



CS 3205 COMPUTER NETWORKS

JAN-MAY 2020

LECTURE 1: 13TH JAN 2020

SCOPE

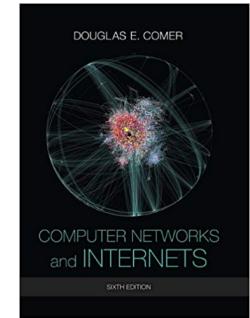
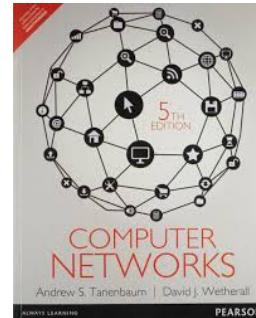
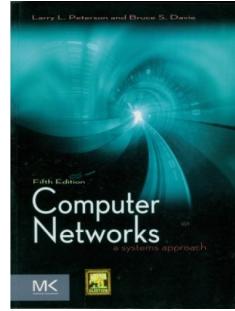
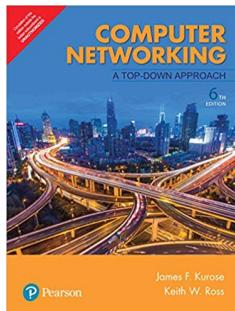


- ✓ Course Goals / Hand out
- ✓ Brief Introduction to Computer Networks
- ✓ Layered Model



COURSE INFORMATION – HANDOUT DETAILS

- ✓ Course related communications will be on IITM Moodle site, Check regularly.
- ✓ To understand the fundamental concepts of computer networks. Includes
 - ✓ Introduction to layered computer networking model, relevant algorithms and architectural aspects.
 - ✓ Learning based on current network applications, with suitable tools and software.
- ✓ Outcomes: Layered Architecture: Physical, Link Layer, Networking, Transport, Application
- ✓ Prerequisites: CS 2800, CS 2810, CS 3500
- ✓ Classes: Slot D on Mon, Tue, Wed, Thu. (Thu is only on specific dates, announced in adv.)
- ✓ Books:



COURSE INFORMATION – SYLLABUS



- ✓ Introduction: Network architecture and protocols, Packet Switching vs Ckt Switching, Computer Networks History; Performance of networks: delay and throughput.
- ✓ Physical Layer: Media types, Physical attributes.
- ✓ Link Layer: Encoding, Framing, Error Detection, Reliable Transmission, Ethernet.
- ✓ Network Layer: Introduction and details - covering IPv4, IPv6, DHCP, NAT, ICMP, ARP, NDP; Routing protocols - (Interior gateway protocols) - RIP, OSPF; Interdomain routing - BGP.
- ✓ Transport Layer: UDP and TCP, Reliability and congestion control in TCP, TCP Models and Analysis.
- ✓ Application Layer: Socket Programming, Examples: FTTP, FTP, SMTP, DNS, P2P.

COURSE INFORMATION – SYLLABUS (COVERAGE BASED ON TIME)



- ✓ Network Device Architecture: Introduction/Overview - Router, Switch Architecture, QoS, key implementation aspects.
- ✓ Link Layer Protocols: VLANs, STP, RSTP
- ✓ Advance Internet Protocols/Technologies - MPLS, L2/L3 VPNs.
- ✓ Multicast Protocols: An overview of IGMP, PIM.
- ✓ Next Generation Networks: Overlay networks - DCN, GRE Tunnels, VxLAN, SDN.

COURSE INFORMATION – TENTATIVE GRADING POLICY



Quiz 1 (Feb. 17, 2020 - Monday)	15%
Quiz 2 (Mar. 30, 2020 - Monday)	15%
4 Micro and 4 Macro Assignments	30%
Final Exam (May 4, 2020 - Saturday)	40%

- ✓ Micro assignments typical turn in time – 1 week, grade weightage – 2.5 marks.
- ✓ Macro assignments typical turn in time – 2 weeks, grade weightage – 5 marks.

COURSE INFORMATION – TOOLS / SOFTWARE THAT WOULD BE USED DURING THE COURSE



- ✓ Wireshark – Network Protocol Analyzer
 - ✓ <https://www.wireshark.org/>
- ✓ Scapy – Packet crafting / construction using Python
 - ✓ <https://scapy.net/>
- ✓ GNS3 – Software for creating networks and performing analysis
 - ✓ <https://www.gns3.com/>
- ✓ Few other software and tools will be also be explored / used



Brief Introduction To Computer Networks, Layers



An Analogy ...

Using the postal communication method, the layering concept is introduced.

AN ANALOGY ... POSTAL SYSTEM (APPLICATION LAYER, PRESENTATION LAYER)



Dear Mama, it is awesome here...

IIT-M



A gift to you Papa, hope you like it...

Vashi,
Mumbai



Dwarka,
New Delhi



AN ANALOGY ... COMMUNICATION MODE (NEXT HOP FOR POSTAL DATA TRANSFER)



AN ANALOGY ... COMMUNICATION MODE (DIFFERENT NEXT HOPS BASED ON DATA TYPE TO BE PROCESSED)





AN ANALOGY ... COMMUNICATION MODE (CONTD..)



AN ANALOGY ... COMMUNICATION MODE (DATA PROCESSING AT THE FIRST HOP NODE. DATA RECEIVED, SORTED, PACKAGED)



AN ANALOGY ... COMMUNICATION MODE (DATA PROPAGATION THROUGH FURTHER HOPS, BASED ON DATA SERVICE TYPES) – IMPACT OF THE TRANSPORT LAYER



AN ANALOGY ... COMMUNICATION MODE (LAST NODE PROCESSING, FINAL DESTINATION)

At the final destination, the receiver, receives the application (data) in the way it is designed to be presented. Money is given, Letter pulled out of the envelope.

The end user need not worry how the data actually reached him/her.



AN ANALOGY ... COMMUNICATION MODE (THE TRACE OF DATA MOVEMENT)



Track Result for: EV247688923IN [Track More](#)

Booked at	Booked On	Delivered at	Delivered on	
HATHI BARKALA	10/04/2012	SANTACRUZ(WEST)	13/04/2012	Details

Detailed Track Events For EV247688923IN

Date	Time	Status at	Status
10/04/2012	14:56:39	HATHI BARKALA	Item Booked
10/04/2012	15:02:44	HATHI BARKALA	Item bagged for DEHRADUN
10/04/2012	15:03:19	HATHI BARKALA	Bag Despatched to DEHRADUN
10/04/2012	18:27:27	DEHRADUN	Bag Received
10/04/2012	18:27:53	DEHRADUN	Bag Opened
10/04/2012	18:27:53	DEHRADUN	Item Received
10/04/2012	19:27:36	DEHRADUN	Item bagged for MUMBAI
10/04/2012	20:34:43	DEHRADUN	Bag Despatched to SAHARANPUR
11/04/2012	13:19:26	PALAM TMO	Bag Received
11/04/2012	16:16:41	PALAM TMO	Bag Despatched to MUMBAI
12/04/2012	06:43:27	MUMBAI	Bag Received
12/04/2012	07:44:30	MUMBAI	Bag Opened
12/04/2012	07:44:31	MUMBAI	Item Received
12/04/2012	14:59:49	MUMBAI	Item bagged for SANTACRUZ(WEST)
13/04/2012	05:27:15	MUMBAI	Bag Despatched to SANTACRUZ(WEST)
13/04/2012	07:48:19	SANTACRUZ(WEST)	Bag Received
13/04/2012	07:48:45	SANTACRUZ(WEST)	Bag Opened
13/04/2012	07:48:45	SANTACRUZ(WEST)	Item Received
13/04/2012	00:00:00	SANTACRUZ(WEST)	Item Delivered [To: PRATYUSHGAUR]

Similar to the postal data traversal that can be traced, data flow in a network can be traced. (in future class..)

Trace shows, how there is a change in every hop, bag received, opened, rebagged.

Similarly the data packet header gets changed at every hop..



AN ANALOGY ... COMMUNICATION MODE

Track Result for: EP1482XXXXIN [Track More](#)

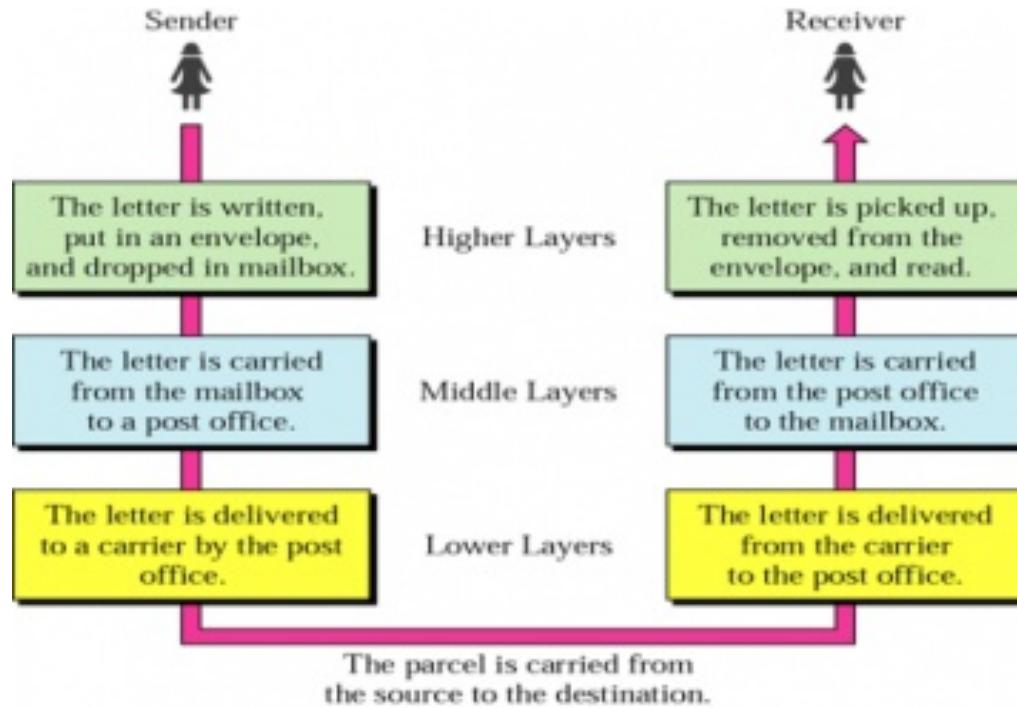
Booked at	Booked On	Delivered at	Delivered on	
Sector 44 (Chandigarh) S.O	20/06/2012	UNITED KINGDOM	25/06/2012	Details

Detailed Track Events For EP1482XXXXIN

Date	Time	Status at	Status
20/06/2012	13:46:16	Sector 44 (Chandigarh) S.O	Item Booked
20/06/2012	16:23:06	Sector 44 (Chandigarh) S.O	Item bagged for CHANDIGARH
20/06/2012	16:24:02	Sector 44 (Chandigarh) S.O	Bag Despatched to CHANDIGARH
20/06/2012	17:47:33	SP TMO CHANDIGARH	Bag Received
20/06/2012	18:08:43	CHANDIGARH	Bag Received
20/06/2012	18:09:40	CHANDIGARH	Bag Opened
20/06/2012	18:09:40	CHANDIGARH	Item Received
20/06/2012	20:27:13	CHANDIGARH	Item bagged for NEW DELHI
20/06/2012	20:52:23	SP TMO CHANDIGARH	Bag Received
20/06/2012	21:10:43	SP TMO CHANDIGARH	Bag Despatched to CHANDIGARH SORTING
20/06/2012	21:11:32	SP TMO CHANDIGARH	Bag Despatched to CHANDIGARH
20/06/2012	21:13:18	CHANDIGARH	Bag Despatched to SP TMO CHANDIGARH
21/06/2012	11:48:44	NEW DELHI	Bag Received
22/06/2012	11:24:28	DELHI EMS SPEED POST CENTRE INDIA	Item Received
22/06/2012	11:25:37	INDIA	Item Bagged
24/06/2012	21:52:00	UNITED KINGDOM	Item Received
24/06/2012	21:53:00	UNITED KINGDOM	Delivery Attempted :Local holiday
24/06/2012	21:54:00	UNITED KINGDOM	Item Bagged
25/06/2012	03:53:00	P95631	Item Received
25/06/2012	09:13:00	UNITED KINGDOM	Item Delivered To: MS H DHILLON

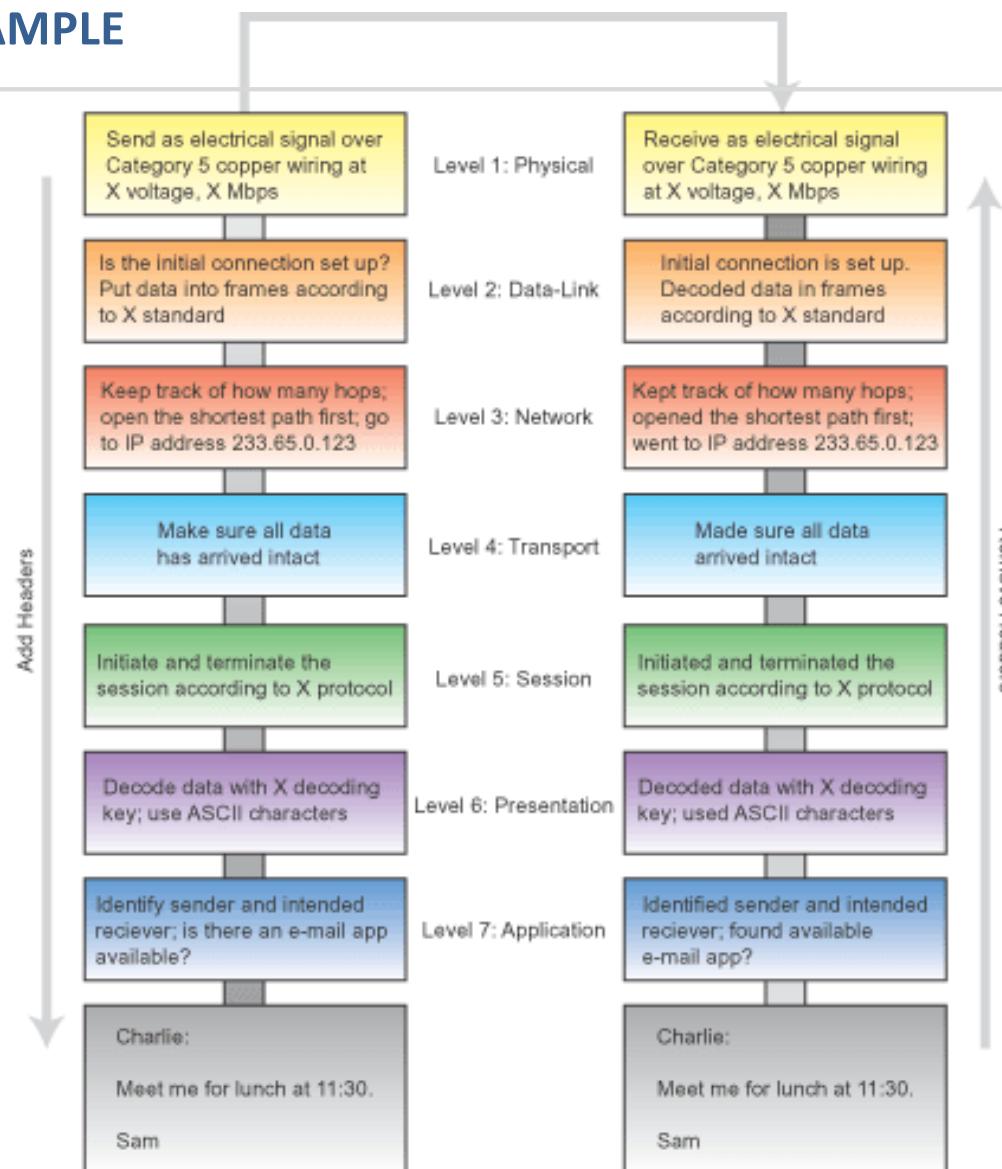
Similar to postal communication across the globe, the data packets traverse across the internet, across continents to reach the end destination (servers, or users)

LAYER SUMMARY – AT HIGH LEVEL



<https://www.bitlanders.com/blogs/network-layers-basics-of-networking-2/275916>

ANOTHER FLOW EXAMPLE

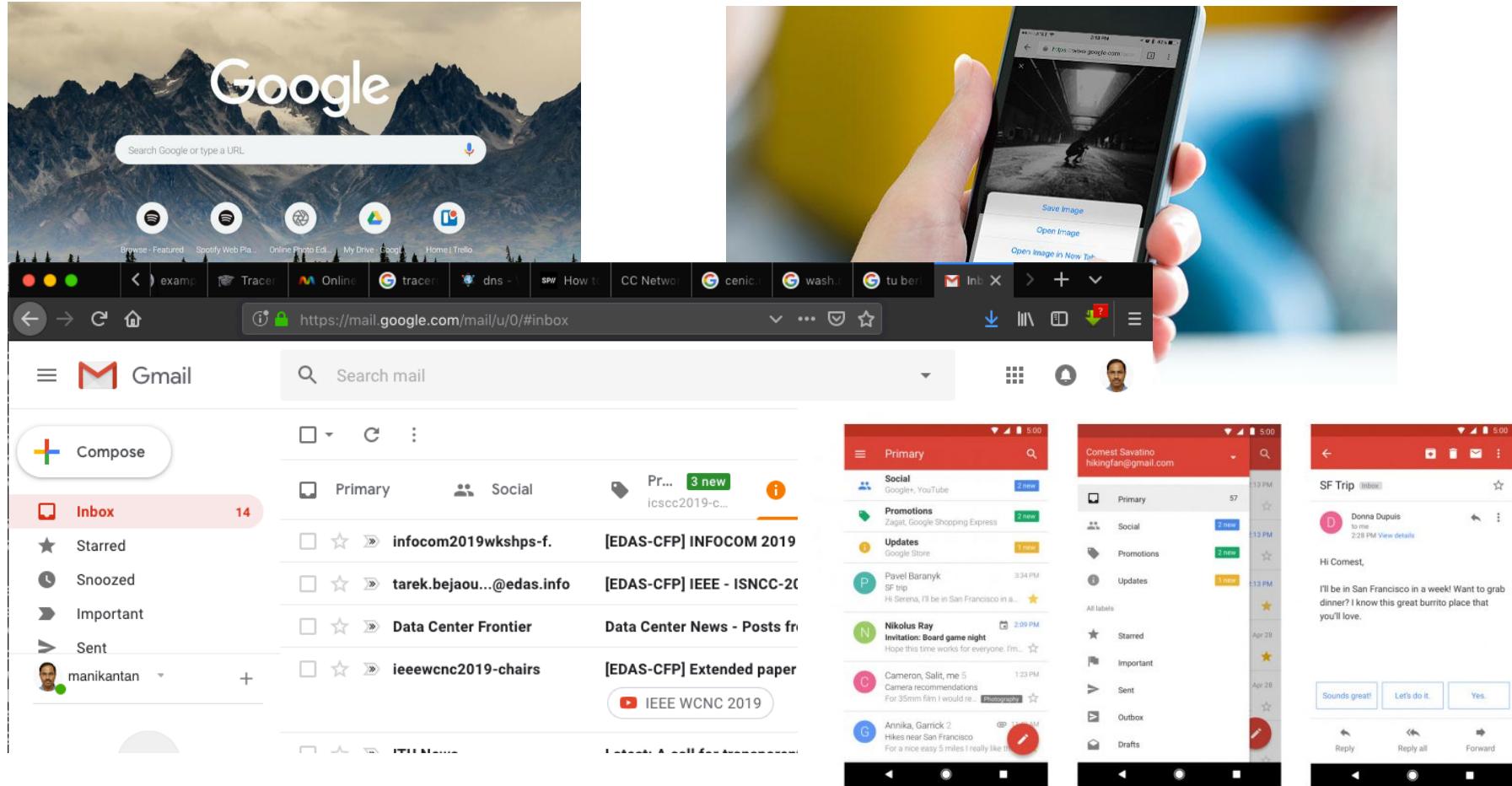




The flow in computer networks...



APPLICATIONS / DRIVERS



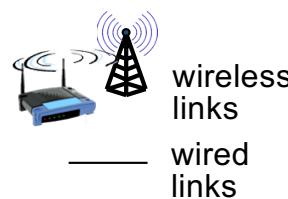
Same application, presentation varies based on the end user device. Application layer, Presentation layer impact. (multiple gmail sessions open, the impact/role of session layer)

13/01/20

CS 3205 - Jan-May 2020

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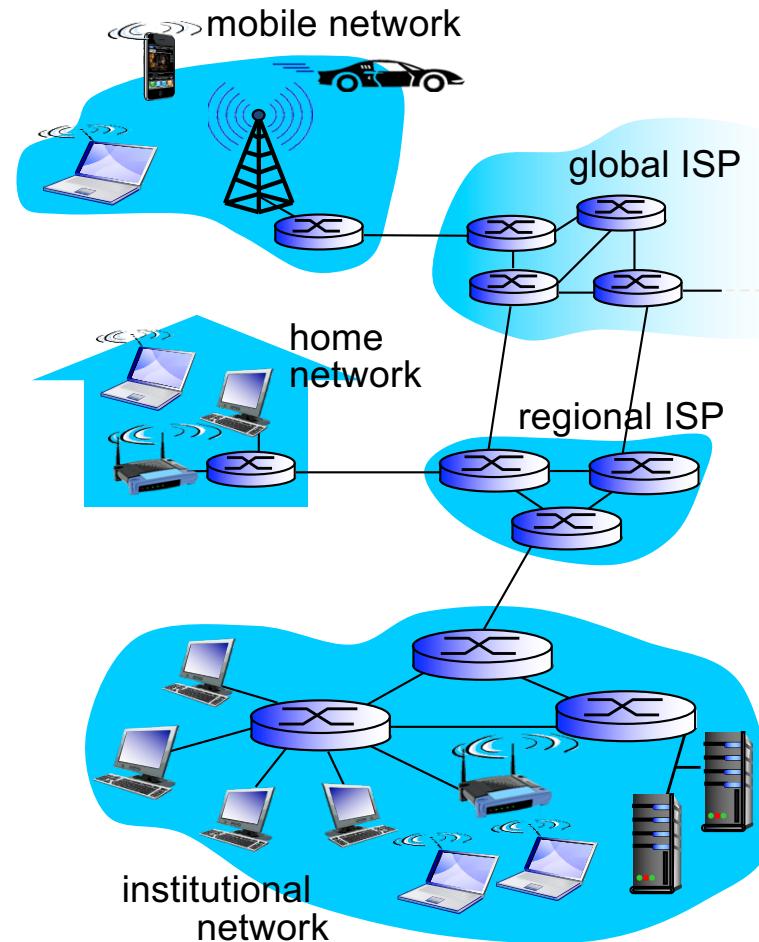
WHAT'S THE INTERNET: "NUTS AND BOLTS" VIEW



- millions of connected computing devices:
 - *hosts = end systems*
 - running *network apps*

- ❖ *communication links*
 - fiber, copper, radio, satellite
 - transmission rate: *bandwidth*

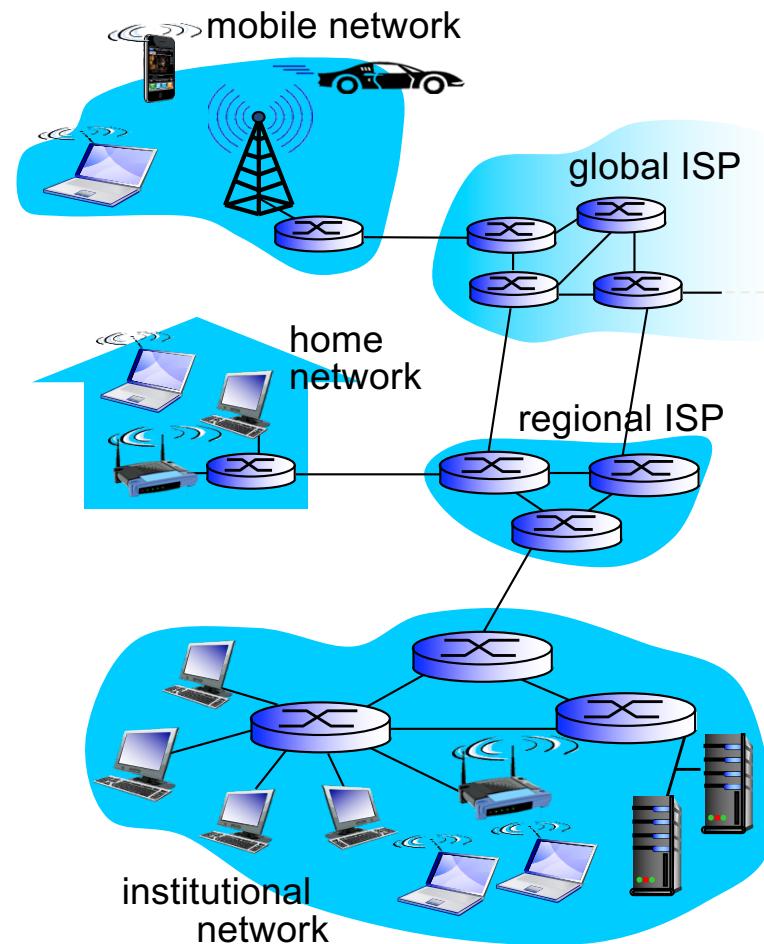
- ❖ *Packet switches: forward packets (chunks of data)*
 - *routers and switches*



WHAT'S THE INTERNET: "NUTS AND BOLTS" VIEW



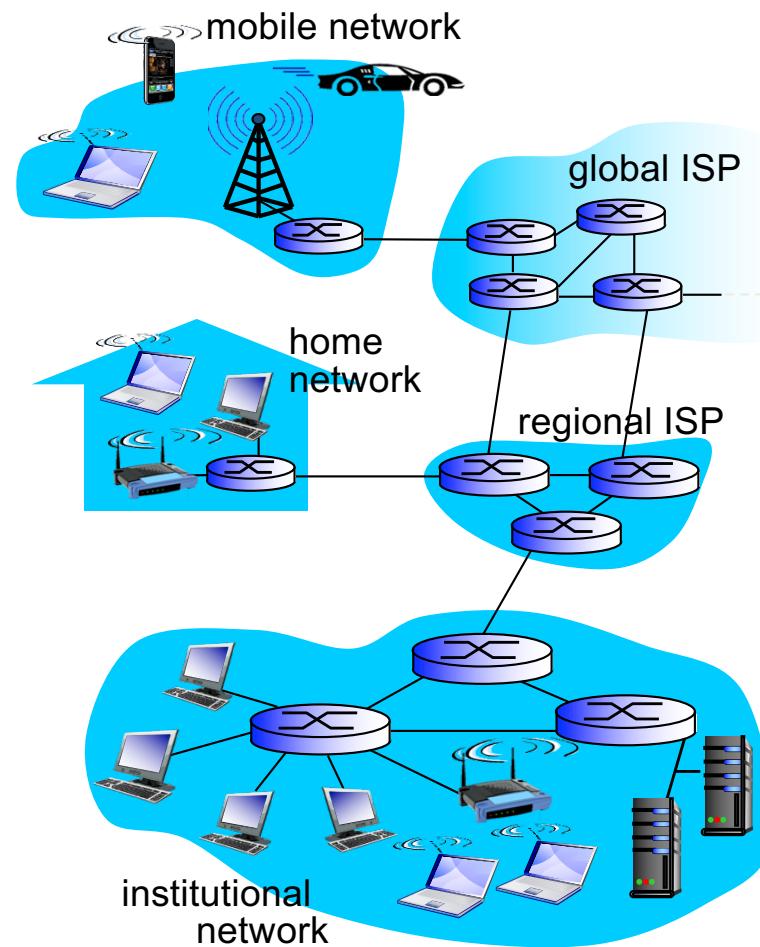
- *Internet: “network of networks”*
 - Interconnected ISPs
- *protocols* control sending, receiving of msgs
 - e.g., TCP, IP, HTTP, Skype, 802.11
- *Internet standards*
 - RFC: Request for comments
 - IETF: Internet Engineering Task Force



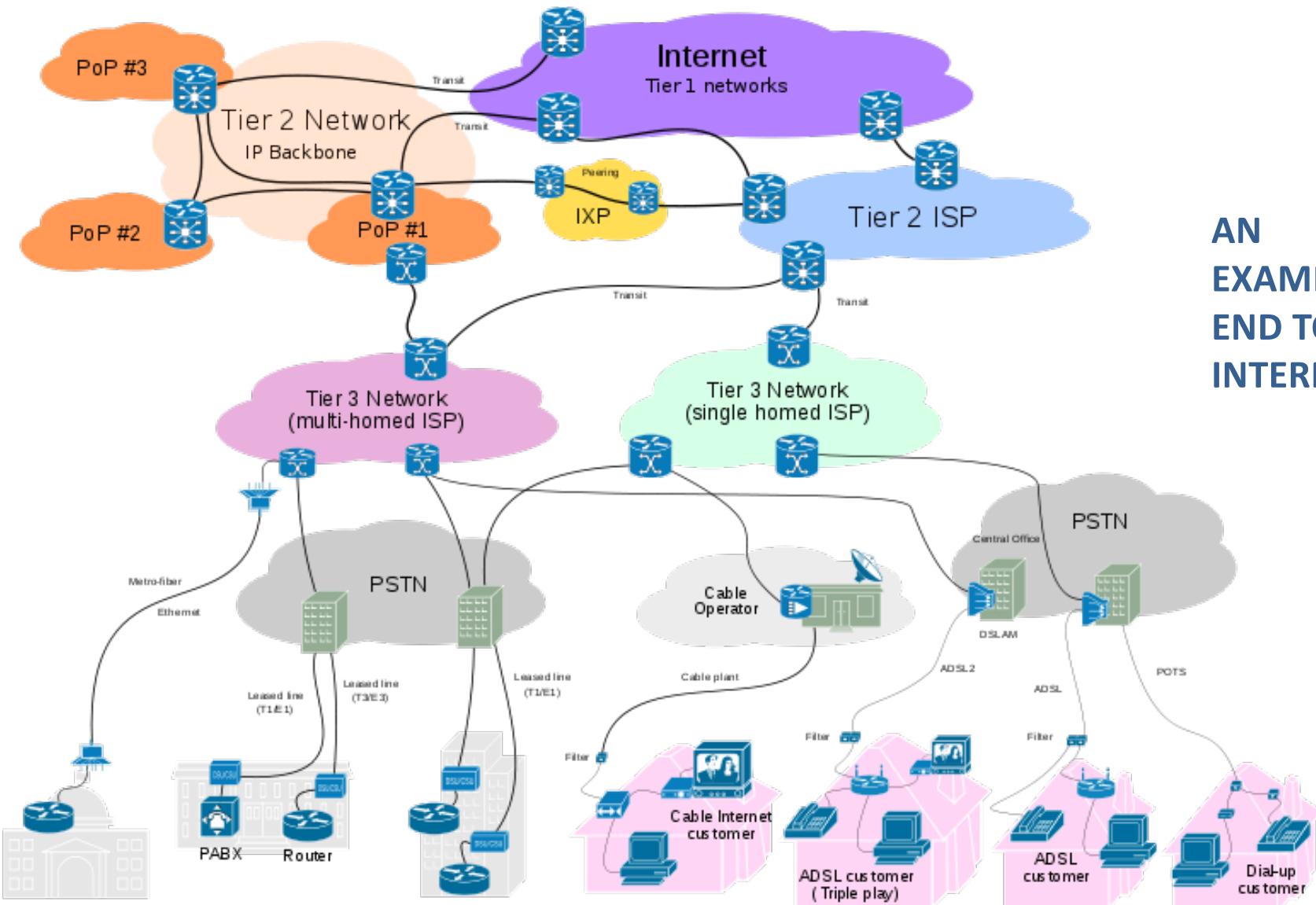
WHAT'S THE INTERNET: A SERVICE VIEW



- *Infrastructure that provides services to applications:*
 - Web, VoIP, email, games, e-commerce, social nets, ...
- *provides programming interface to apps*
 - hooks that allow sending and receiving app programs to “connect” to Internet
 - provides service options, analogous to postal service



AN EXAMPLE END TO END INTERNET





human protocols:

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

... specific msgs sent

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

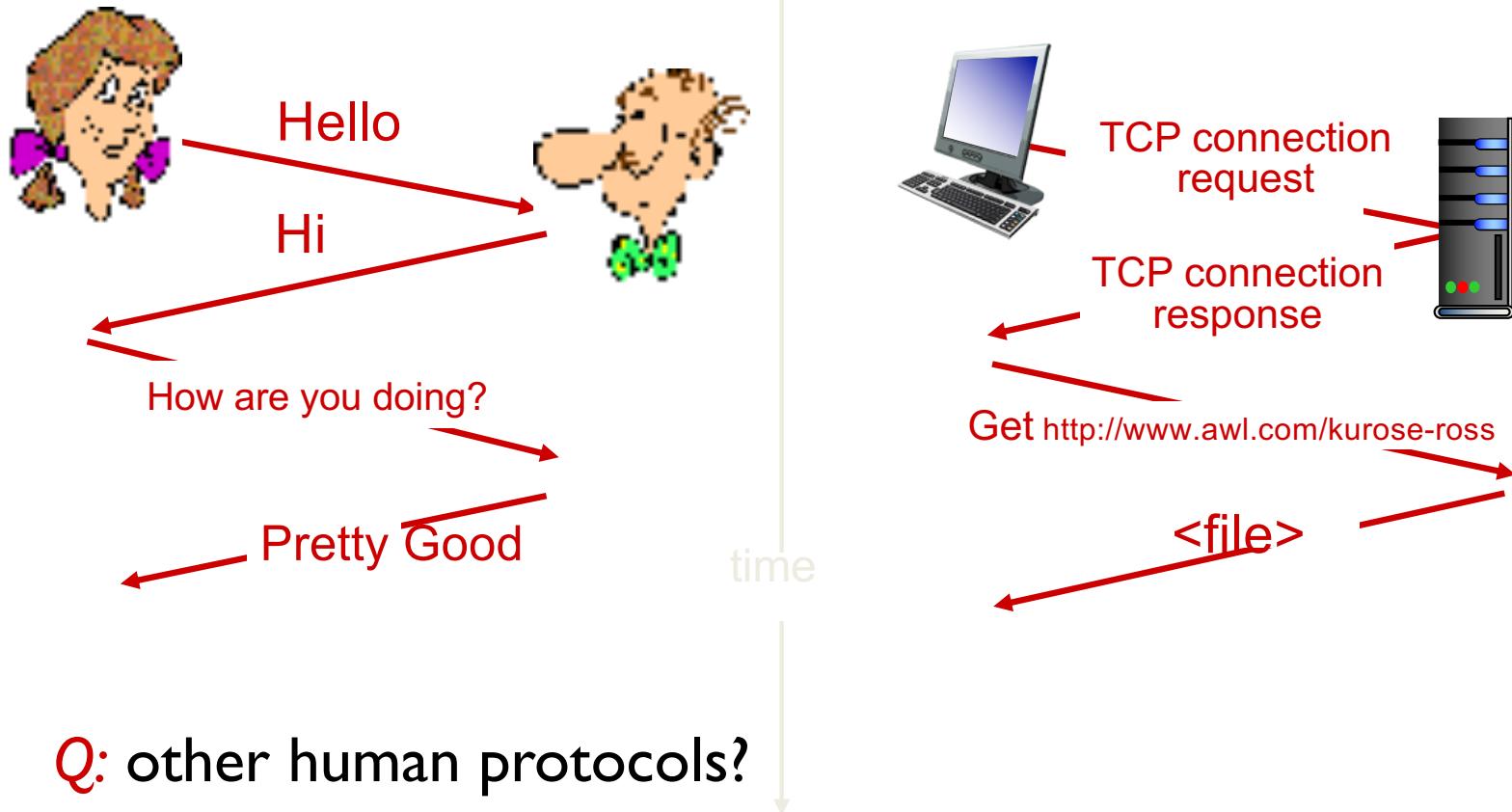
network protocols:

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

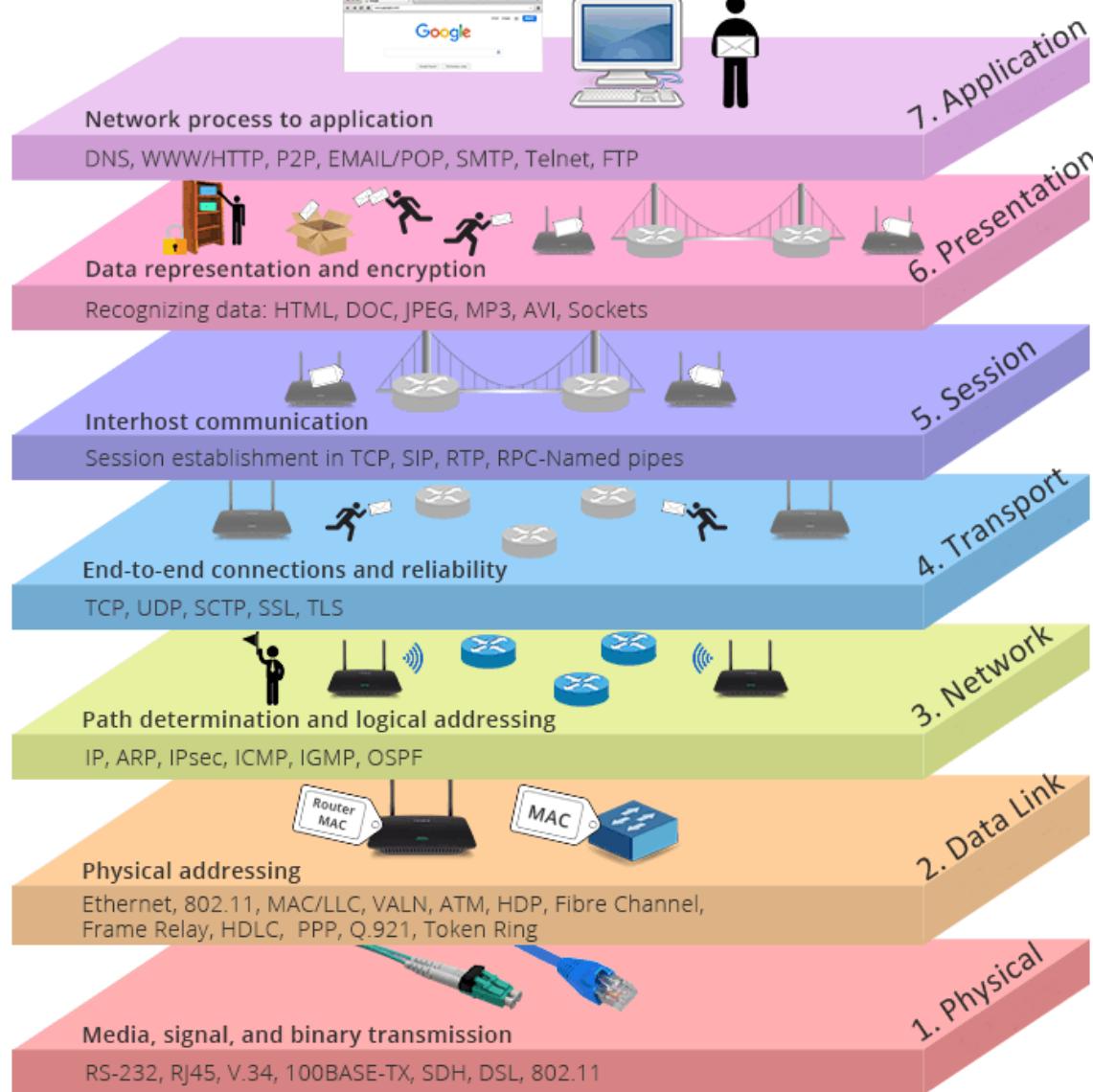
protocols define format, order of msgs sent and received among network entities, and actions taken on msg transmission, receipt



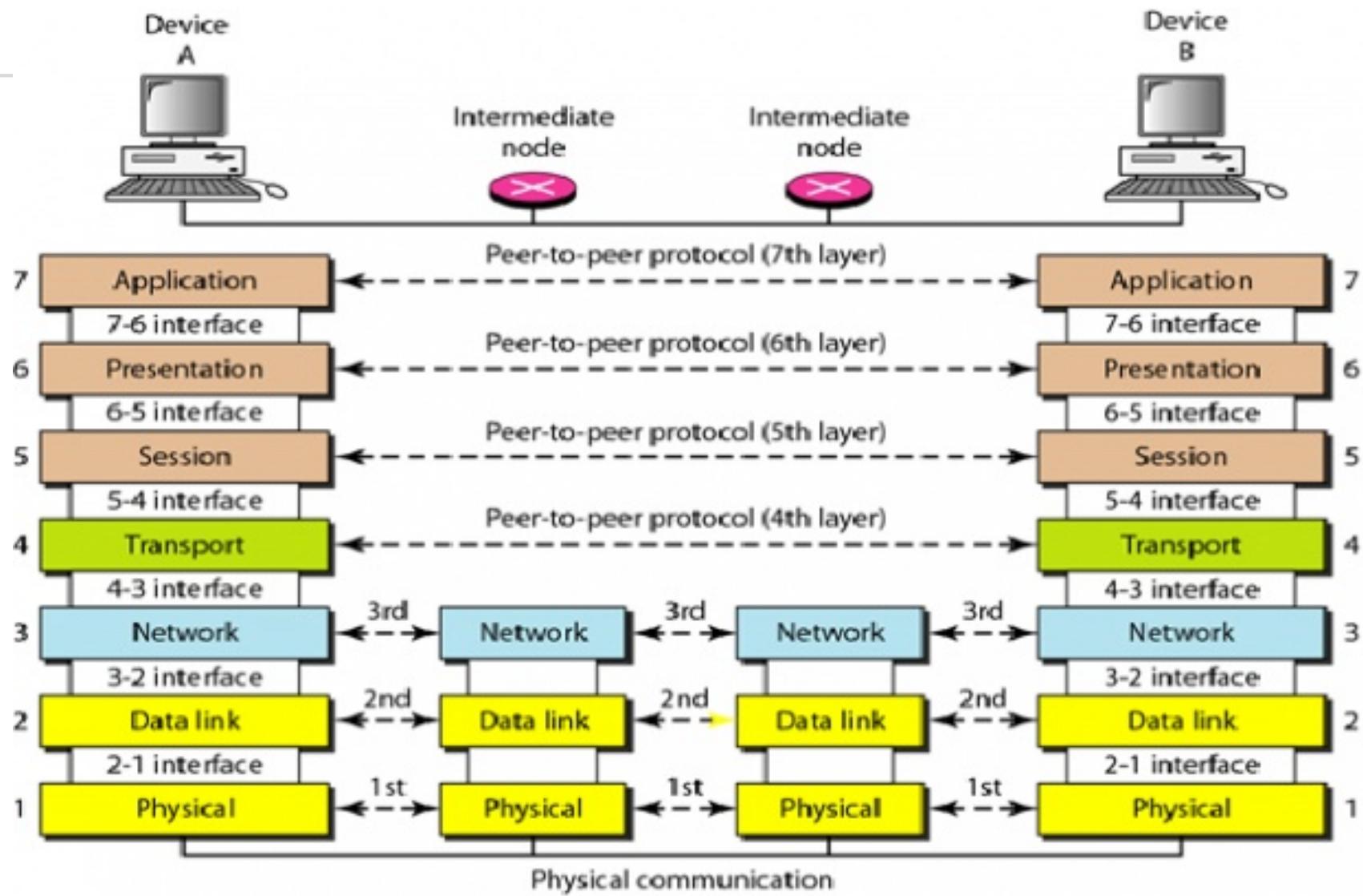
a human protocol and a computer network protocol:



Q: other human protocols?



THE LAYERS - ANOTHER HIGH LEVEL OVERVIEW





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	
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	Process
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	F I L T E R P A C K E T R O U T E S 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	R O U T E R S IP/IPX/ICMP	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 acknowledgment • Frame delimiting • Frame error checking • Media access control	S W I T C H B R I D W A P P P P /S L I P	Can be used on all layers
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	H u b L a n d B a s e d L a y e r s	Network

THE LAYERS AN HIGH LEVEL OVERVIEW

Source: <https://cohesive.net/2017/09/4-things-everyone-should-know-about-network-layers.html>