



**BITS Pilani**  
Pilani Campus

# Network Fundamentals for Cloud

Nishit Narang  
WILPD-CSIS



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# **CC ZG503: Network Fundamentals for Cloud**

## **Lecture No. 1**



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# Introductions

# Faculty Introduction – Dr Nishit Narang



**Head and Associate Professor**, Computer Science and Information Systems,  
Off Campus BITS Pilani (*joined Dec 2020*)

## Academic Background:

- B.Tech and PhD from IIT Delhi in Computer Science and Engineering

## Expertise:

- Computer & Communication Networks and Information Security

## Past Experience:

- Before BITS Pilani, worked for 23 years in the IT industry
- Projects in terrestrial, satellite, and mobile communication networks, Industrial and Consumer IoT solutions involving industrial automation, smart city solutions, and consumer wearables
- Over the years and across projects, focused extensively on Information Security and Cybersecurity.

## Books Authored:

- Co-author of four books in the communications domain, which are published by McGraw Hill and sold internationally



# Course Introduction: Objectives

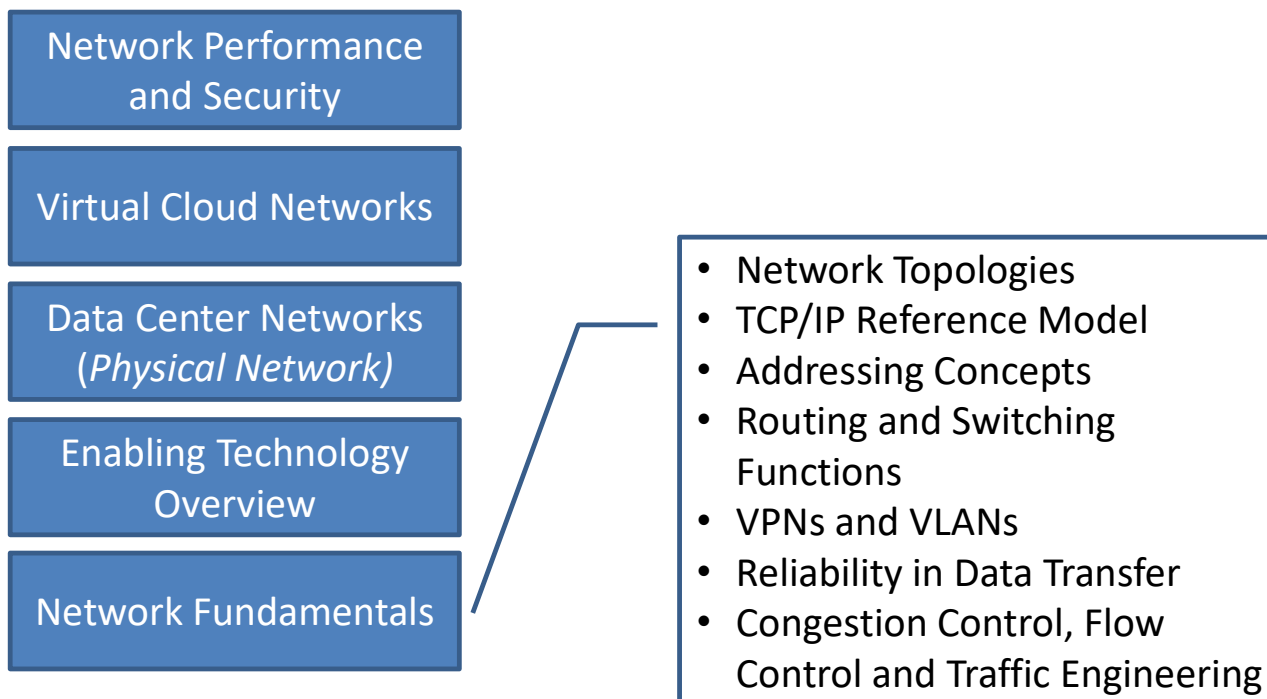
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No	Description
CO1	Understanding design and architectural choices for a data center network.
CO2	Understand enabling technologies, protocols, tools and services used for implementation of cloud networks.
CO3	Understanding cloud network performance and security challenges and methods to address them.

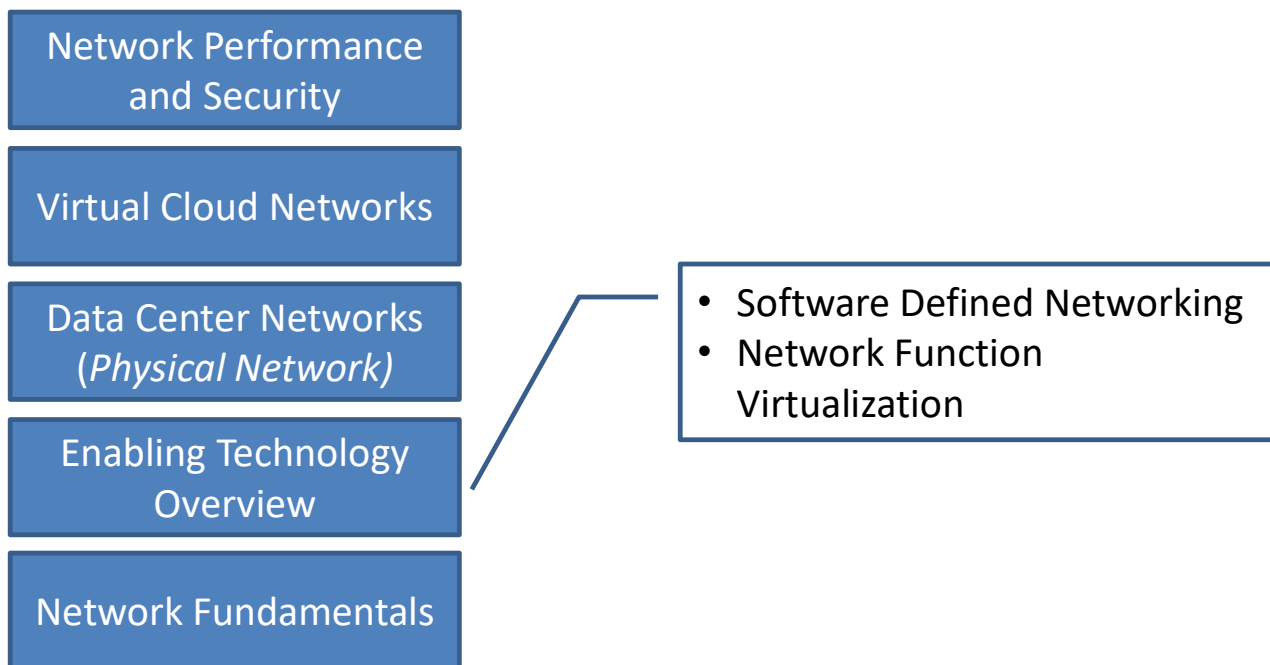


# Course Structure Overview



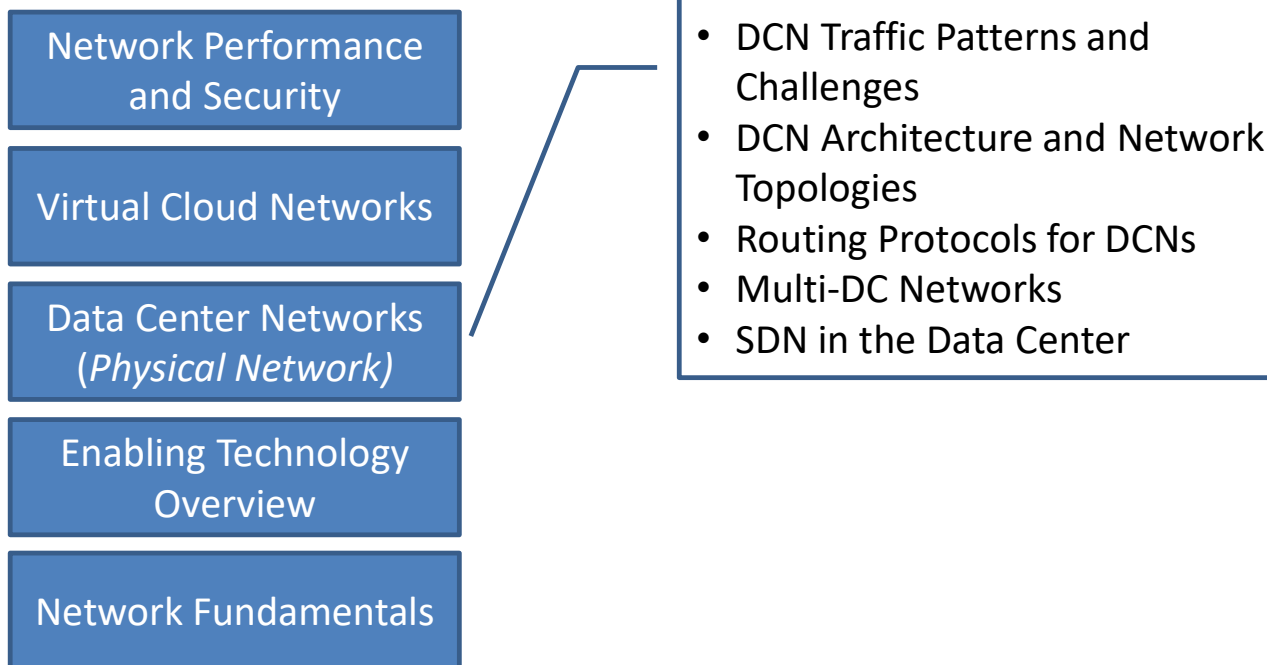


# Course Structure Overview





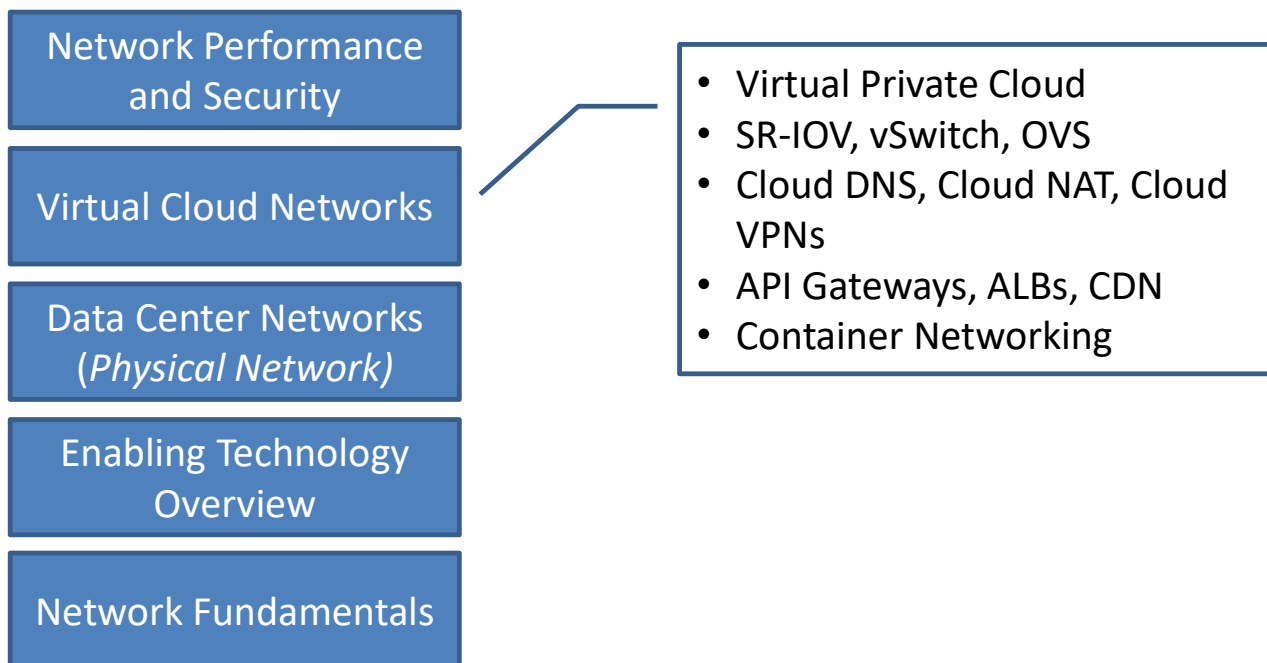
# Course Structure Overview





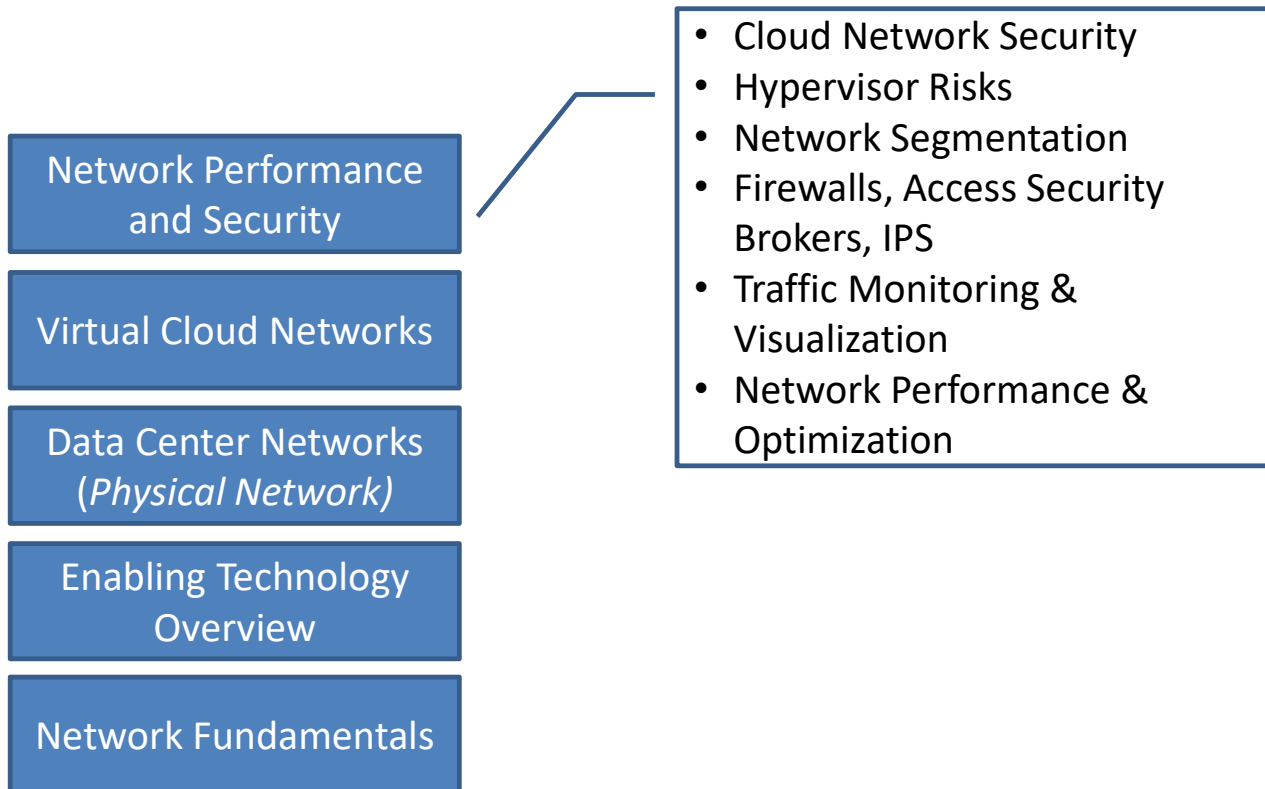


# Course Structure Overview





# Course Structure Overview



# Text & Reference Books



Text Book(s)	
T1	Kurose James F and Keith W. Ross: Computer Networking: A Top-Down Approach, Pearson India, 6th Edition, 2013
T2	Lei Zhang, Le Chen. Cloud Data Center Network Architectures and Technologies, CRC Press 2021
T3	Dinesh G. Dutt. Cloud Native Data Center Networking: Architecture, Protocols and Tools, O'Reilly 2020
R1	Paul Goransson, Chuck Black. Software Defined Networks: A Comprehensive Approach, MK (Elsevier) 2014
R2	Ken Gray, Thomas D. Nadeau. Network Function Virtualization, MK (Elsevier) 2016
R3	Ronald L. Krutz, Russell Dean Vines. Cloud Security: A Comprehensive Guide to Secure Cloud Computing, John Wiley & Sons, 2010

# Supporting Material



## Other Reading Material

O1	Jupiter Rising: A Decade of Clos Topologies and Centralized Control in Google's Datacenter Network by Arjun Singh and Others
O2	A Scalable, Commodity Data Center Network Architecture by Mohammad Al-Fares, Alexander Loukissas and Amin Vahdat
O3	B4: Experience with a Globally-Deployed Software Defined WAN by Sushant Jain and Others
O4	Cloud Service Provider (AWS, Azure, GCP) Public Domain Technical Documentation

# Proposed Evaluation Scheme



No	Name	Type	Duration	Weight
EC-1	Quiz-I	Online	-	5%
EC-1	Quiz-II	Online	-	5%
EC-1	Assignment-I	Online	-	10%
EC-1	Assignment-II	Online	-	10%
EC-2	Mid-Semester Test	Closed Book	2 hours	30%
EC-3	Comprehensive Exam	Open Book	3 hours	40%



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# Fundamentals of Networking: Part 1

**Slides Source:** Computer Networking: A Top-Down Approach, 8<sup>th</sup> edition, Jim Kurose, Keith Ross, Pearson, 2020

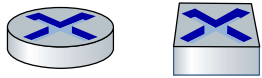
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J.F Kurose and K.W. Ross, All Rights Reserved

# The Internet: a “nuts and bolts” view



Billions of connected computing *devices*:

- *hosts* = end systems
- running *network apps* at Internet's “edge”



*Packet switches*: forward packets (chunks of data)

- *routers, switches*

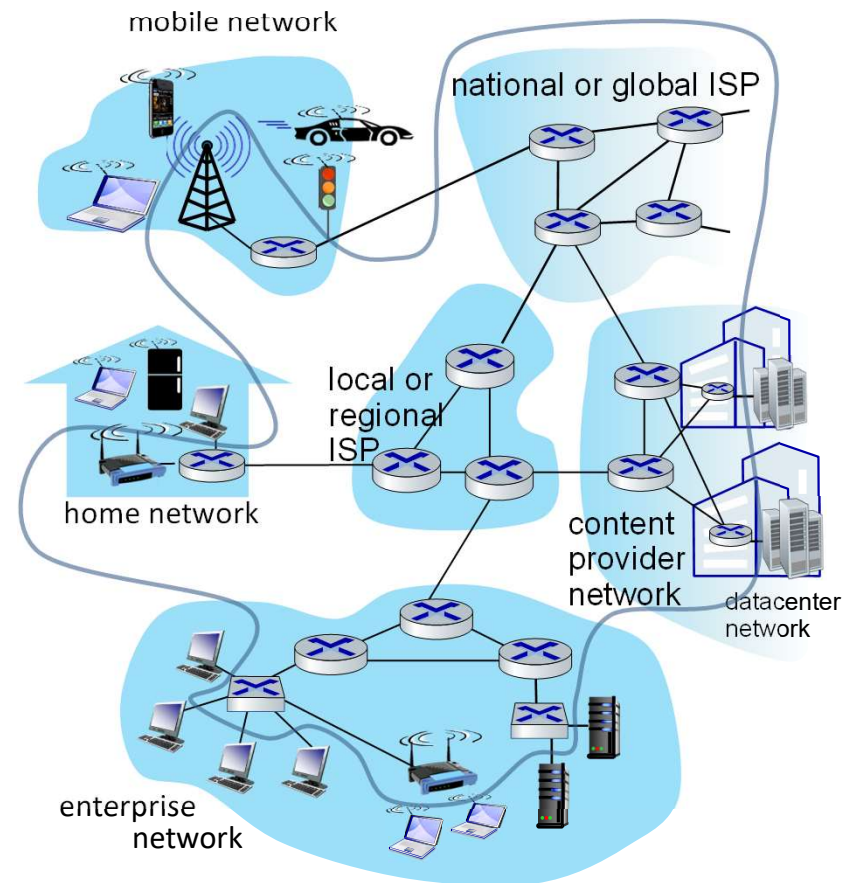


*Communication links*

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

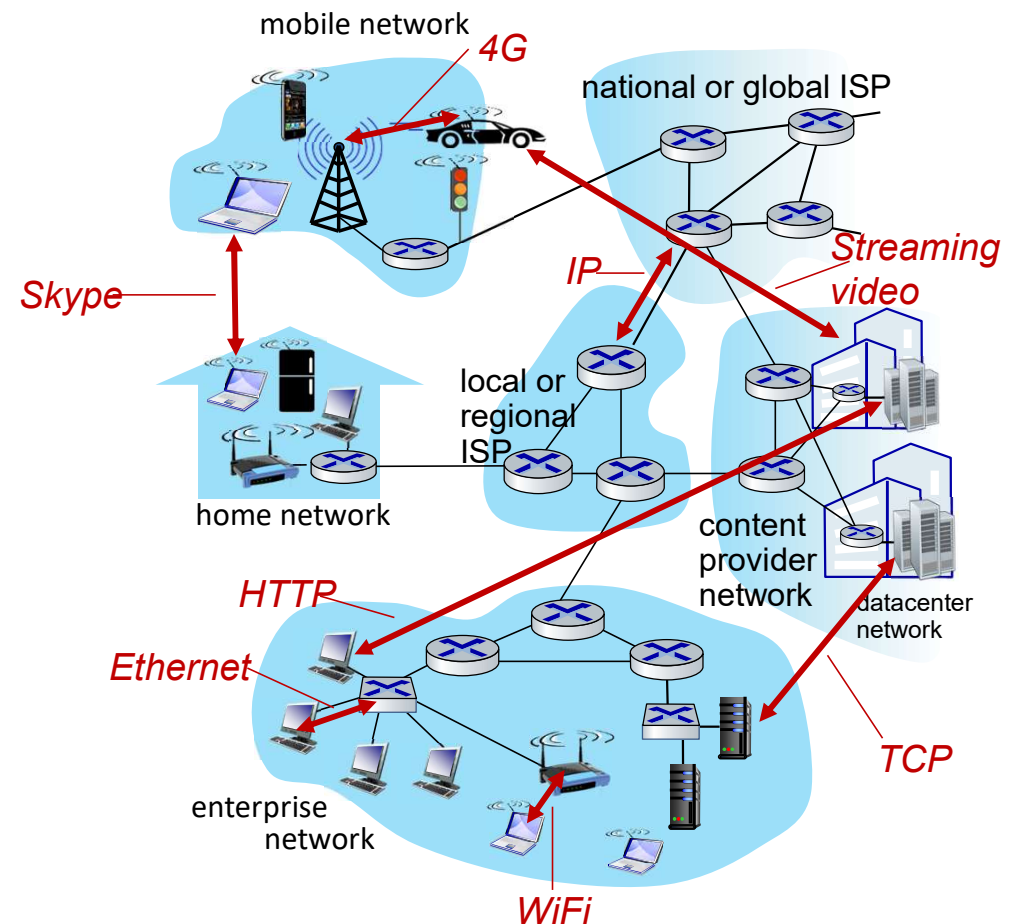
*Networks*

- collection of devices, routers, links: managed by an organization



# The Internet: a “nuts and bolts” view

- *Internet: “network of networks”*
  - *protocols are everywhere*
    - Interconnected ISPs
      - control sending, receiving of messages
      - e.g., HTTP (Web), streaming video, Skype, TCP, IP, WiFi, 4G, Ethernet
- *Internet standards*
  - RFC: Request for Comments
  - IETF: Internet Engineering Task Force





# What's a protocol?

## *Human protocols:*

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

Rules for:

- ... specific messages sent
- ... specific actions taken  
when message received,  
or other events

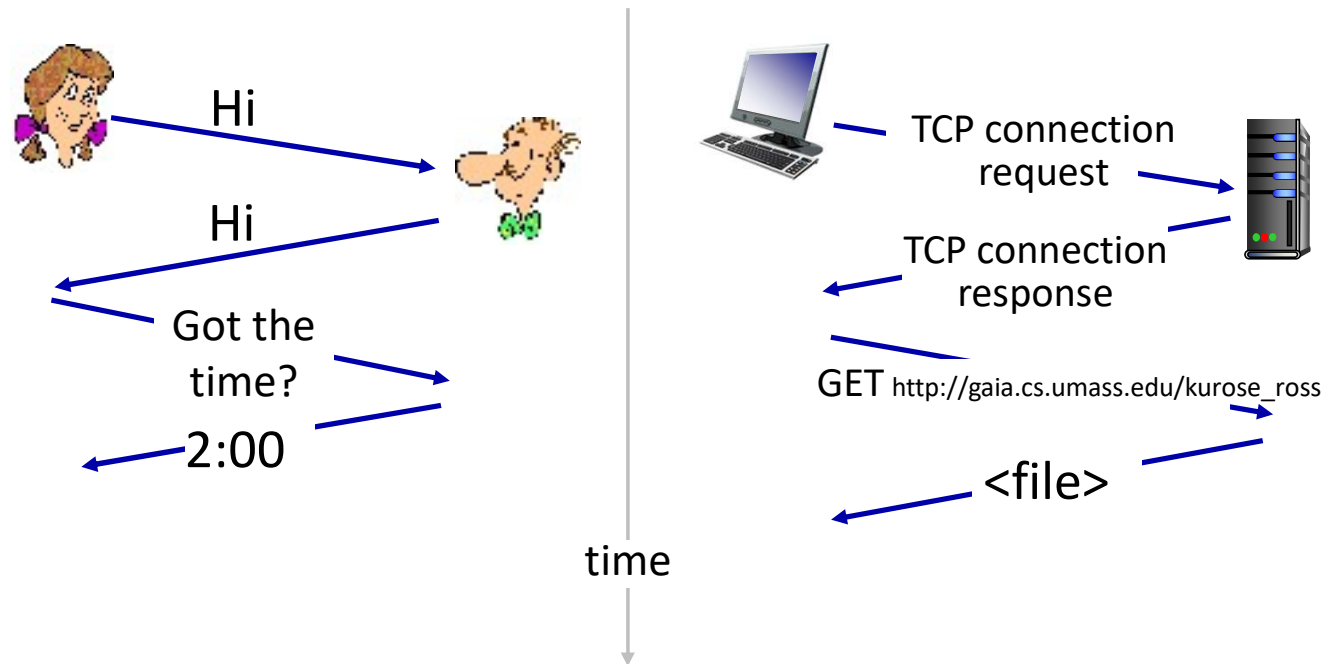
## *Network protocols:*

- computers (devices) rather than humans
- all communication activity in Internet  
governed by protocols

*Protocols define the **format, order** of  
**messages sent and received** among  
network entities, and **actions taken**  
on message transmission, receipt*

# What's a protocol?

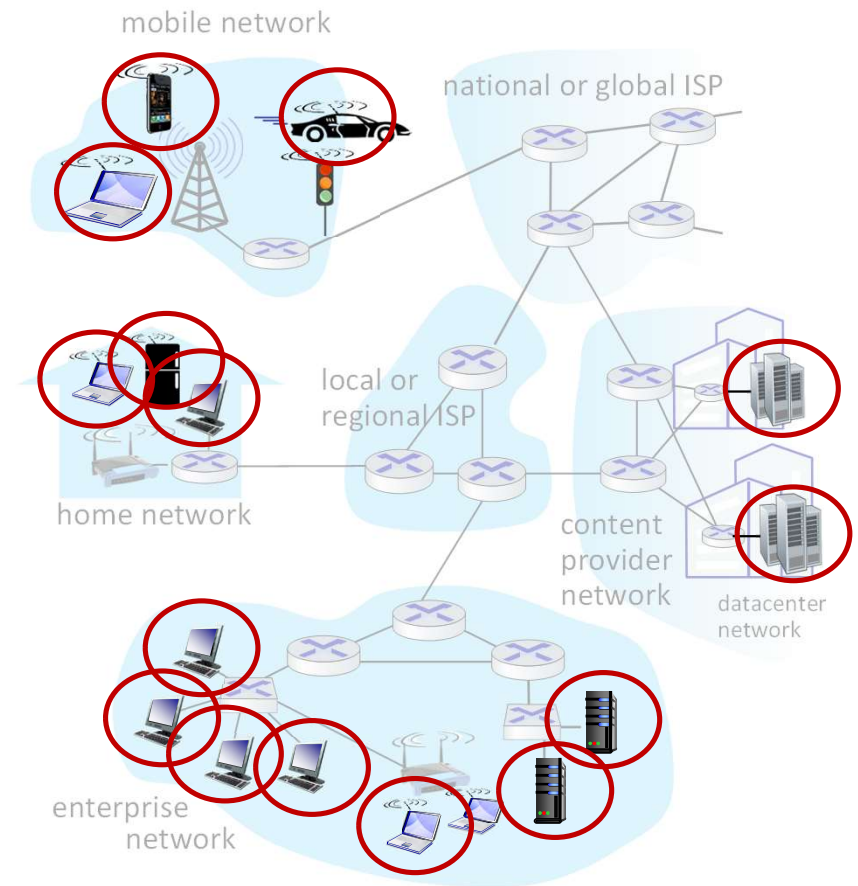
A human protocol and a computer network protocol:



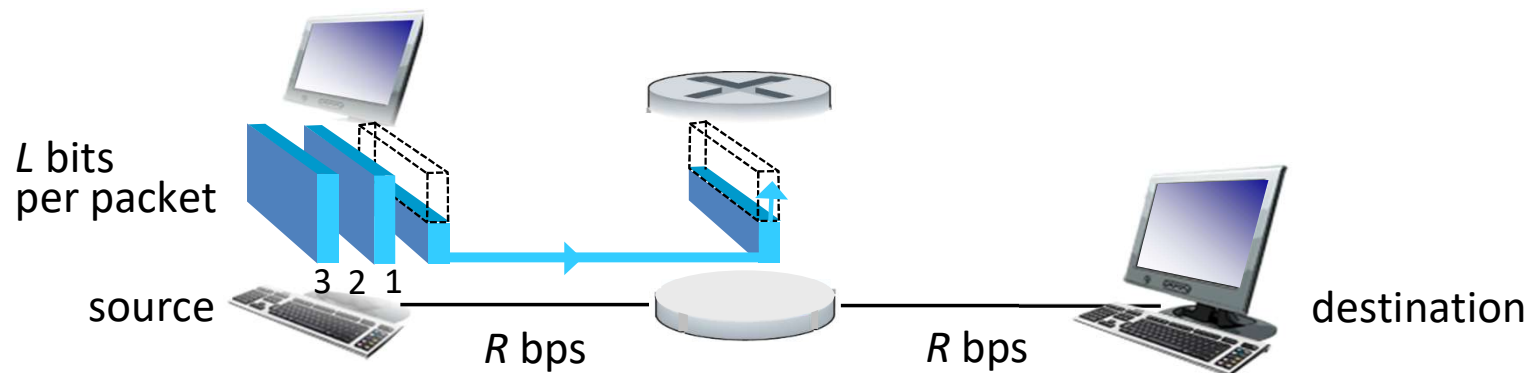
# A closer look at Internet structure

## Network edge:

- hosts: clients and servers
- servers often in data centers



# Packet-switching: store-and-forward



- **packet transmission delay:** takes  $L/R$  seconds to transmit (push out)  $L$ -bit packet into link at  $R$  bps
- **store and forward:** entire packet must arrive at router before it can be transmitted on next link

## *One-hop numerical example:*

- $L = 10$  Kbits
- $R = 100$  Mbps
- one-hop transmission delay = 0.1 msec

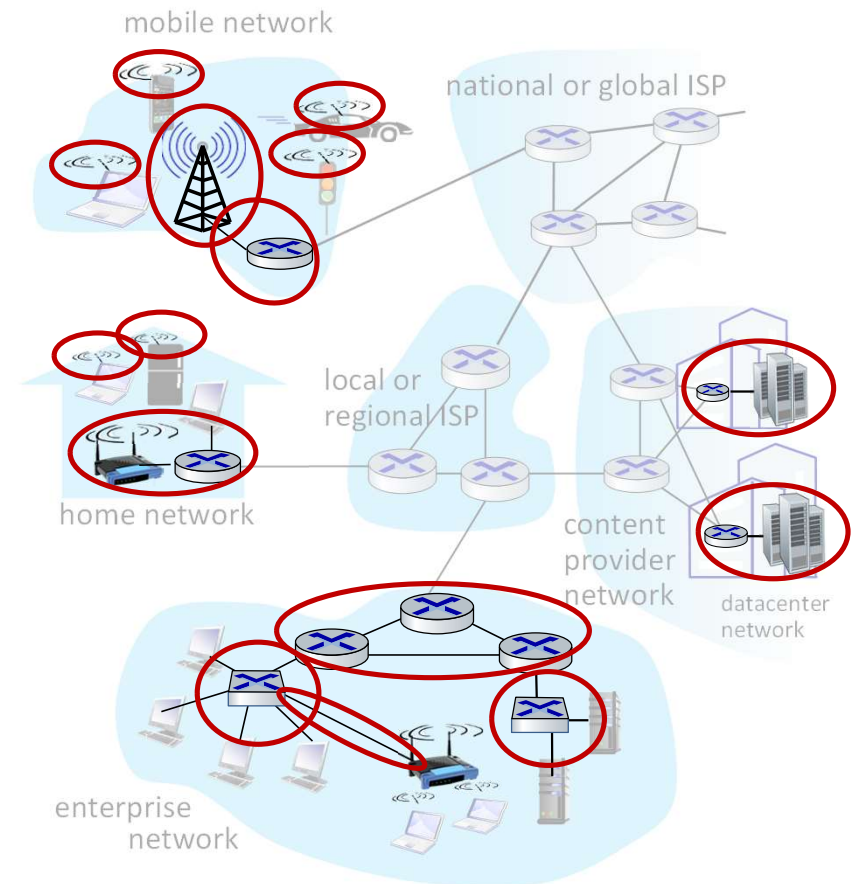
# A closer look at Internet structure

## Network edge:

- hosts: clients and servers
- servers often in data centers

## Access networks, physical media:

- wired, wireless communication links



# A closer look at Internet structure

## Network edge:

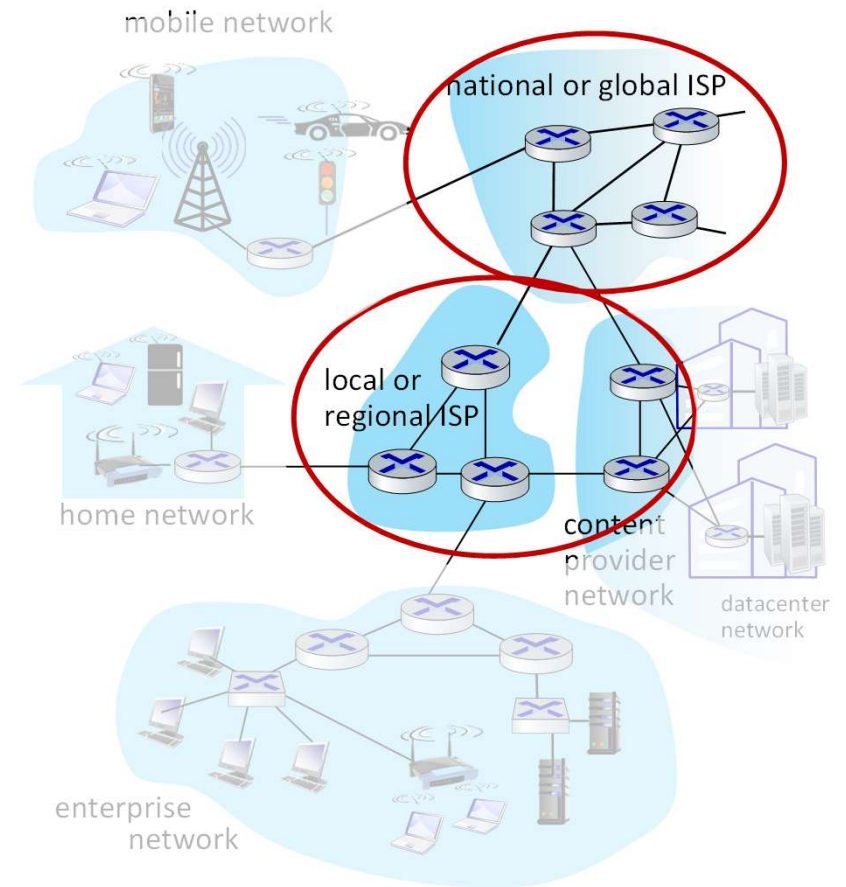
- hosts: clients and servers
- servers often in data centers

## Access networks, physical media:

- wired, wireless communication links

## Network core:

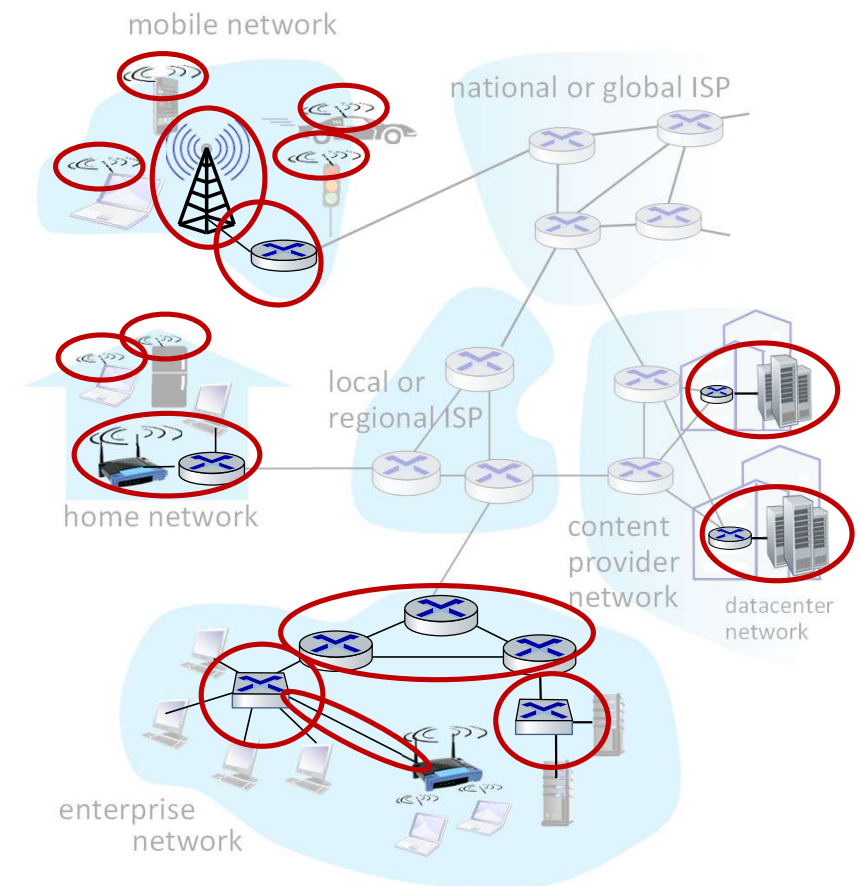
- interconnected routers
- network of networks



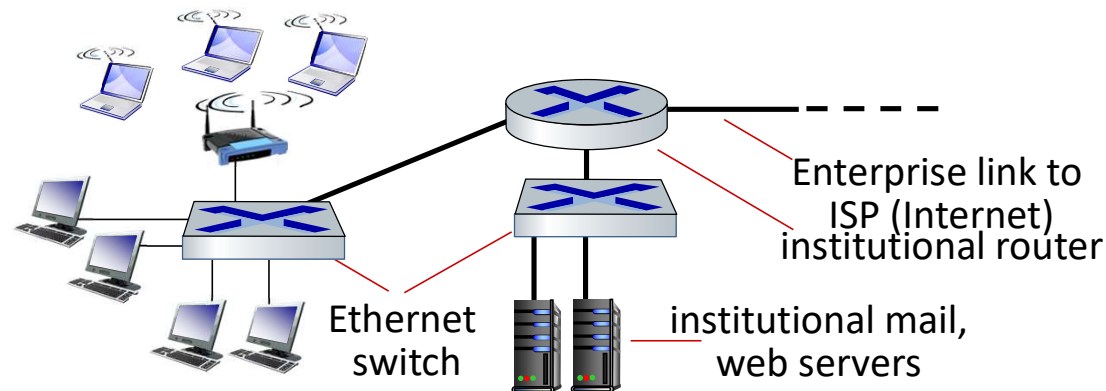
# Access networks and physical media

*Q: How to connect end systems to edge router?*

- residential access nets
- institutional access networks (school, company)
- mobile access networks (WiFi, 4G/5G)



# Access networks: enterprise networks



- companies, universities, etc.
- mix of wired, wireless link technologies, connecting a mix of switches and routers (we'll cover differences shortly)
  - Ethernet: wired access at 100Mbps, 1Gbps, 10Gbps
  - WiFi: wireless access points at 11, 54, 450 Mbps



# Access networks: data center networks

- high-bandwidth links (10s to 100s Gbps) connect hundreds to thousands of servers together, and to Internet



Courtesy: Massachusetts Green High Performance Computing Center ([mghpcc.org](http://mghpcc.org))

