
Networks, Security, and Privacy

158.235

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A/Prof Julian Jang-Jaccard
Massey University
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(Today covers chapter 1 in the textbook)

Housekeeping

- Textbook

- J. FitzGerald and A. Dennis, "*Business Data Communications & Networking*", 12th edition. Wiley, 2012.



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- Delivery

- One Lecture (2-hour) per week, wk1 – wk12 (12 weeks)
 - One lab (1-hour) per week, wk2 – 11 (10 weeks)
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Housekeeping

- **Assessments**

- Internal Assessments (40%)
 - May have 2-3 assignments throughout the semester
- Final exam (60%)

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- **Software**

- Wireshark (<https://www.wireshark.org>) :
 - network traffic capture & analysis
- Packet tracer (<https://www.netacad.com/about-networking-academy/packet-tracer/>)
 - Network simulation

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Introduction

Our goal:

- ❖ get “feel” and terminology
- ❖ more depth, detail *later* in course
- ❖ approach:
 - use Internet as example

overview:

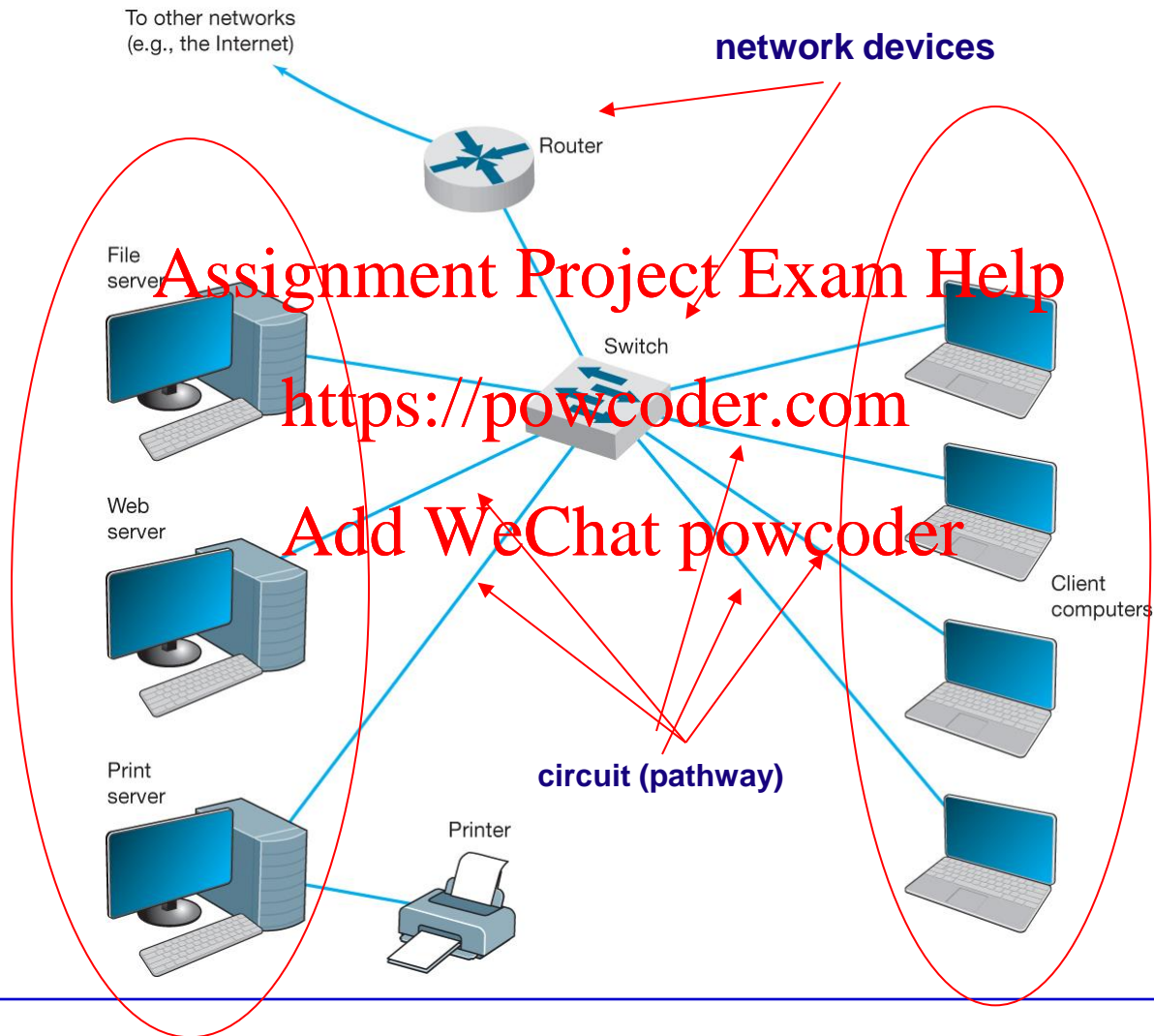
- ❖ Network components
- ❖ types of network
- ❖ protocol layers
 - ISO 7 layer
 - Internet 5 layer
- ❖ what's a protocol?
- ❖ network standards

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Components of a Network



Network Types (based on Scale)



Network Types (based on Scale)

- **Local Area Networks (LAN)** - room, building
 - a group of PCs that share a circuit (~100Mbps)
 - **Backbone Networks (BN)** - less than few kms
 - a high speed backbone linking together organizational LANs at various locations. (~100-1000 Mbps)
 - **Metropolitan Area Networks (MAN)** - (more than a few kms)
 - connects LANs and BNs across different locations
 - Often uses leased lines or other services used to transmit data (expensive, high transfer rate; ISP alternative)
 - **Wide Area Networks (WANs)** - (far greater than 10 kms)
 - Same as MAN except wider scale
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Network: nuts and bolts



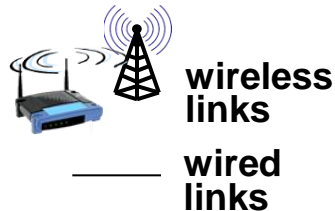
- millions of connected computing devices:

– **hosts** = **end systems**

– **running network apps**

❖ **communication links**

- fiber, copper, radio, satellite
- transmission rate: **bandwidth**



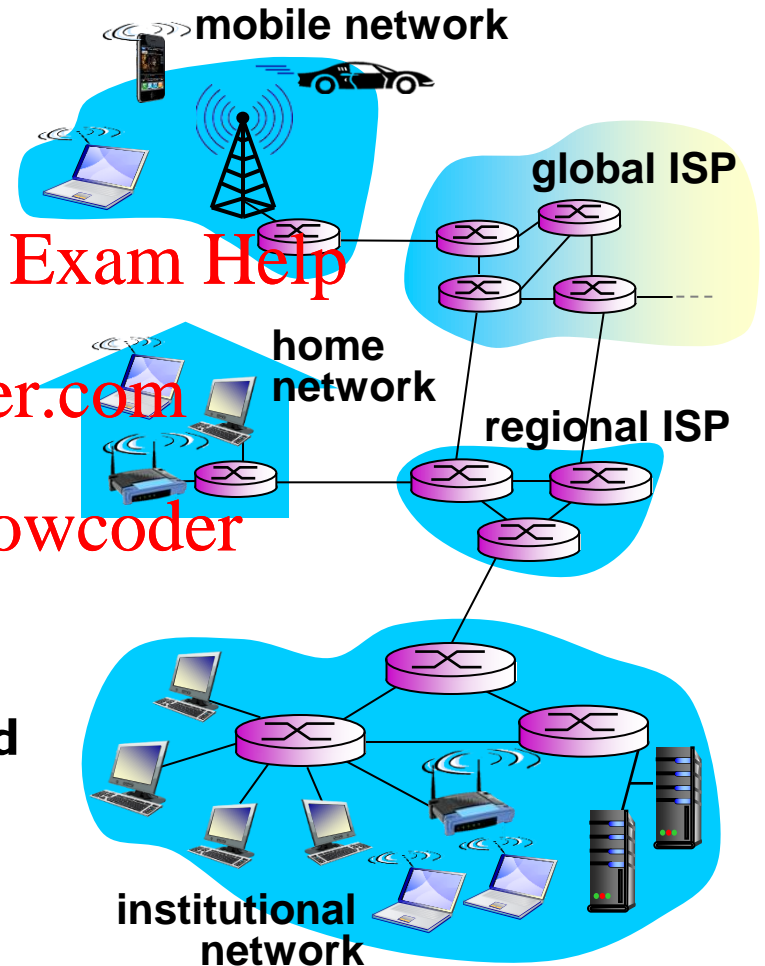
Switch



router

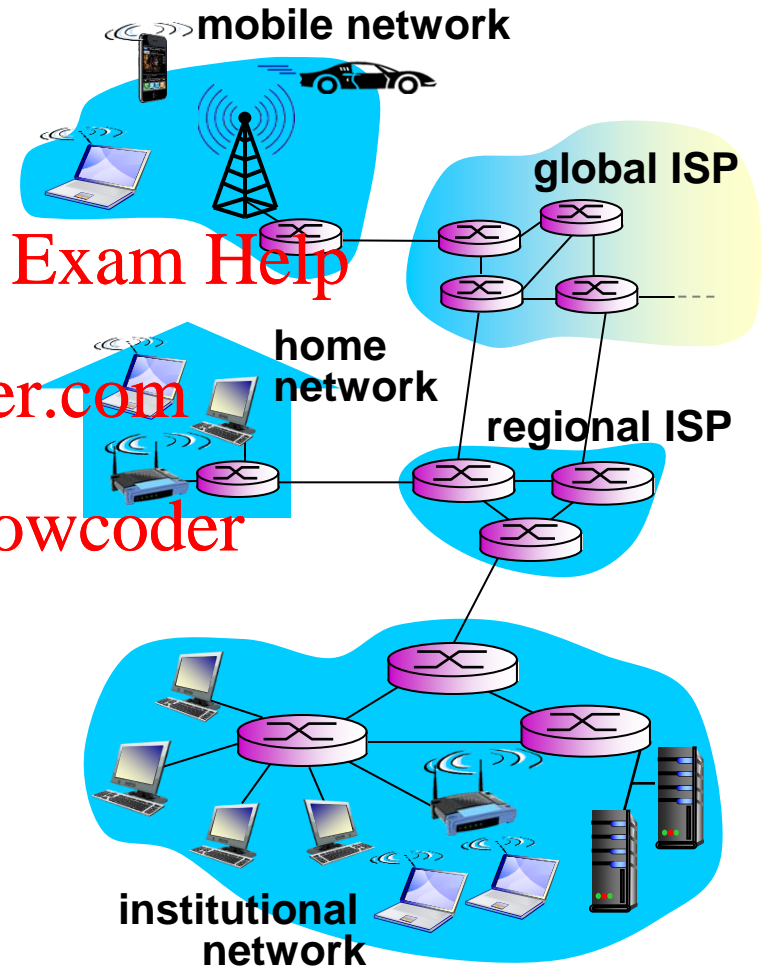
- ❖ **Network devices: forward packets (chunks of data)**

- **routers** and **switches**



Network: nuts and bolts

- **Internet: “network of networks”**
 - Interconnected ISPs
- **protocols control sending, receiving of msgs**
 - e.g., TCP, IP, HTTP, Skype, 802.11
- **Internet standards**
 - RFC: Request for comments
 - IETF: Internet Engineering Task Force



What is a protocol?

human protocols:

- “what’s the time?”
- “I have a question”
- introductions

... specific msgs sent
... specific actions
taken when msgs
received, or other
events

network protocols:

- machines rather than humans
- all communication activity in Internet governed by protocols

protocols define format, order of msgs sent and received among network entities, and actions taken on msg transmission, receipt

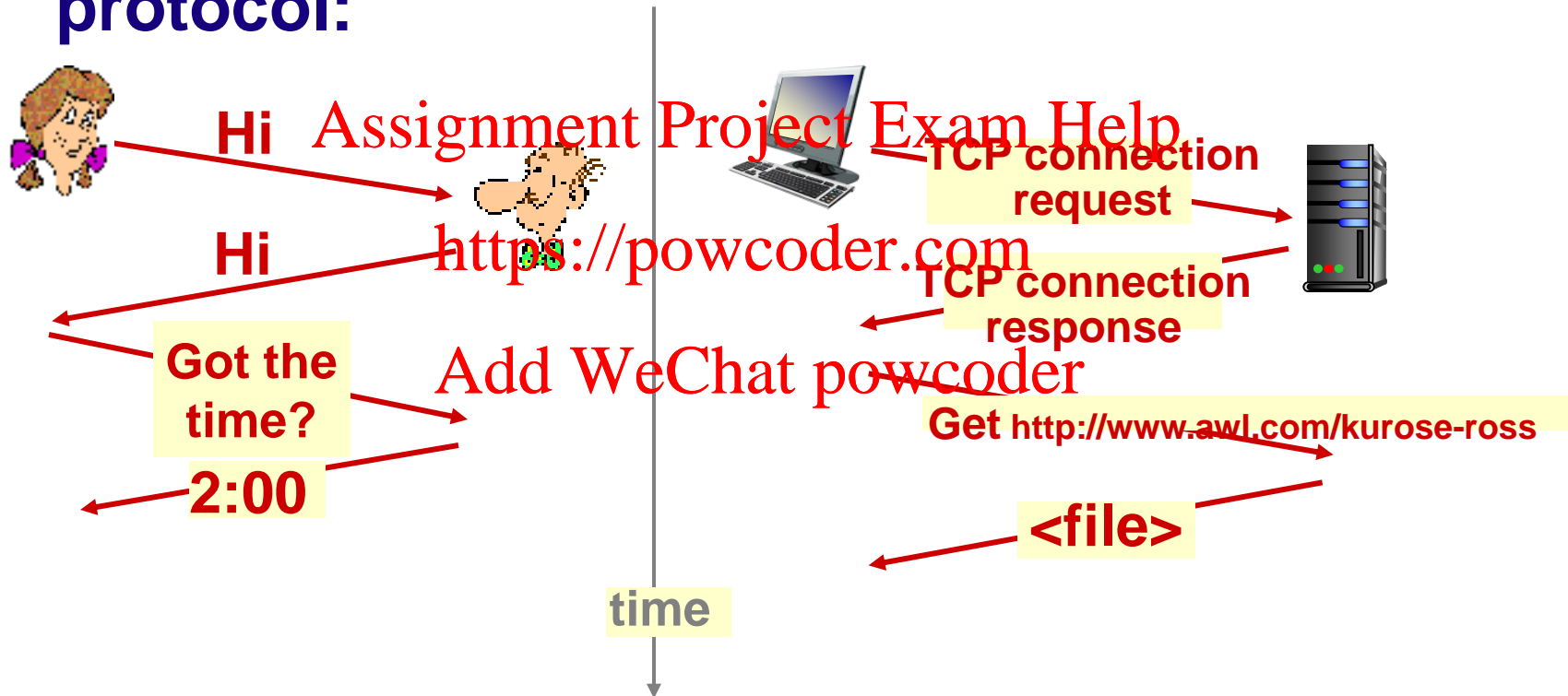
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What is a protocol?

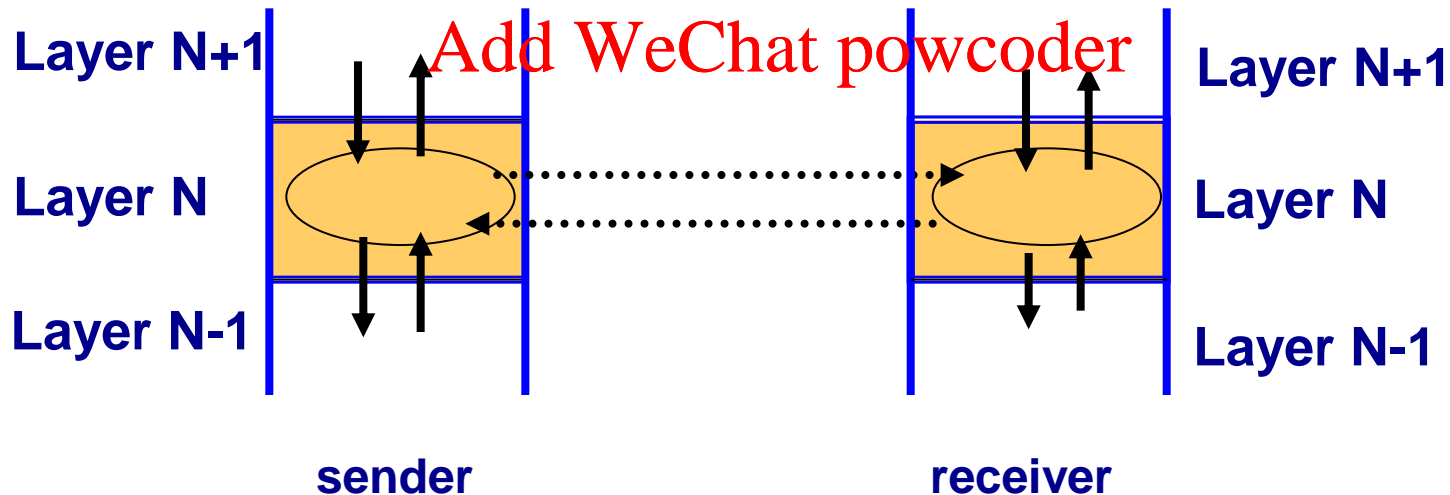
a human protocol and a computer network protocol:



Network Protocols

- Used by network model layers
- Sets of standardized rules to define **how to communicate at each layer** and **how to interface with adjacent layers**

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Protocol “layers”

*Networks are complex,
with many “pieces”:*

- hosts
- Routers/switches
- links of various media
- protocols
- applications
- hardware, software

Question:

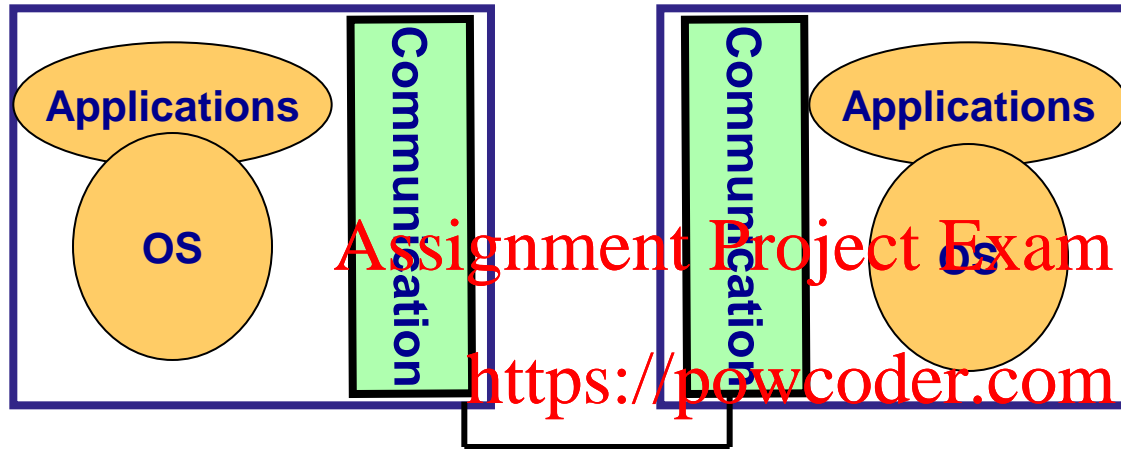
**is there any hope of
organizing structure
of network?**

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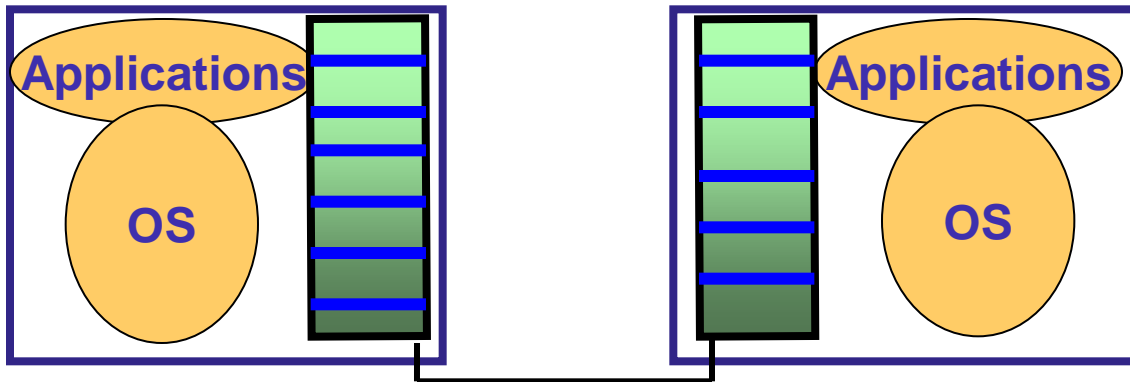
Layered Implementation



Single layer implementation

-Networking with large components is complex to understand and implement

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Multi layer implementation

-Breaking down into smaller components
-Easier to implement

Multi-layer Network Models

- The two most important such network models: OSI and Internet
- **Open Systems Interconnection Model (OSI)**
 - Created by International Standards Organization (ISO) as a framework for computer network standards in 1984
 - Based on 7 layers
- **Internet Model (also called TCP/IP model)**
 - Created by DARPA originally in early 1970's
 - Developed to solve the problem of internetworking
 - Based on 5 layers
 - Based on Transmission Control Protocol/ Internet Protocol (TCP/IP) suite

7-Layer Model of OSI

Physical	Data Link	Network	Transport	Session	Presentation	Application
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"Please Do Not Touch Steve's Pet Alligators"

- **Application Layer**
 - set of utilities used by application programs
- **Presentation Layer**
 - formats data for presentation to the user
 - provides data interfaces, data compression and translation between different data formats
- **Session Layer**
 - initiates, maintains and terminates each logical session between sender and receiver

7-Layer Model of OSI

- **Transport Layer**

- deals with end-to-end issues such as segmenting the message for network transport, and maintaining the logical connections between sender and receiver

- **Network Layer**

- responsible for making routing decisions from source to destination

- **Data Link Layer**

- Responsible for moving messages from one device to another reliably

- **Physical Layer**

- defines how individual bits are formatted to be transmitted through the network
-

Internet's 5-Layer Model



"Please Do Not Touch Alligators"

- **Application Layer –**
– Combines Application, Presentation, session layer of OSI model
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 - **Transport Layer – Same as transport layer of OSI model**
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 - **Network Layer – Same as OSI model**
 - **Data Link Layer – Same as OSI model**
 - **Physical Layer – Same as OSI model**
-

LAN, BB, WAN, and Internet



Comparison of Network Models

OSI Model	Internet Model	Groups of Layers	Examples
7. Application Layer	5. Application Layer	<i>Application Layer</i>	Internet Explorer and Web pages
6. Presentation Layer			
5. Session Layer			
4. Transport Layer	4. Transport Layer	<i>Internetwork Layer</i>	TCP/IP Software
3. Network Layer	3. Network Layer		
2. Data Link Layer	2. Data Link Layer	<i>Hardware Layer</i>	Ethernet port, Ethernet cables, and Ethernet software drivers
1. Physical Layer	1. Physical Layer		

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Network models

- **Protocol** defines the language of transmission
 - It specifies the rules, functionality, and messages for communication at the layer
 - **Protocol Data Unit (PDU)** contains layer-specific information necessary for a message to be transmitted through a network
 - Each layer adds a PDU
 - PDUs act like nested envelopes
 - Encapsulation occurs when a higher level PDU is placed inside of a lower level PDU
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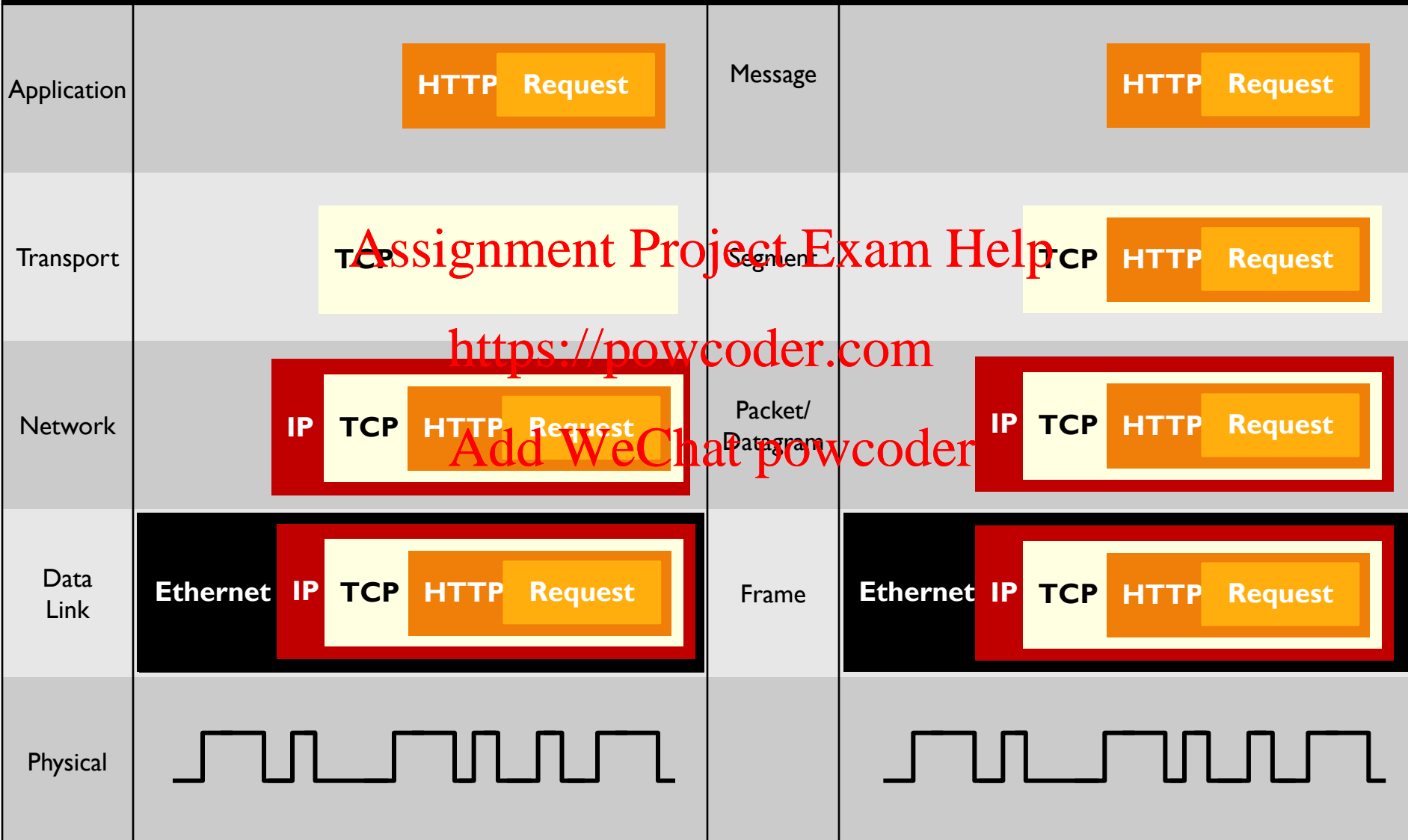
Network Models

Layer	Purpose	Example Protocols / Standards	PDU
5. Application	User's access to network, software to perform work	HTTP, SMTP, DNS, FTP, DHCP, IMAP, POP, SSL	Packet (or Data)
4. Transport	End-to-End Management 1.Link application layer to network 2.Segmenting and tracking 3.Flow control	TCP, UDP	Segment
3. Network	Deciding where the message goes 1.Addressing 2.Routing	IP, ICMP	Packet
2. Data Link	Move a message from one device to the next 1.Controls hardware 2.Formats the message 3.Error checking	Ethernet	Frame
1. Physical	Transmits the message	100BASE-T, 802.11n	

Sender

PDU

Receiver



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Points about Network Layer View

- **Layers allow simplicity of networking in some ways**
 - Easy to develop new software that fits each layer
 - Relatively simple to change the software at any level
 - **Matching layers communicate between different computers and computer platforms**
 - Accomplished by standards that we all agree on
 - e.g., Physical layer at the sending computer must match up with the same layer in the receiving computer
 - **Somewhat inefficient**
 - Involves many software packages and packets
 - Packet overhead (slower transmission, processing time)
 - Interoperability achieved at the expense of perfectly streamlined communication
-

Network Standards

- **Why?**

- Provide a “fixed” way for hardware and/or software systems (different companies) to communicate
- Help promote competition and decrease the price

- **Types of Standards**

- **Formal standards**

- Developed by an industry or government standards-making body

- **De-facto standards**

- Emerge in the marketplace and widely used
 - Lack official backing by a standards-making body
-

Major Standards Bodies

- ISO (International Organization for Standardization)
- ITU-T (International Telecommunications Union – Telecom Group)
- ANSI (American National Standards Institute)
- IEEE (Institute of Electrical and Electronic Engineers)
- IETF (Internet Engineering Task Force)

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