

EEE 432

Introduction to Data Communications

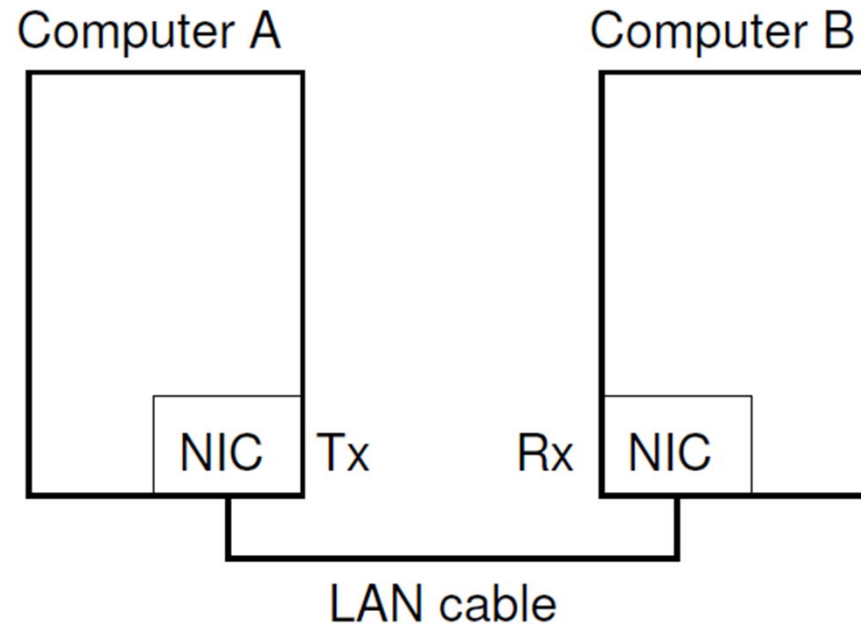
Asst. Prof. Dr. Mahmut AYKAÇ

NETWORKING AND PROTOCOL ARCHITECTURES

Course Information

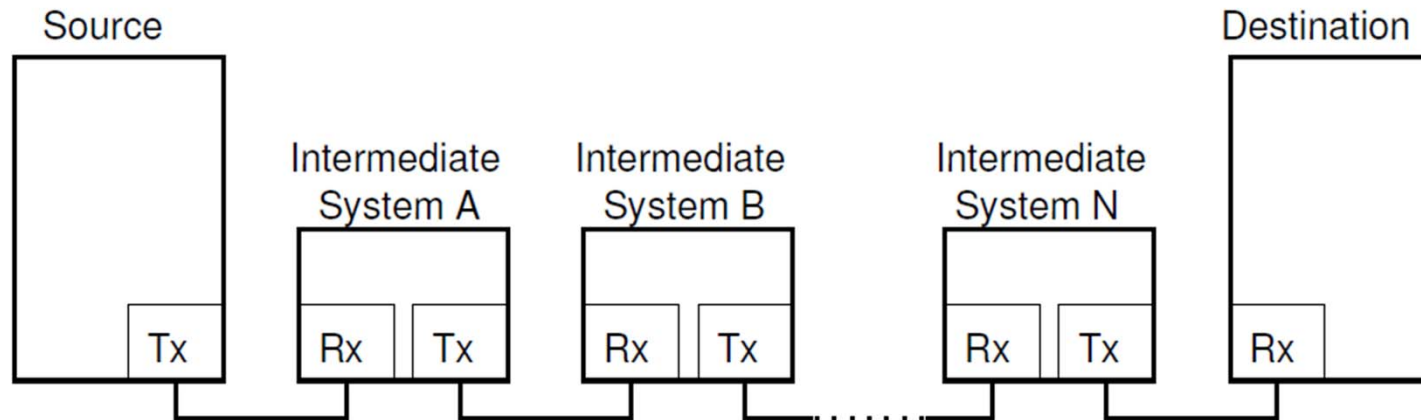
1. Data Communications and Networks
2. Data Transmission
3. Transmission Media
4. Signal Encoding Techniques
5. Digital Data Communication Techniques
6. Multiplexing
7. **Networking and Protocol Architectures**
8. Switching
9. Routing in Switched Networks
10. LANs and WANs
11. Ethernet
12. The Internet

Layering and Protocol Architectures: Data Communications Across a Link



- Converting data (e.g. bits) into signals to be sent across the link (**Physical Layer**)
- Ensuring link is ready for data transmission, reliable/efficient transmission of data (**Data Link Layer**)

Data Communications Across a Network



- Data traverses multiple links; each link may have its own Physical and Data Link layer protocols
- How do intermediate systems receive/send data? How to select which intermediate systems to send via? (**Network Layer**)
- What happens if failures within intermediate systems?
- How to create applications without knowing the details of underlying network and technologies?

Layers

Divide-and-Conquer

- As data communications is complex, separate tasks into layers
- Design and implement protocols for each layer

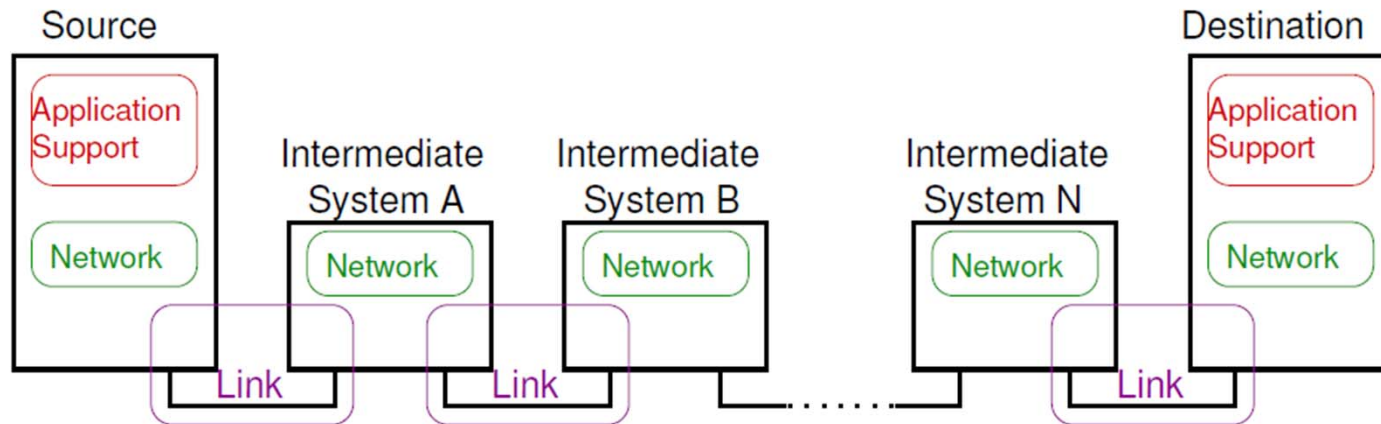
Advantages

- Simplify design and implementation
- Change/upgrade protocols without modifying the whole system
- Select implementations from different vendors

Disadvantages

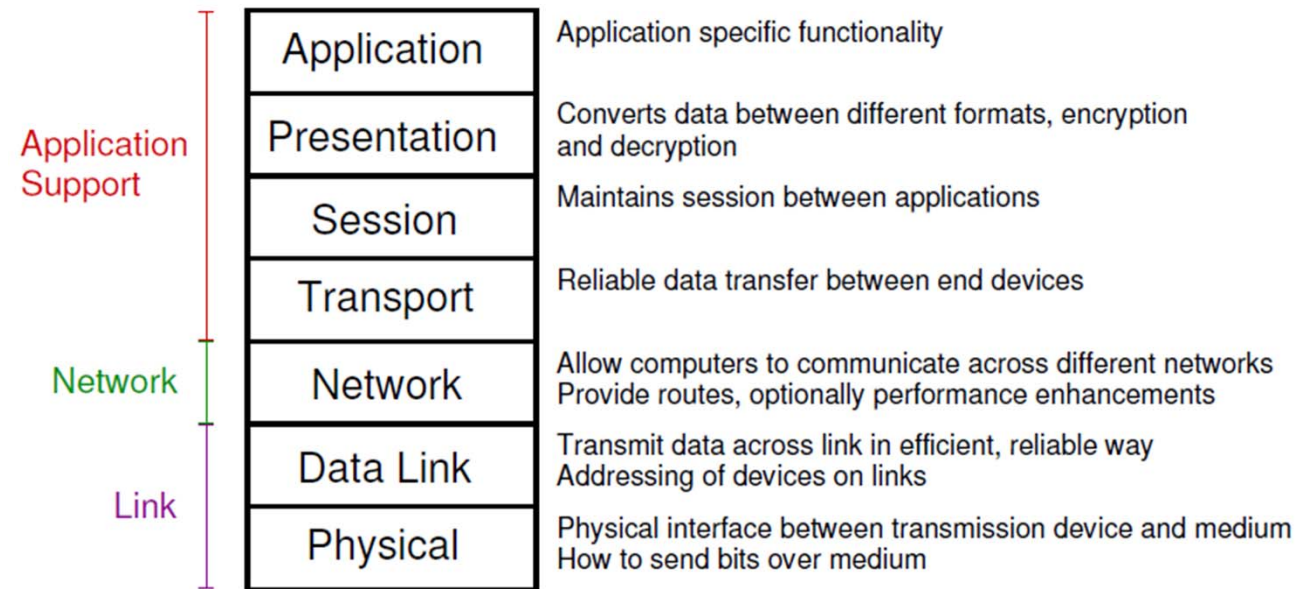
- Sub-optimal designs, overheads of each layer

General Layered Architecture



- Layers to support:
 - Communications across a link
 - Communications across a network
 - Applications to operate efficiently on end devices
- Different specific layered architectures have been developed
- Some are standards (e.g. OSI); others are loosely defined (e.g. Internet stack)

OSI 7-layer Protocol Architecture

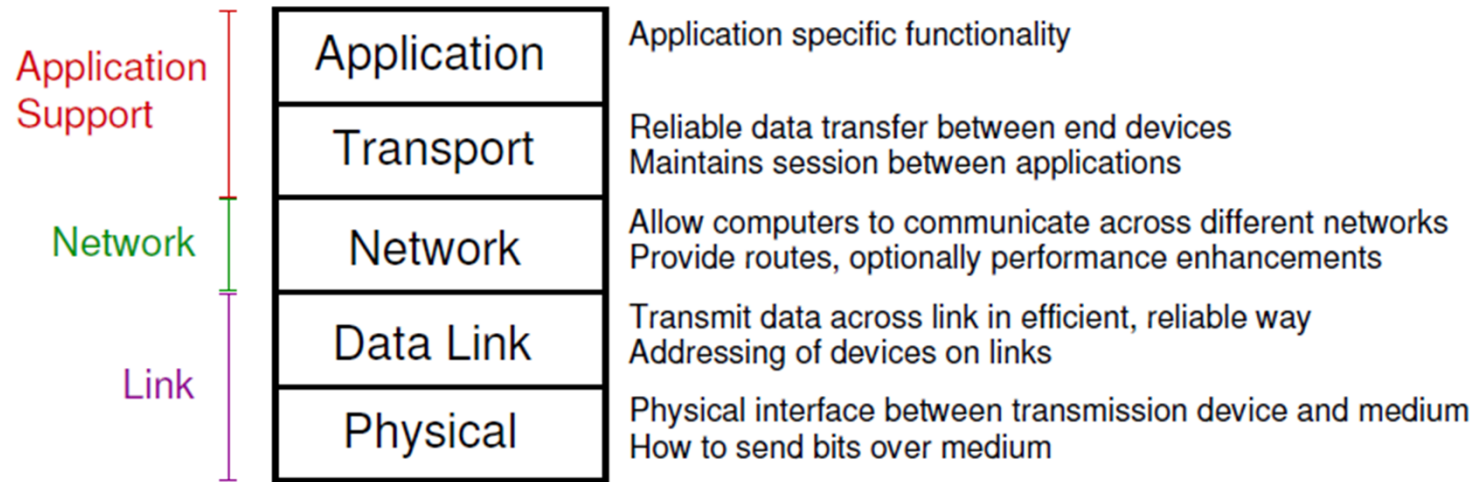


- ISO developed Open Systems Interconnection (OSI) in 1970's
- TCP/IP became more popular; but concepts and terminology still used today
- Others: IBM SNA, Appletalk, Novel IPX; SS7, UMTS, IEEE 802, . . .

TCP/IP Protocol Architecture

- ARPANET used two key protocols, TCP and IP; together (as well as other related protocols) referred to as **TCP/IP protocol suite**
- Used in global Internet today
- Many protocol standardized by Internet Architecture Board (IAB) and Internet Engineering Task Force (IETF)
- No official protocol architecture; generally divided into 5 layers
- Different names: TCP/IP protocol architecture, TCP/IP protocol suite, Internet stack, . . .

TCP/IP 5-layer Protocol Architecture



- There is no standard definition of the layers
- Sometimes have different names, and overlap between functionality

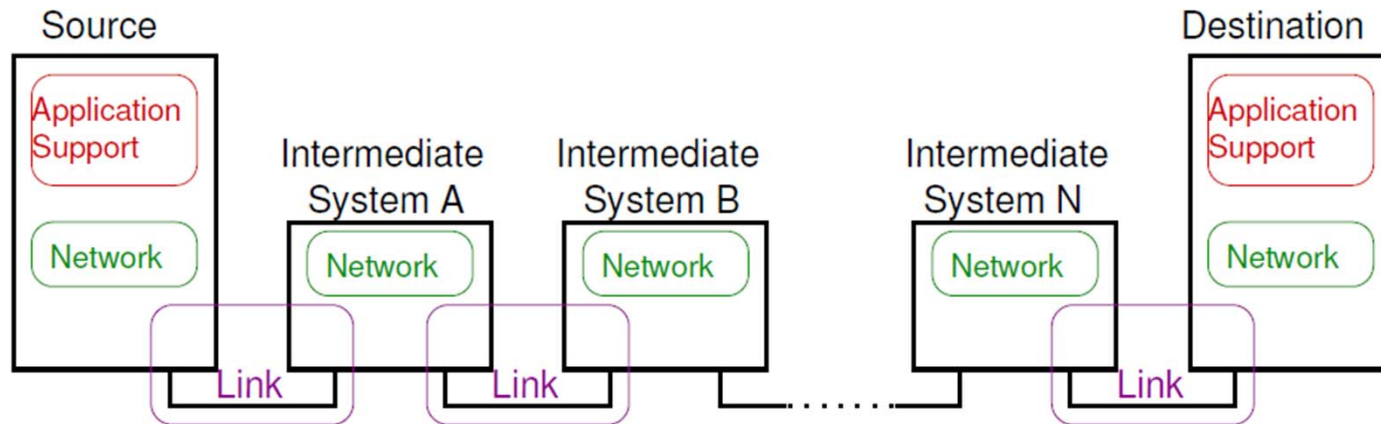
Layers and Devices

- One or more protocols are implemented in each layer in a device
- End devices (**hosts(source and destination)**) implement all layers in stack
- Intermediate devices usually do not implement all layers
- May refer to device by highest layer it implements, e.g. "layer 2 device"
 - Modems and repeaters are related to physical layer, layer 1 device
 - Ethernet switches, WiFi access points are layer 2 devices
 - **Routers** are layer 3 devices

OSI (Open Source Interconnection) 7 Layer Model

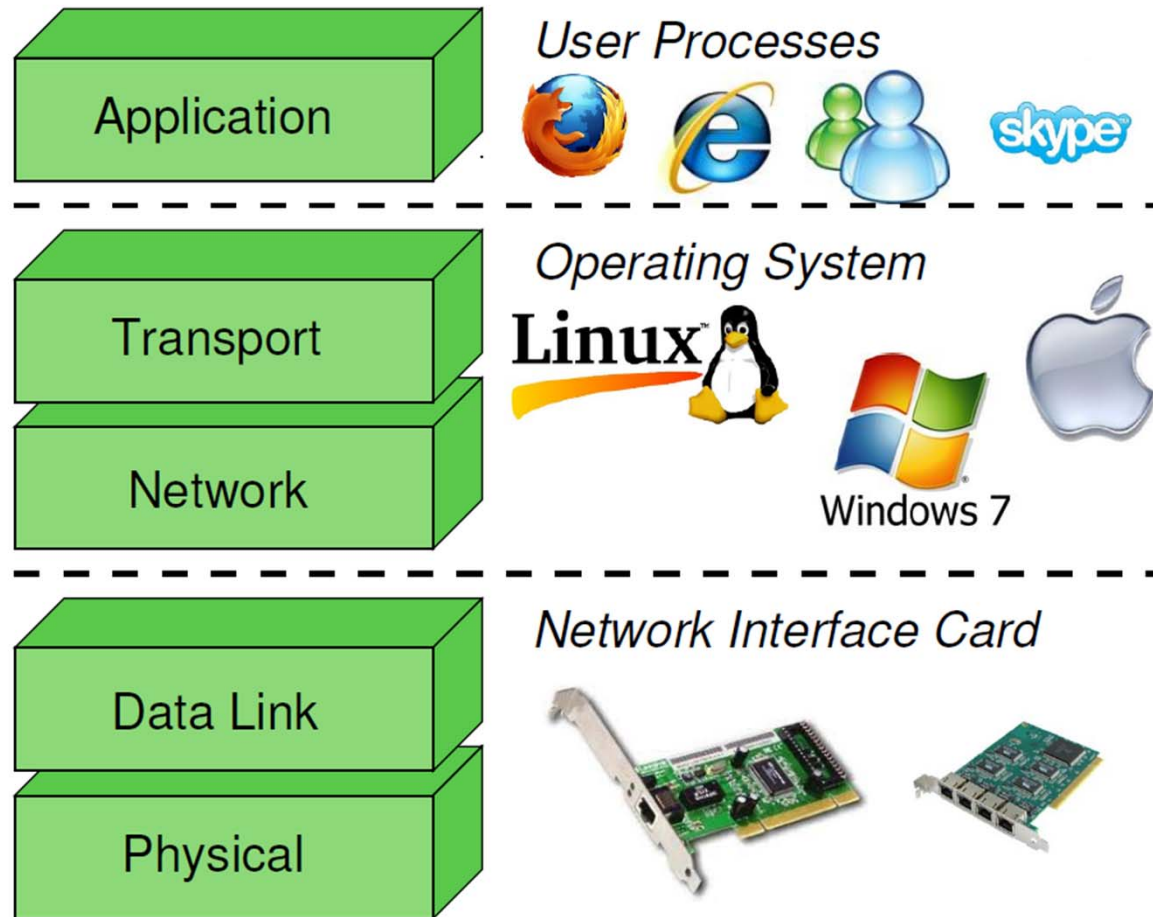
Layer	Application/Example	Central Device/Protocols	DOD4 Model
Application (7) Serves as the window for users and application processes to access the network services.	End User layer Program that opens what was sent or creates what is to be sent Resource sharing • Remote file access • Remote printer access • Directory services • Network management	User Applications SMTP	G A T E W A Y Process
Presentation (6) Formats the data to be presented to the Application layer. It can be viewed as the "Translator" for the network.	Syntax layer encrypt & decrypt (if needed) Character code translation • Data conversion • Data compression • Data encryption • Character Set Translation	JPEG/ASCII EBDIC/TIFF/GIF PICT	
Session (5) Allows session establishment between processes running on different stations.	Synch & send to ports (logical ports) Session establishment, maintenance and termination • Session support • perform security, name recognition, logging, etc.	Logical Ports RPC/SQL/NFS NetBIOS names	
Transport (4) Ensures that messages are delivered error-free, in sequence, and with no losses or duplications.	TCP Host to Host, Flow Control Message segmentation • Message acknowledgement • Message traffic control • Session multiplexing	PACKET FILTERING TCP/SPX/UDP	Host to Host
Network (3) Controls the operations of the subnet, deciding which physical path the data takes.	Packets ("letter", contains IP address) Routing • Subnet traffic control • Frame fragmentation • Logical-physical address mapping • Subnet usage accounting		Internet
Data Link (2) Provides error-free transfer of data frames from one node to another over the Physical layer.	Frames ("envelopes", contains MAC address) [NIC card — Switch — NIC card] (end to end) Establishes & terminates the logical link between nodes • Frame traffic control • Frame sequencing • Frame acknowledgement • Frame delimiting • Frame error checking • Media access control	Switch Bridge WAP PPP/SLIP	Can be used on all layers Network
Physical (1) Concerned with the transmission and reception of the unstructured raw bit stream over the physical medium.	Physical structure Cables, hubs, etc. Data Encoding • Physical medium attachment • Transmission technique • Baseband or Broadband • Physical medium transmission Bits & Volts	Hub Land Based Layers	

General Layered Architecture

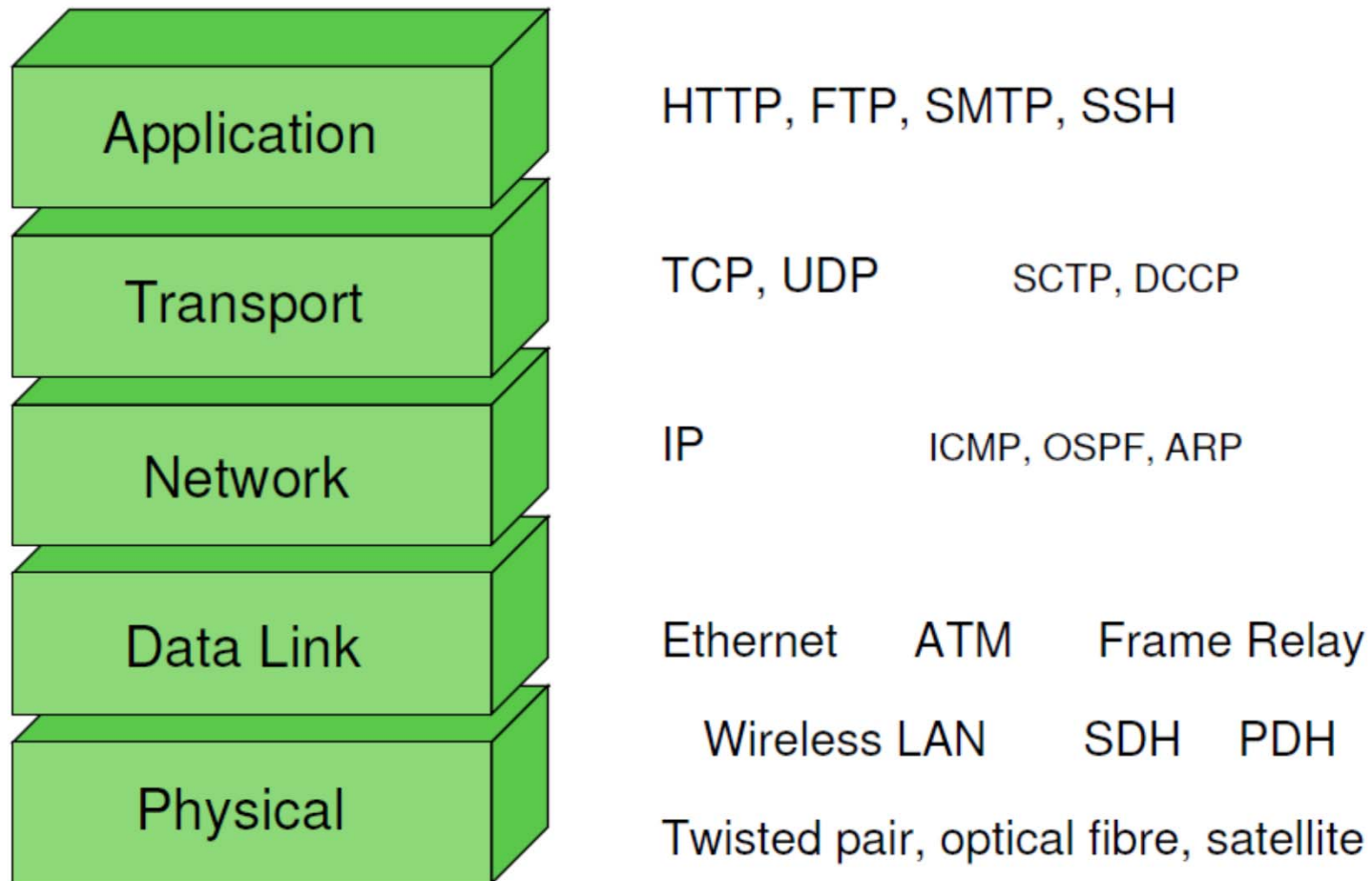


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Implementing Layers



Example Protocols in the TCP/IP



Encapsulation in TCP/IP

Example: Web browser has requested web page from server; server needs to send the page requested back to browser

