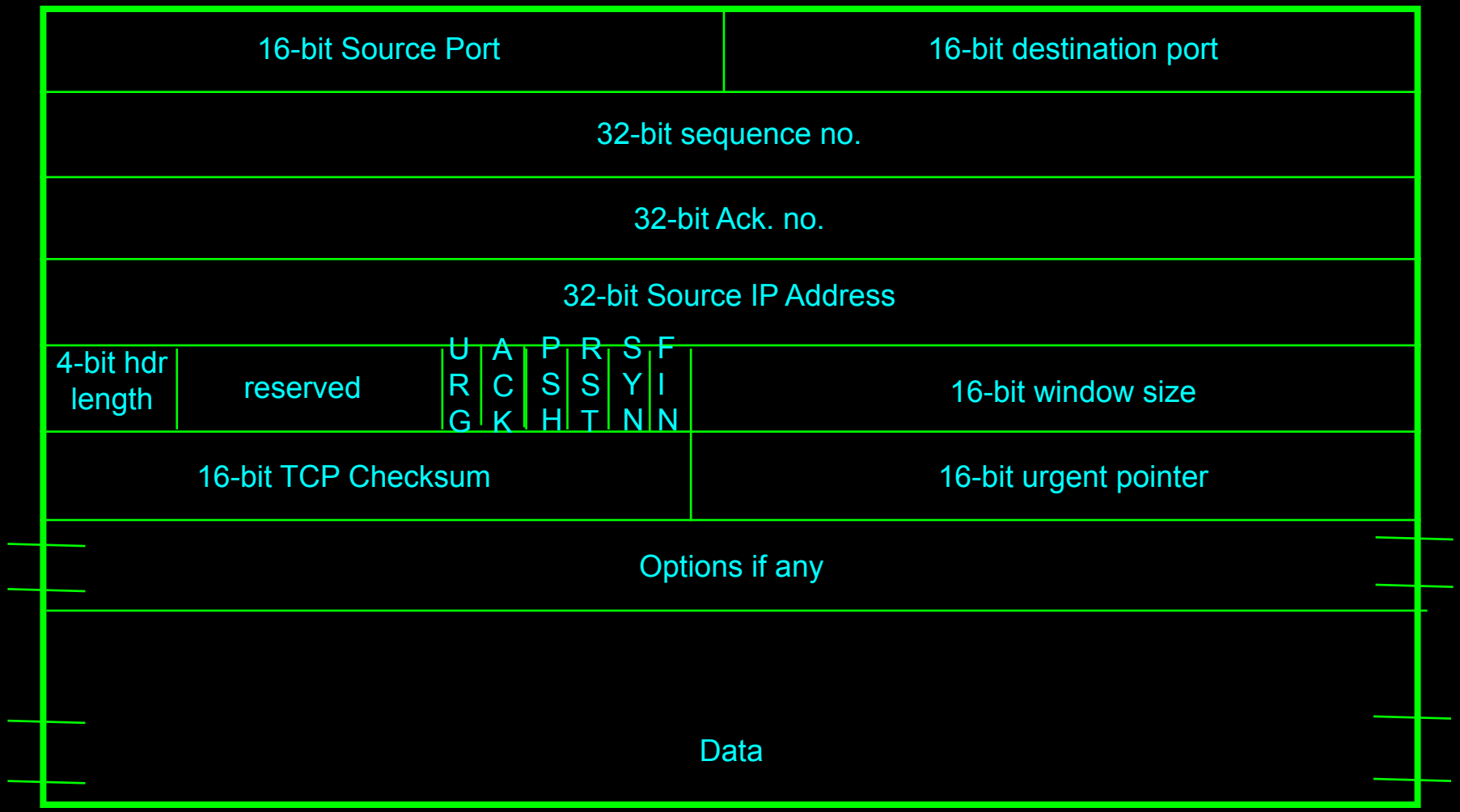



Sender
PDU
Receiver
Application Layer
Transport Layer
Network Layer
Data Link Layer
Physical Layer
HTTP Request
TCP HTTP Request
IP TCP HTTP Request
Ethernet IP TCP HTTP Request
Packet
Segment
Packet
Frame
Bit
Application Layer
Transport Layer
Network Layer
Data Link Layer
Physical Layer
HTTP Request
TCP HTTP Request
IP TCP HTTP Request
Ethernet IP TCP HTTP Request

The IP Protocol



The TCP Segment Header



Standards Bodies

International Organization for Standardization (ISO....
why ISO and not IOS?)

International Telecommunications Union - Telecommunications Group (ITU-T)

American National Standards Institute (ANSI)

Institute of Electrical and Electronics Engineers (IEEE)

Standards Bodies
(continued)

International Electrotechnical Commission (IEC)

Inernational Telegraph and Telephone Consultative Commitee (CCITT)

Eurpean Computer Manufactures' Association (ECMA)

Electronic Industries Association (EIA)

Standards Bodies
(Internet Specific)

Internet Engineering Task Force (IETF)

www.ietf.org

Internet Corporation for Assigned Names and Numbers (ICANN)

www.icann.org

Internet Assigned Numbers Authority (IANA)

www.iana.org

The IEEE 802 Working Group

802.1	Overview and architecture of LANS
802.2	Logical Link Control
802.3	Ethernet
802.4	Token bus (briefly used in manufacturing plants)
802.5	Token ring (IBM's entry into the LAN world)
802.6	Dual queue dual bus (early metropolitan area network)
802.7	Technical advisory group on broadcast technologies
802.8	Technical advisory group on fiber optic technologies
802.9	Isochronous LANs (for real time applications)
802.10	Virtual Local Area Networks (VLANs) and security
802.11	Wireless LANs (Wi-Fi)
802.12	Demand priority (Hewlett-Packard's AnyLAN)
802.13	Unlucky number, nobody wanted it
802.14	Cable modems (now defunct)
802.15	Personal area networks (Bluetooth, Zigbee)
802.16	Broadband wireless (WiMAX)
802.17	Resilient packt ring
802.18	Technical advisory group on radio regulatory issues
802.19	Technical advisory group on coexistence of all these standards
802.20	Mobil broadband wireless (similar to 802.16e)
802.21	Media independent handoff (for roaming across technologies)
802.22	Wireless regional area network

Standards Bodies
(continued)

"The nice thing about standards is that there are so many of them to choose from." (Andrew S. Tanenbaum)

"Open" and "Closed" Systems

"At its most basic, the Reference Model is an architecture for the development of standards. The purpose of the architecture and the standards is to enable processing systems to communicate easily with others. This is the distinction between '*open*' and '*closed*' systems that do not need to communicate outside their own community of similar types of systems."

Open Systems Interconnection Computer Communications Standards, Gary Dickson and Alan Llyod, page 8. Printice Hall.

Why The OSI Reference Model ???

Why The OSI Reference Model ???

"At its most basic, the Reference Model is an architecture for the development of standards."

Why Standards ???

Why Standards ???

"Ensure that hardware and software produced by different vendors will work together." (FitzGerald and Dennis)

References

W. Richard Stevens, “TCP/IP Illustrated, Volume 1 The Protocols”. Addison Wesley

Gary Dickson and Alan Llyod, “Open Systems Interconnection Computer Communications Standards”. Printice Hall

Future Trends

Pervasive Networking: Anything-to-anything, anywhere

Bit speeds expected to reach and exceed 25 terabits per second! In other words, 25 trillion bits per second. Some research centers advocating one petabit per second (1 quadrillion bits per second, also called a femto-second)

Integration of Voice, Video, Data, and ???

“Application” Service Providers

Metric Units

Exp.	Explicit	Prefix	Exp.	Explicit	Prefix
10^{-3}	0.001	milli	10^{3}	1,000	Kilo
10^{-6}	0.000001	micro	10^{6}	1,000,000	Mega
10^{-9}	0.000000001	nano	10^{9}	1,000,000,000	Giga
10^{-12}	0.000000000001	pico	10^{12}	1,000,000,000,000	Tera
10^{-15}	0.000000000000001	femto	10^{15}	1,000,000,000,000,000	Peta
10^{-18}	0.000000000000000001	atto	10^{18}	1,000,000,000,000,000,000	Exa
10^{-21}	0.000000000000000000001	zepto	10^{21}	1,000,000,000,000,000,000,000	Zetta
10^{-24}	0.000000000000000000000001	yocto	10^{24}	1,000,000,000,000,000,000,000,000	Yotta