

The TCP/IP Model

Why Another Model?

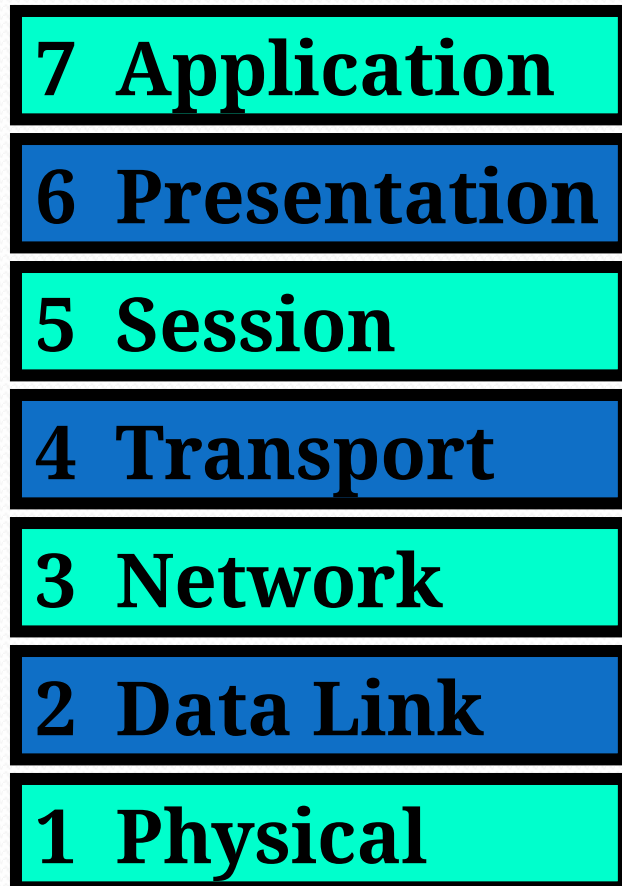
Although the OSI reference model is universally recognized, the historical and technical open standard of the Internet is Transmission Control Protocol / Internet Protocol (TCP/IP).

The TCP/IP reference model and the TCP/IP protocol stack make data communication possible between any two computers, anywhere in the world, at nearly the speed of light.

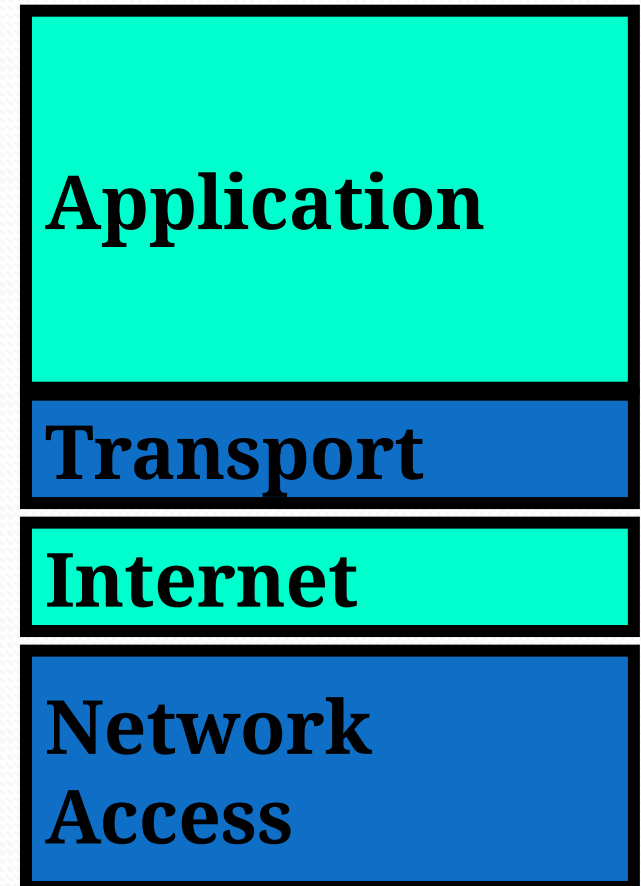
The U.S. Department of Defense (DoD) created the TCP/IP reference model because it wanted a network that could survive any conditions, even a nuclear war.

Don't Confuse the Models

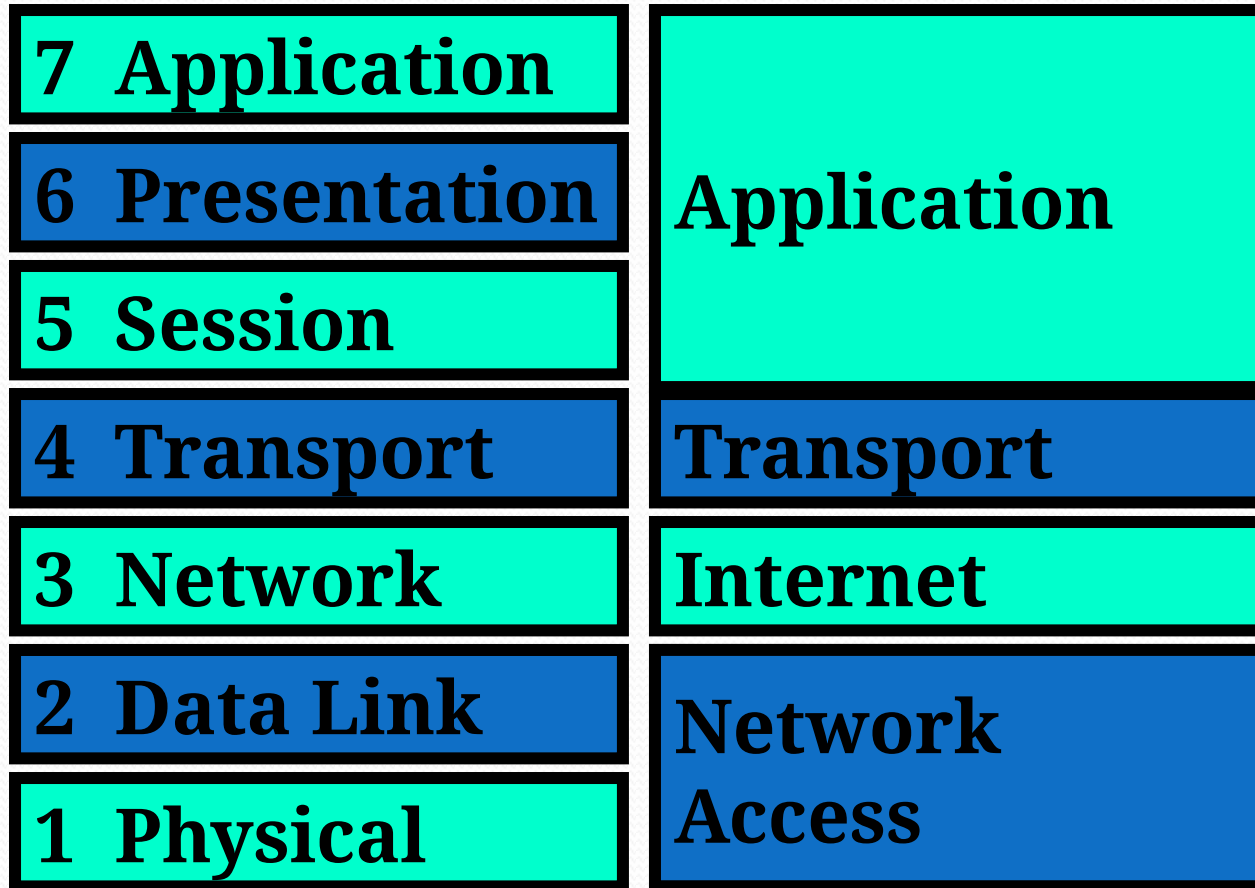
OSI Model



TCP/IP Model

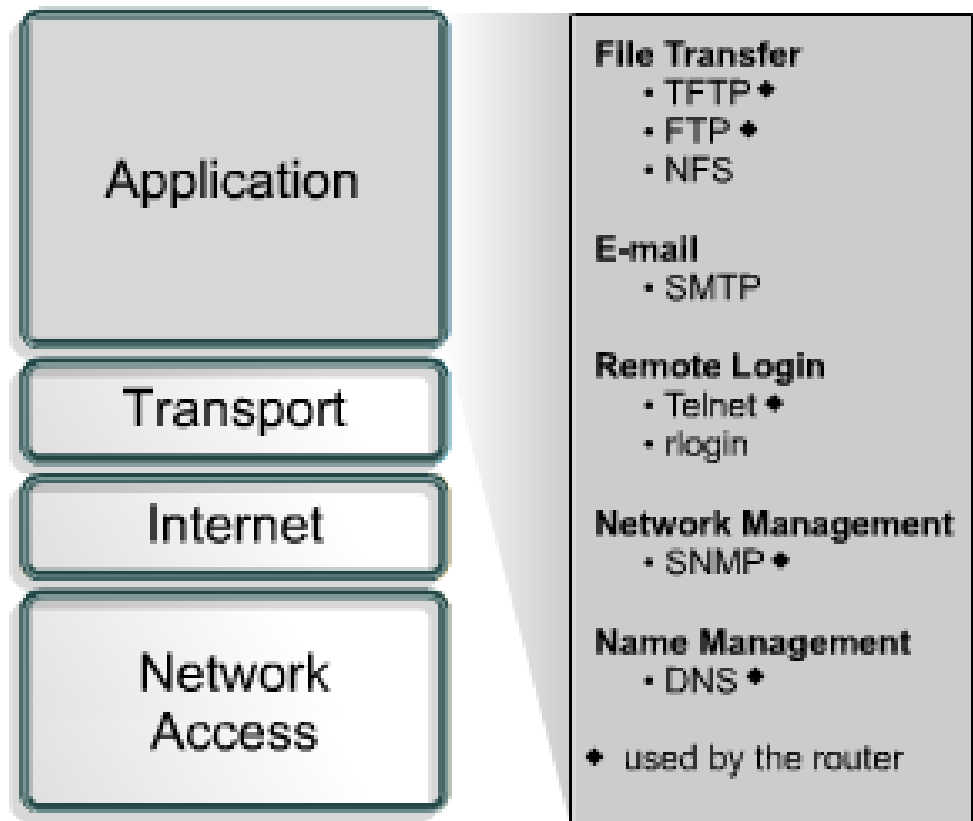


2 Models Side-By-Side

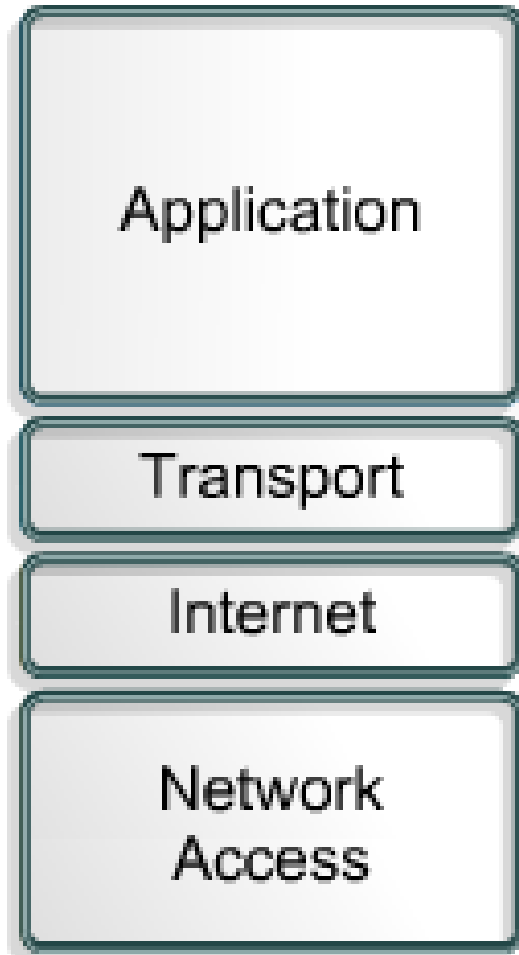


The Application Layer

The application layer of the TCP/IP model handles high-level protocols, issues of representation, encoding, and dialog control.



The Transport Layer



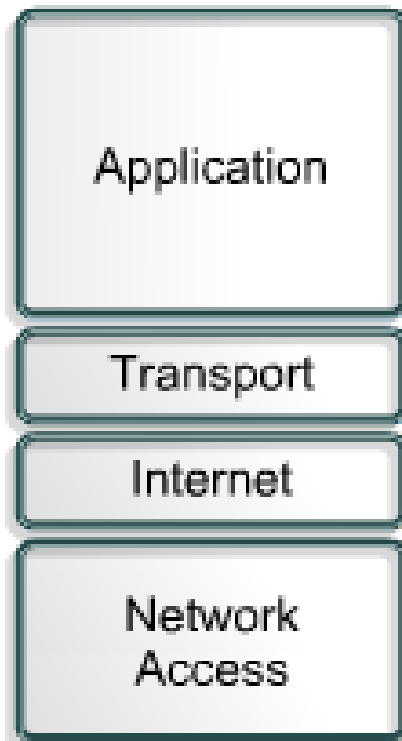
Transmission Control Protocol (TCP)
Connection-Oriented
User Datagram Protocol (UDP)
Connectionless

The transport layer provides transport services from the source host to the destination host. It constitutes a logical connection between these endpoints of the network. Transport protocols segment and reassemble upper-layer applications into the same data stream between endpoints.

The transport layer data stream provides end-to-end transport services.

The Internet Layer

The purpose of the Internet layer is to select the best path through the network for packets to travel. The main protocol that functions at this layer is the Internet Protocol (IP). Best path determination and packet switching occur at this layer.



Internet Protocol (IP)
Internet Control Message Protocol (ICMP)
Address Resolution Protocol (ARP)
Reverse Address Resolution Protocol (RARP)

The Network Access Layer

The network access layer is also called the host-to-network layer. It is the layer that is concerned with all of the issues that an IP packet requires to actually make a physical link to the network media. It includes LAN and WAN details, and all the details contained in the OSI physical and data-link layers. NOTE: ARP & RARP work at both the Internet and Network Access Layers.

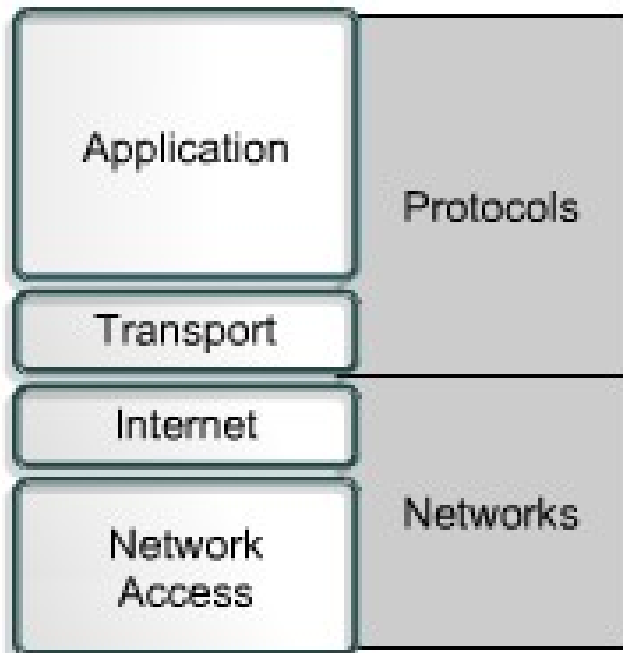


- Ethernet
- Fast Ethernet
- SLIP & PPP
- FDDI
- ATM, Frame Relay & SMDS
- ARP
- Proxy ARP
- RARP

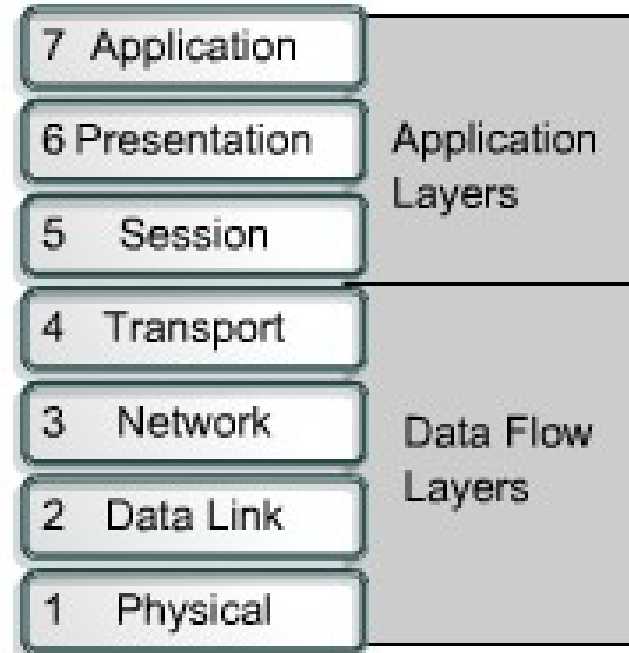
Comparing TCP/IP & OSI Models

NOTE: TCP/IP transport layer using UDP does not always guarantee reliable delivery of packets as the transport layer in the OSI model does.

TCP/IP Model



OSI Model



Introduction to the Transport Layer

The primary duties of the transport layer, Layer 4 of the OSI model, are to transport and regulate the flow of information from the source to the destination, reliably and accurately.

End-to-end control and reliability are provided by sliding windows, sequencing numbers, and acknowledgments.

Reliable transport can accomplish the following:

- Ensure that segments delivered will be acknowledged to the sender
- Provide for retransmission of any segments that are not acknowledged
- Put segments back into their correct sequence at the destination
- Provide congestion avoidance and control

More on The Transport Layer

The transport layer provides transport services from the source host to the destination host.

It establishes a logical connection between the endpoints of the network.

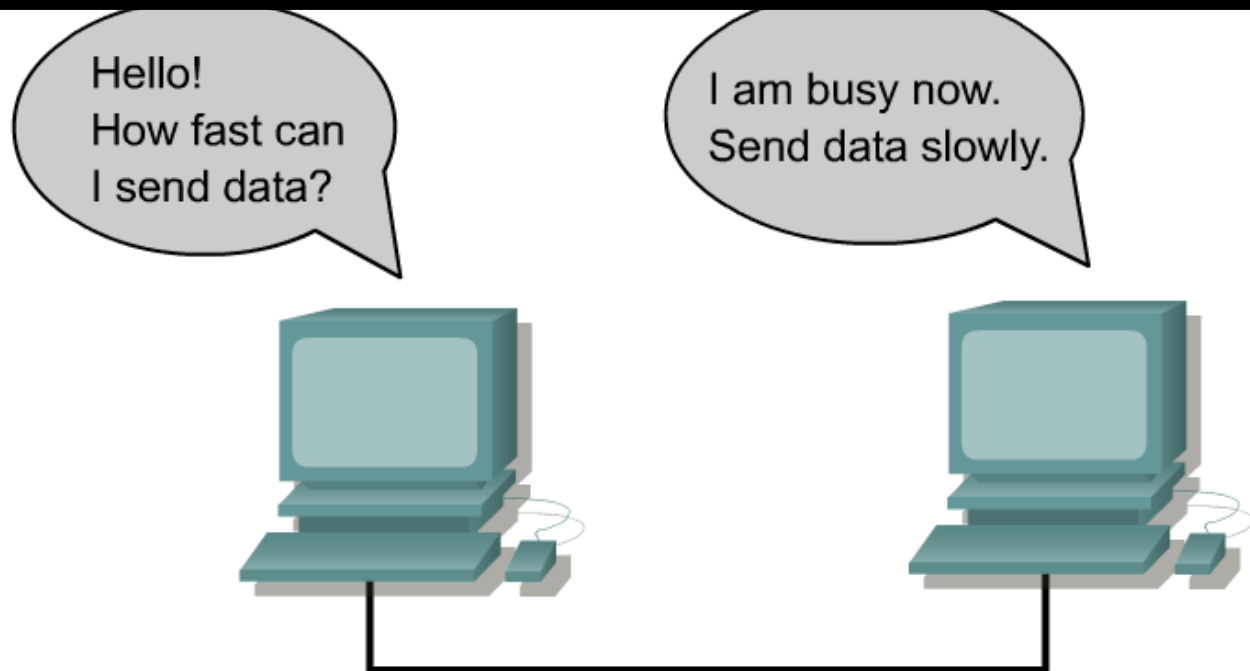
- Transport services include the following basic services:
 - Segmentation of upper-layer application data
 - Establishment of end-to-end operations
 - Transport of segments from one end host to another end host
 - Flow control provided by sliding windows
 - Reliability provided by sequence numbers and

Flow Control

As the transport layer sends data segments, it tries to ensure that data is not lost.

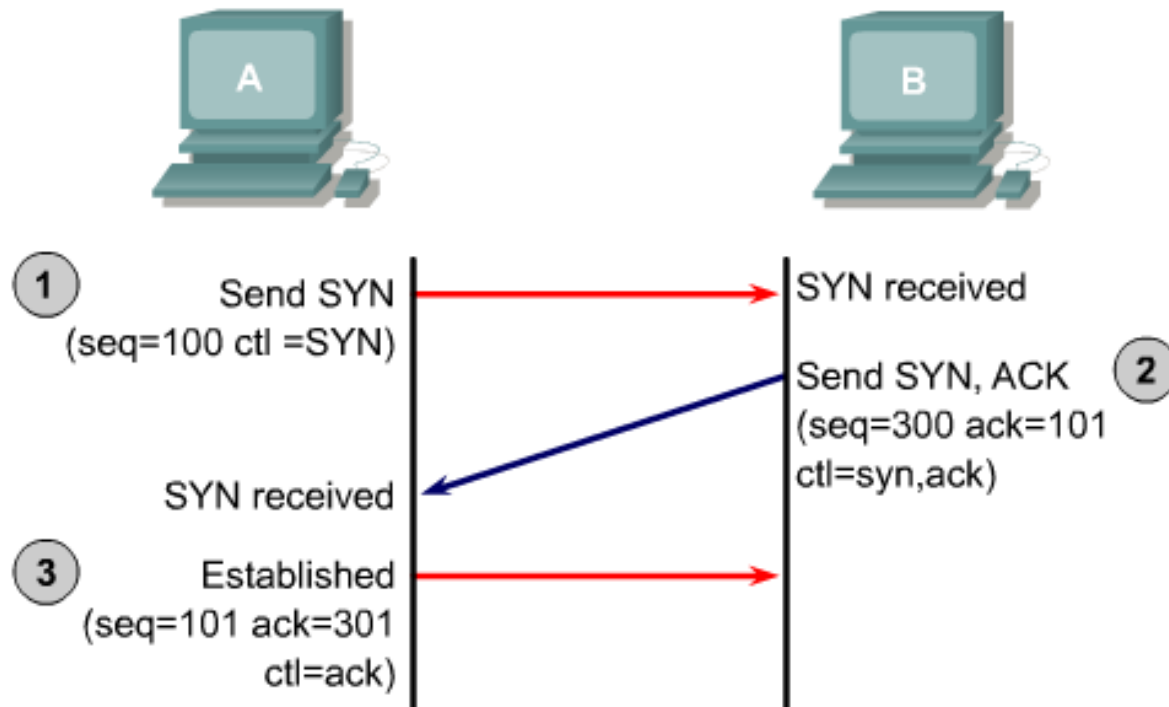
A receiving host that is unable to process data as quickly as it arrives could be a cause of data loss.

Flow control avoids the problem of a transmitting host overflowing the buffers in the receiving host.



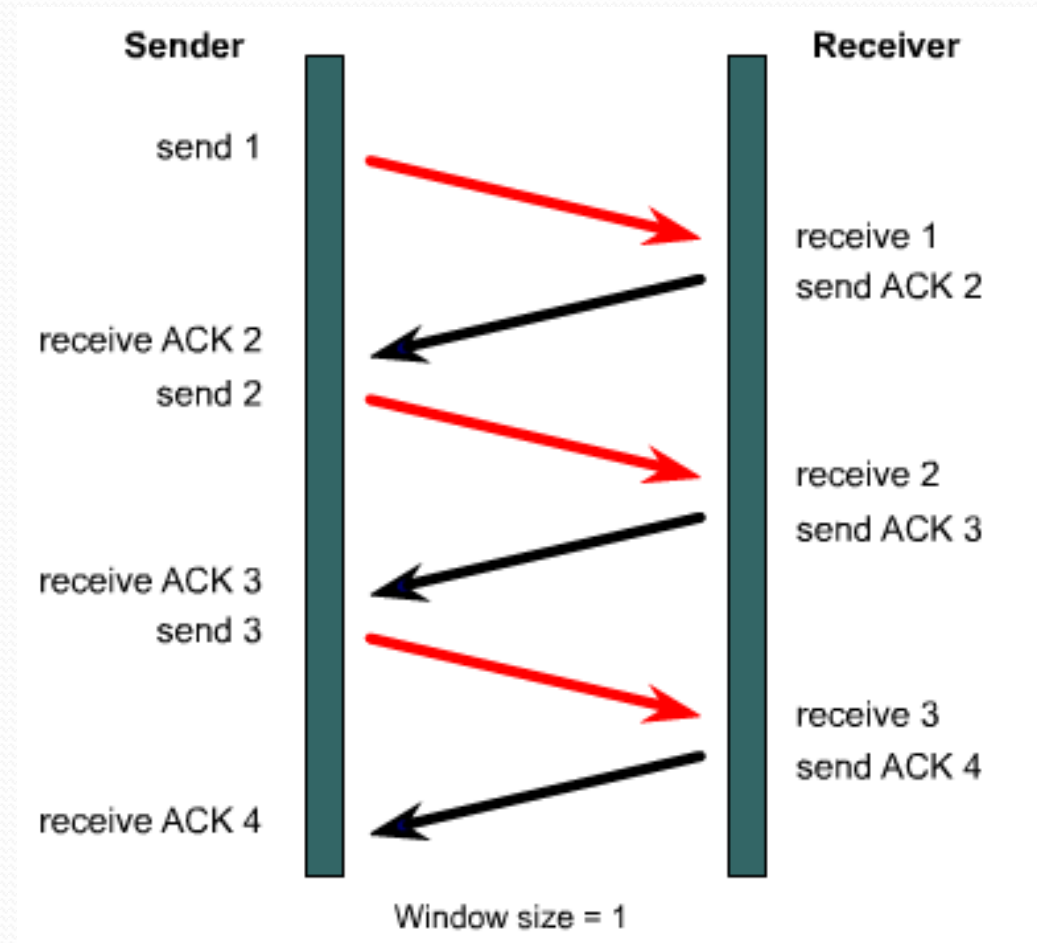
3-Way Handshake

TCP requires connection establishment before data transfer begins.
For a connection to be established or initialized, the two hosts must synchronize their Initial Sequence Numbers (ISNs).

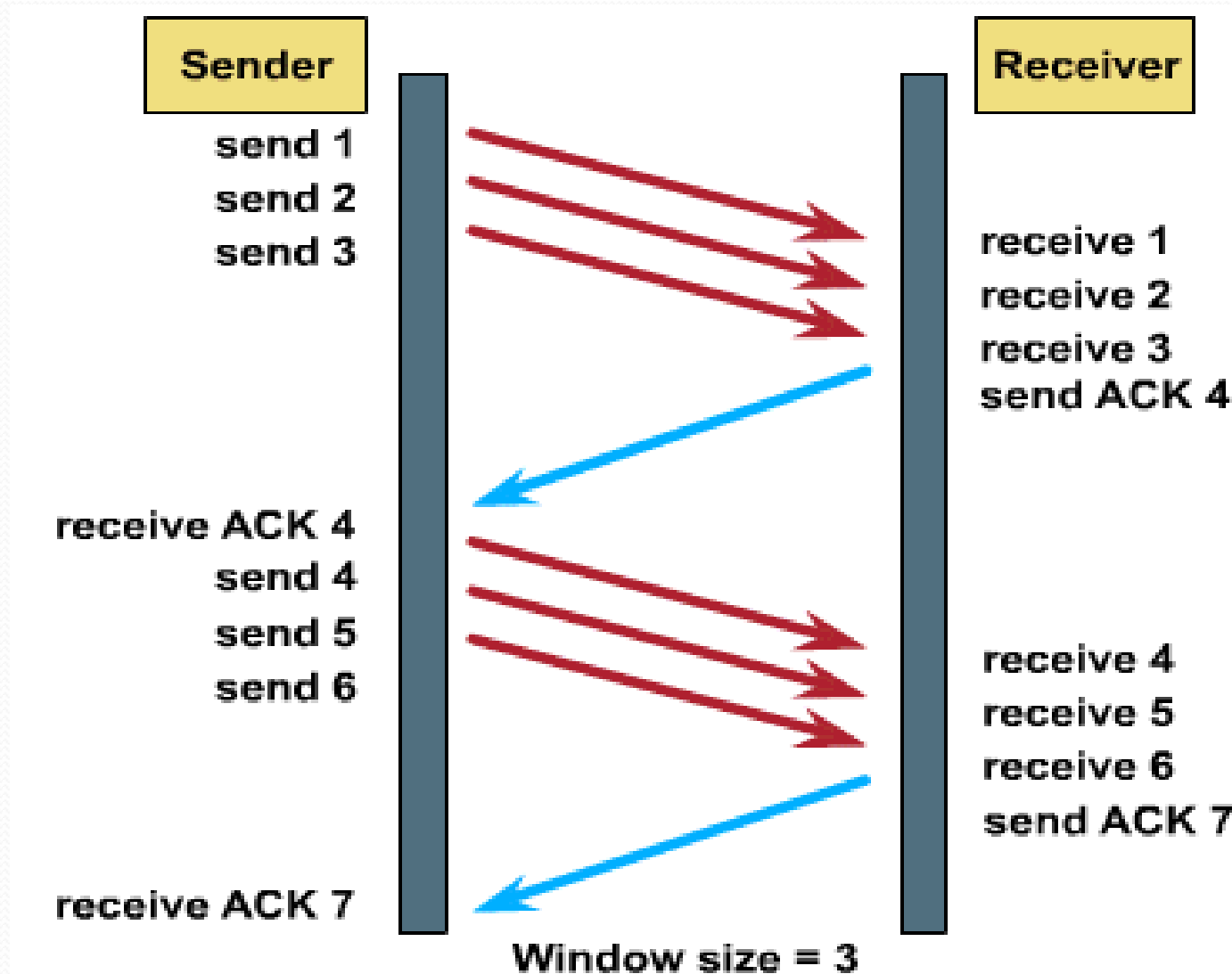


Basic Windowing

Data packets must be delivered to the recipient in the same order in which they were transmitted to have a reliable, connection-oriented data transfer. The protocol fails if any data packets are lost, damaged, duplicated, or received in a different order. An easy solution is to have a recipient acknowledge the receipt of each packet before the next packet is sent.



Sliding Window



Sliding Window with Different Window Sizes

Sender Host

Receiving Host

send 1
send 2
send 3

receive 1
receive 2
~~receive 3~~
ACK 3 window size 2

send 3
send 4
send 5

receive 3
receive 4
~~receive 5~~
ACK 5 window size 2

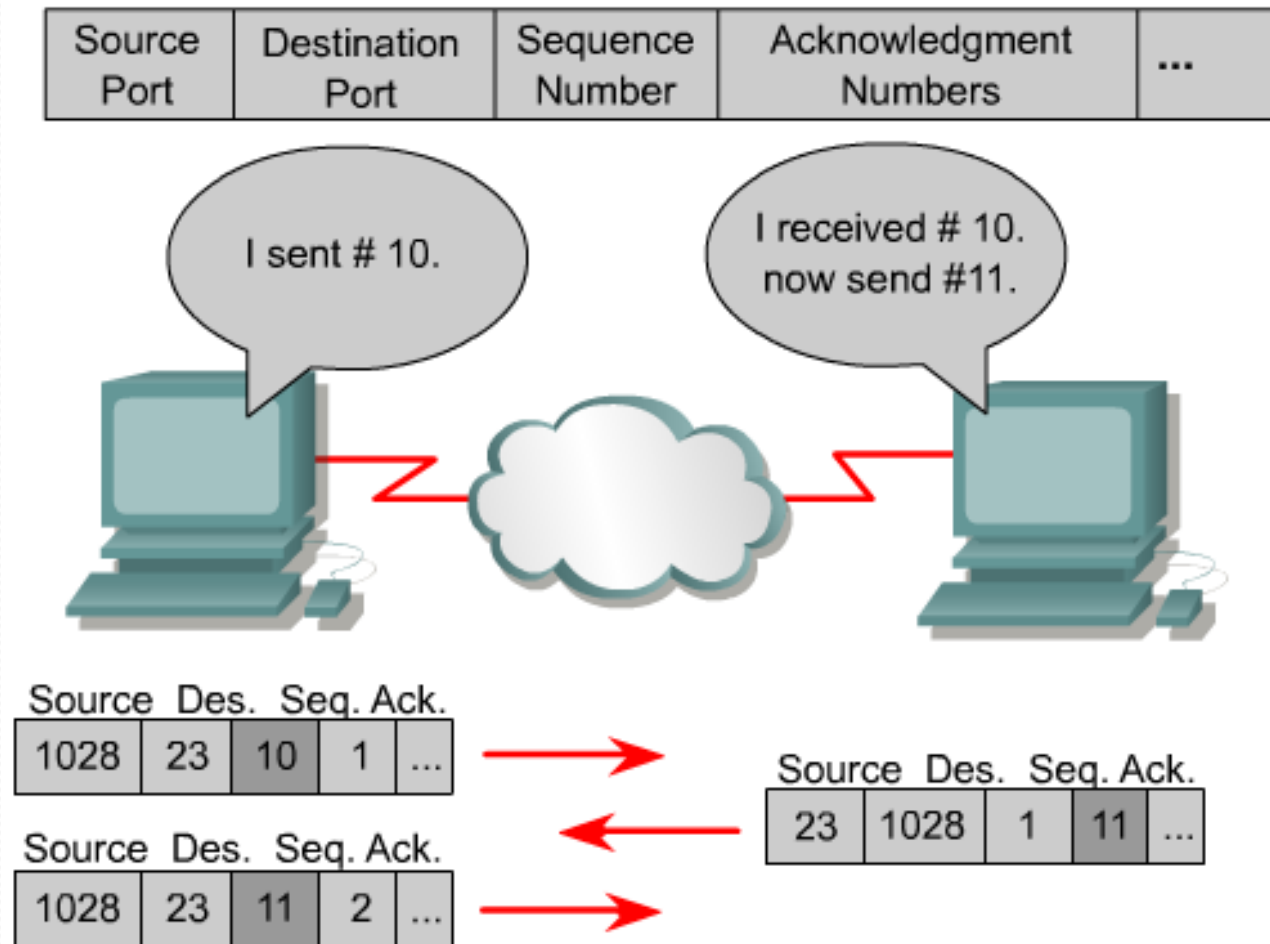
send 5
send 6

receive 3
receive 4
ACK 7 window size 2

Window Size 3

Window Size 2

TCP Sequence & Acknowledgement



TCP

Transmission Control Protocol (TCP) is a connection-oriented Layer 4 protocol that provides reliable full-duplex data transmission.

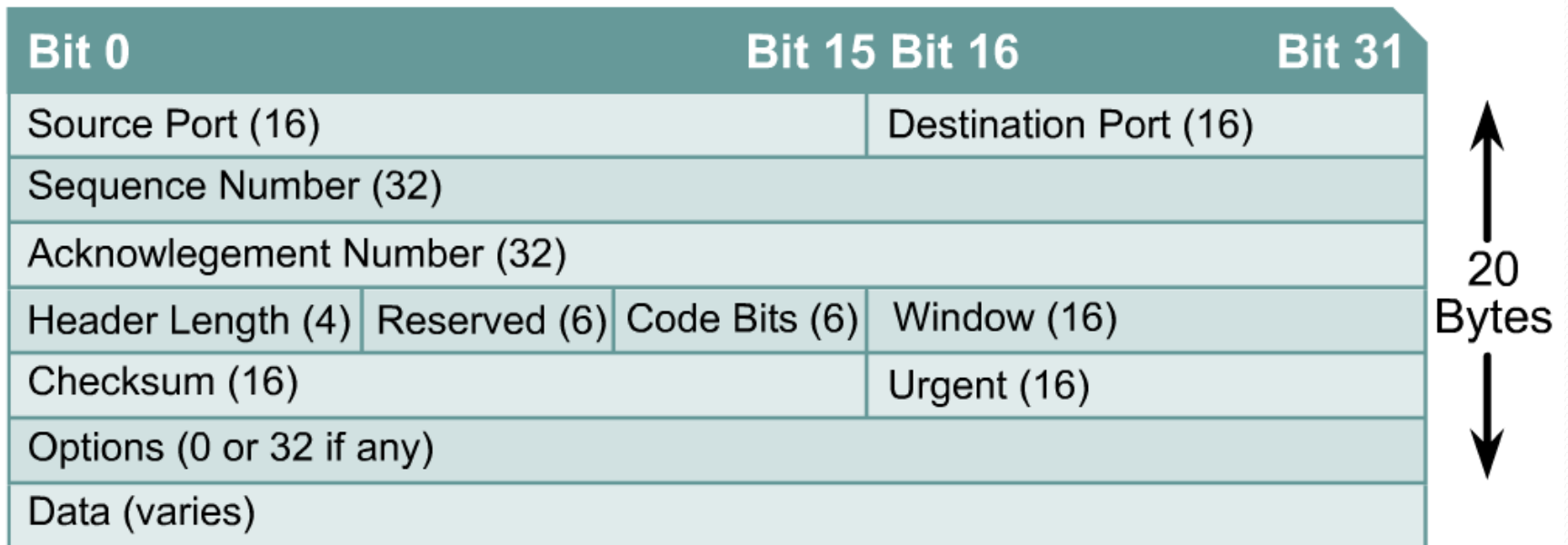
TCP is part of the TCP/IP protocol stack. In a connection-oriented environment, a connection is established between both ends before the transfer of information can begin.

TCP is responsible for breaking messages into segments, reassembling them at the destination station, resending anything that is not received, and reassembling messages from the segments. TCP supplies a virtual circuit between end-user applications.

The protocols that use TCP include:

- FTP (File Transfer Protocol)
- HTTP (Hypertext Transfer Protocol)
- SMTP (Simple Mail Transfer Protocol)
- Telnet

TCP Segment Format



UDP

User Datagram Protocol (UDP) is the connectionless transport protocol in the TCP/IP protocol stack.

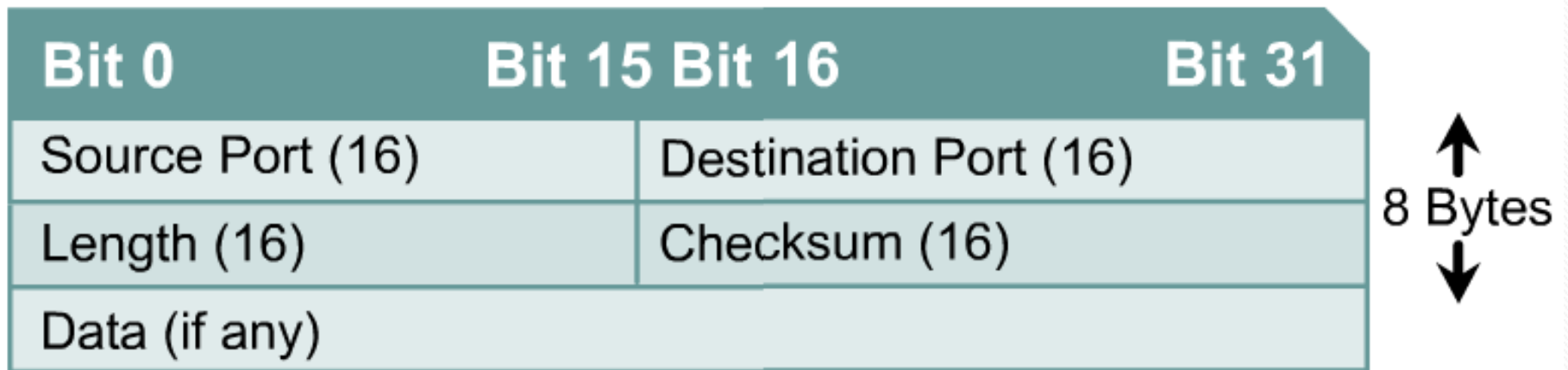
UDP is a simple protocol that exchanges datagrams, without acknowledgments or guaranteed delivery. Error processing and retransmission must be handled by higher layer protocols.

UDP uses no windowing or acknowledgments so reliability, if needed, is provided by application layer protocols. UDP is designed for applications that do not need to put sequences of segments together.

The protocols that use UDP include:

- TFTP (Trivial File Transfer Protocol)
- SNMP (Simple Network Management Protocol)
- DHCP (Dynamic Host Control Protocol)
- DNS (Domain Name System)

UDP Segment Format



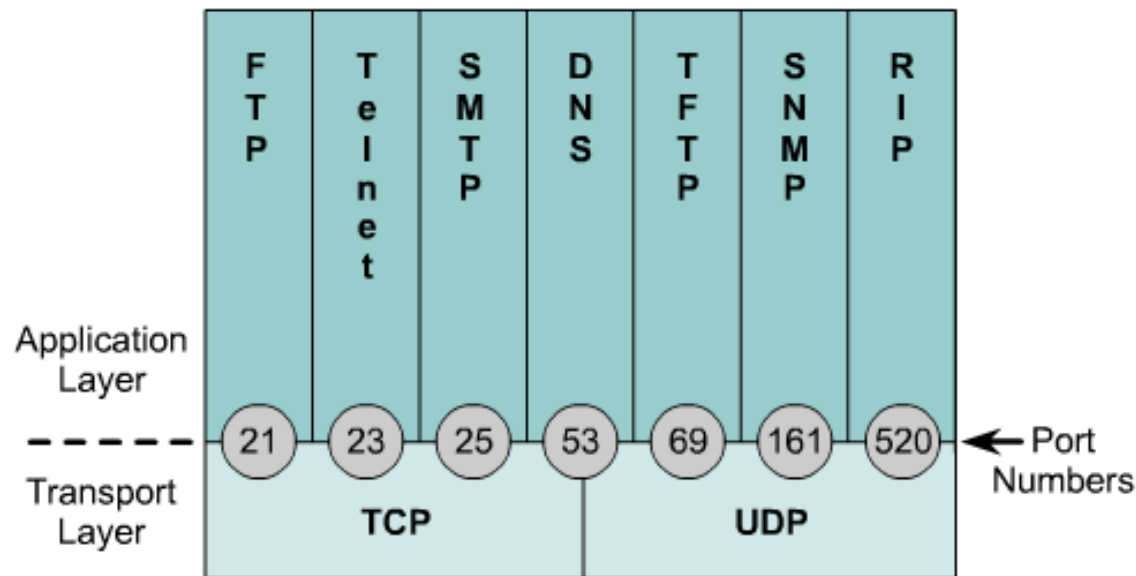
No sequence or acknowledgement fields

Well Known Port Numbers

The following port numbers should be memorized:

NOTE:

The curriculum forgot to mention one of the most important port numbers. **Port 80** is used for **HTTP** or **WWW** protocols. (Essentially access to the internet.)

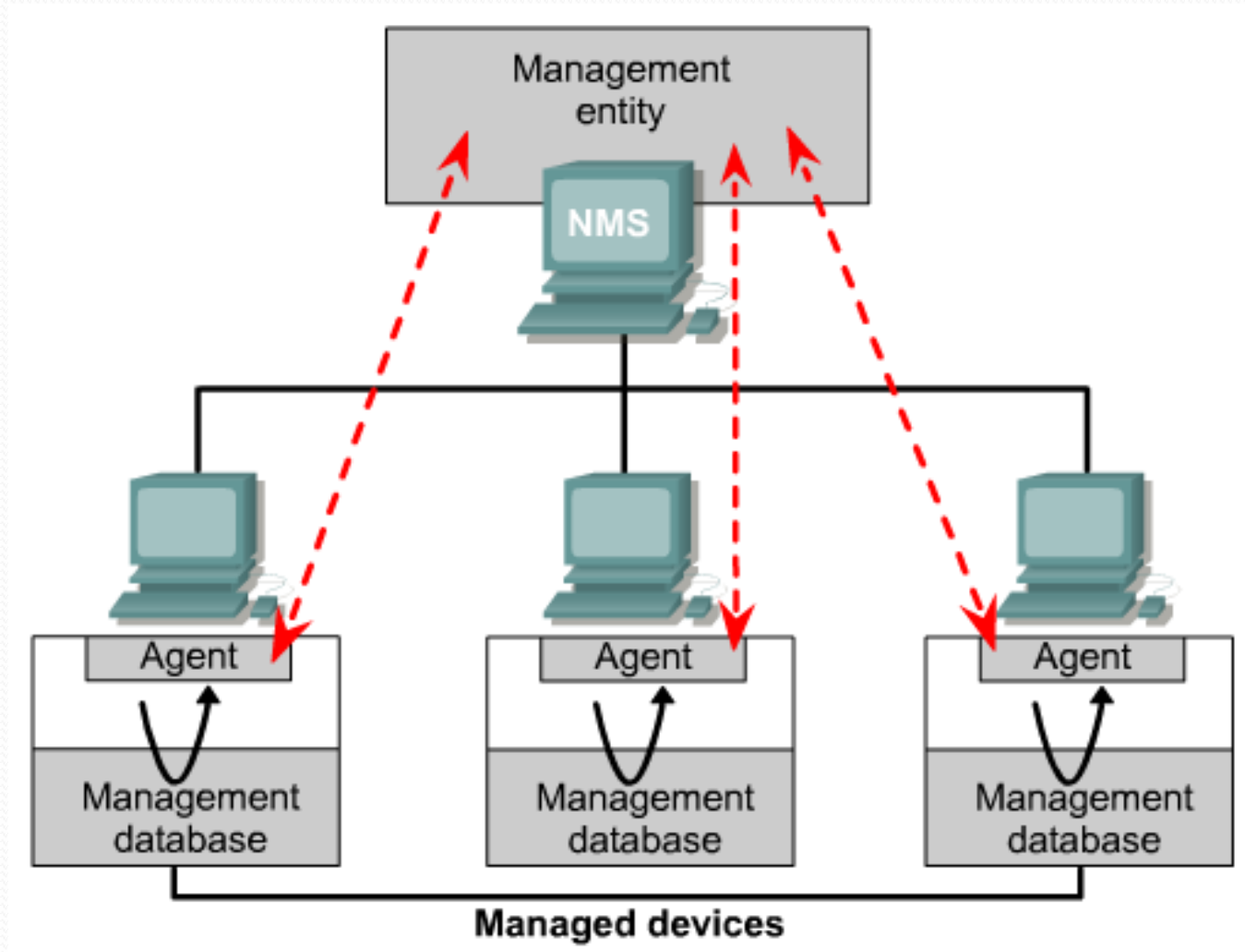


URL

http://	www.	cisco.com	/edu/
Identifies to the browser what protocol should be used.	Identifies the hostname or name of a specific machine	Represents the domain entity of the web site.	Identifies the folder where the web page is located on the server. Also since no name is specified, the browser will load the default page identified by the server

Identified here are the parts of a standard URL (Uniform Resource Locator) address.

SNMP – Managed Network



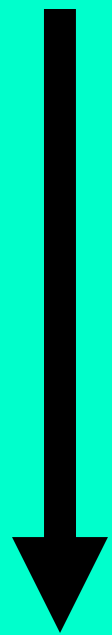
Base 2 Number System

$$10110_2 = (1 \times 2^4 = 16) + (0 \times 2^3 = 0) + (1 \times 2^2 = 4) + (1 \times 2^1 = 2) + (0 \times 2^0 = 0) = 22$$

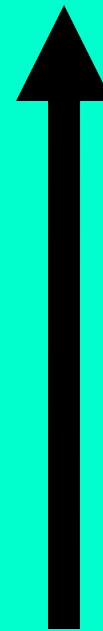
Place Value	<u>128</u>	<u>64</u>	<u>32</u>	<u>16</u>	<u>8</u>	<u>4</u>	<u>2</u>	<u>1</u>
Base ^{Exponent}	$2^7 = 128$		$2^3 = 8$					
	$2^6 = 64$		$2^2 = 4$					
	$2^5 = 32$		$2^1 = 2$					
	$2^4 = 16$		$2^0 = 1$					
Number of Symbols	2							
Symbols	0, 1							
Rationale	Two-state (discrete binary) voltage systems made from transistors can be diverse, powerful, inexpensive, tiny and relatively immune to noise.							

Converting Decimal to Binary

Convert 201_{10} to binary:



201	/	2	=	100	remainder	1
100	/	2	=	50	remainder	0
50	/	2	=	25	remainder	0
25	/	2	=	12	remainder	1
12	/	2	=	6	remainder	0
6	/	2	=	3	remainder	0
3	/	2	=	1	remainder	1
1	/	2	=	0	remainder	1



When the quotient is 0, take all the remainders in reverse order for your answer: $201_{10} =$

11001001_2