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# Advanced Networks

(EENGM4211)

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Best Contact : Microsoft Team

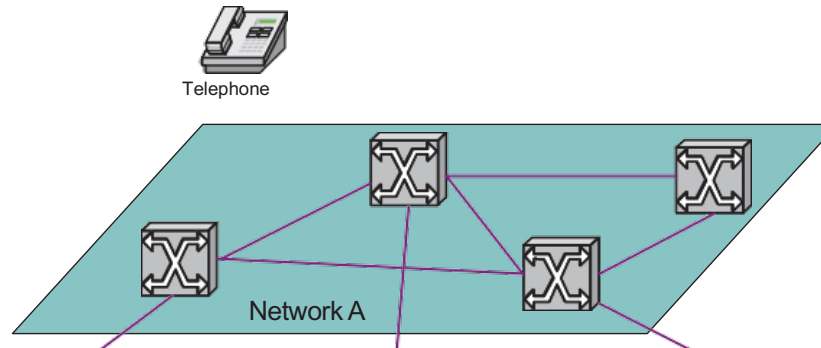
- Module lead → ***Dr. Rasheed Hussain***
- This course is divided in 6 parts:
  - Introduction
  - Internet Routing and Switching
  - IP Multicast
  - Networking for Realtime Applications
  - Routing in Wireless Networks
  - Quality of Service
- Exam is 100% final,

- Cybersecurity enthusiast
- Worked on vehicular communication security since 2008
- Worked on autonomous cars security
- Internet of Things security
- SDN and blockchain security & Trust
- AI for cybersecurity AND
- Digital Twins security

# Part 1: Introduction

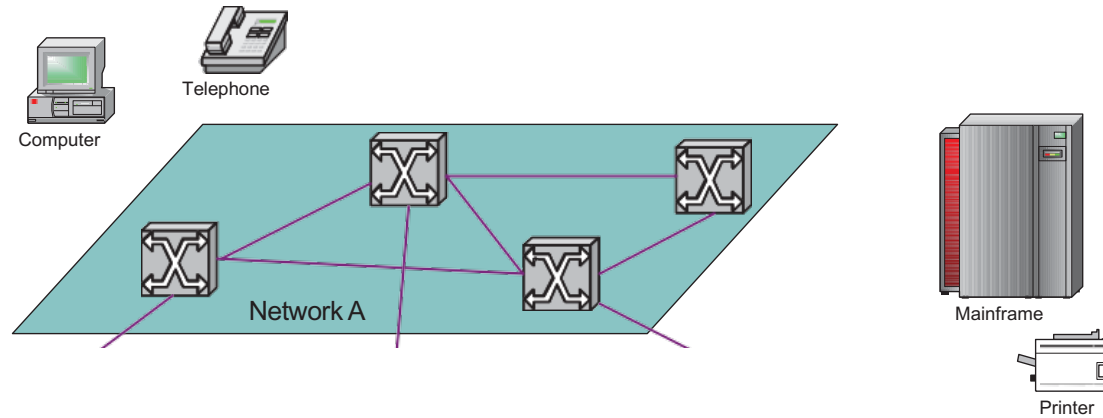
# Voice communication

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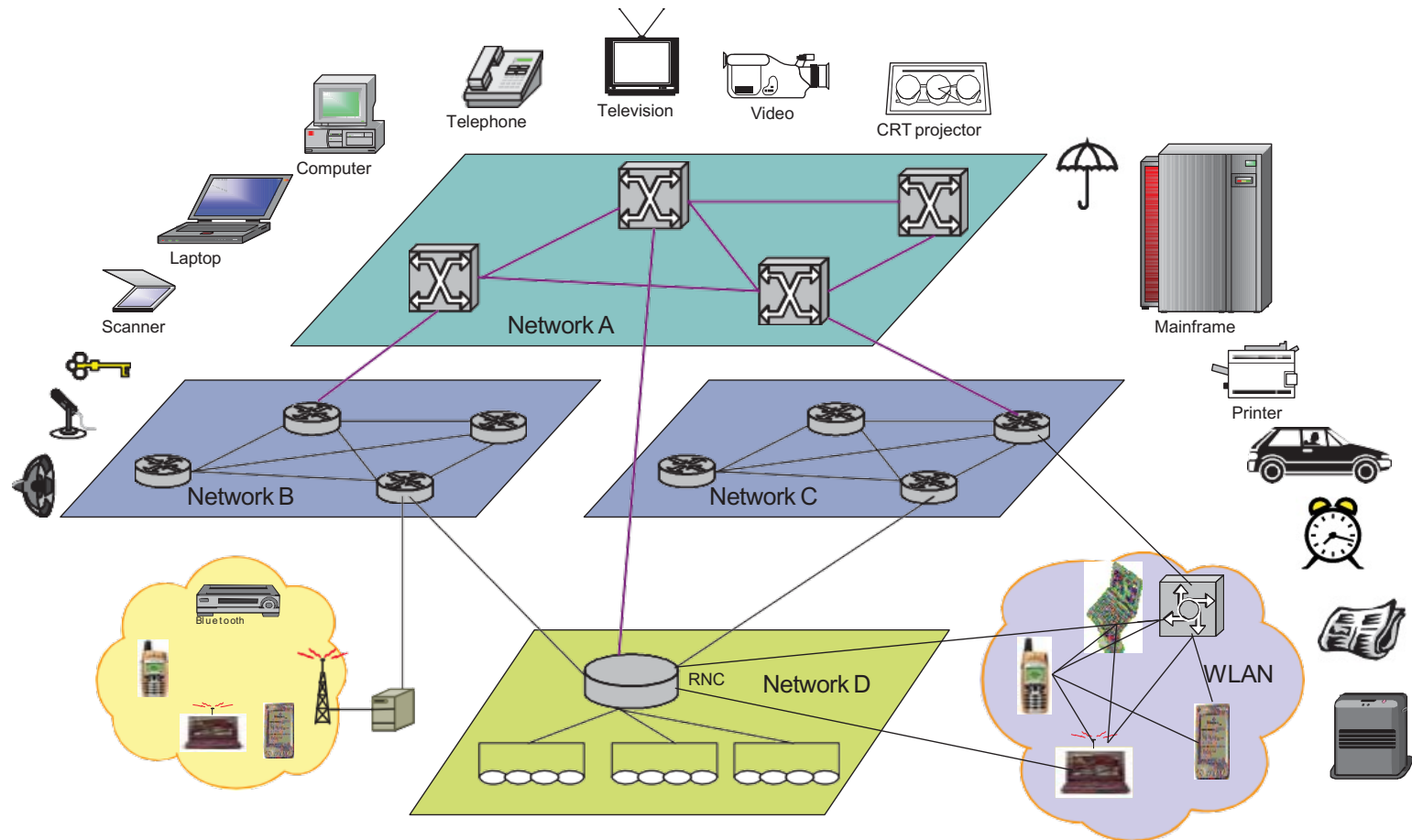
- Until '*recently*', the network was solely used for telephony
  - Of course occasionally for other applications (email, file sharing) as well

# Data connectivity

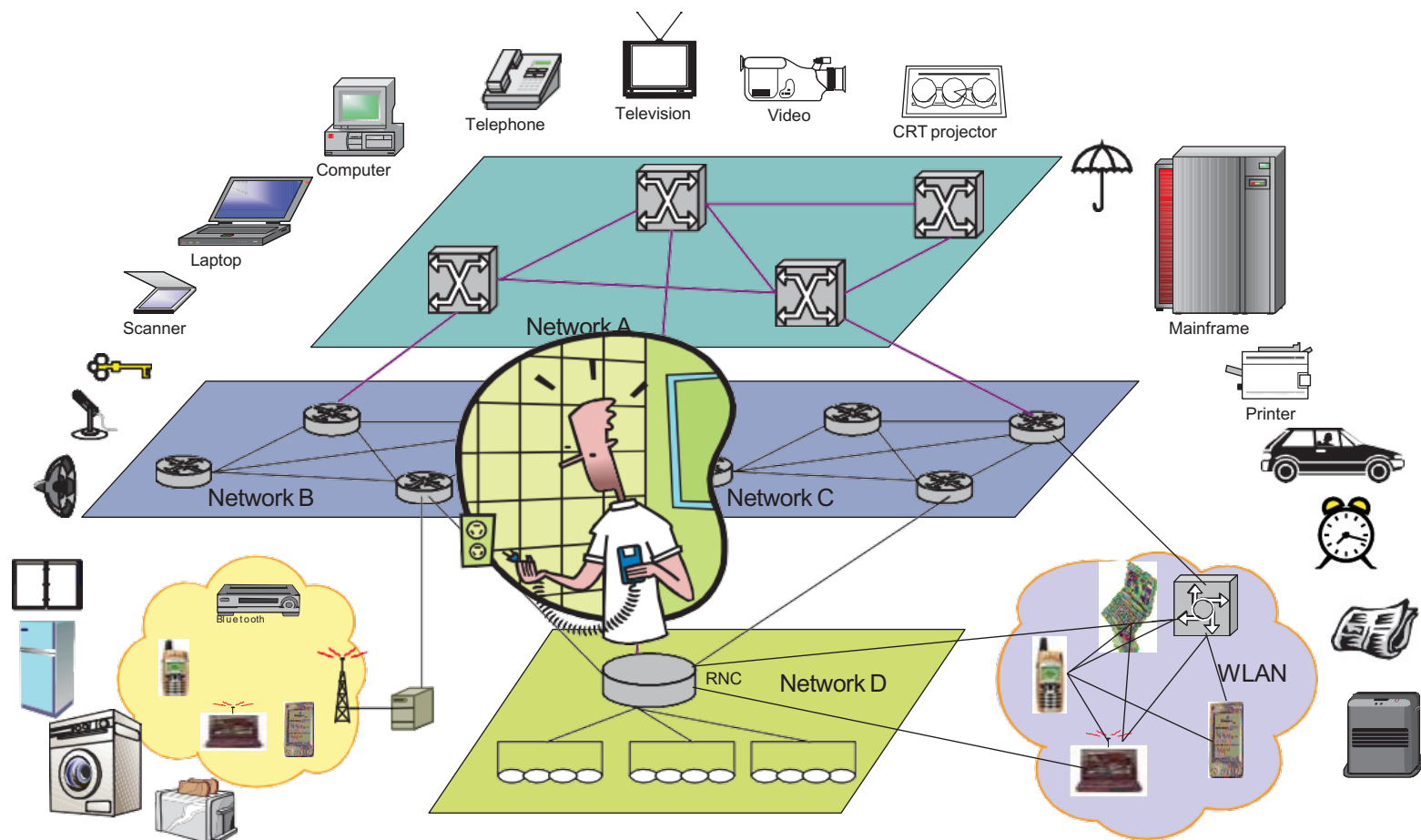


- Then we added more resources (computational and storage) to it which enhanced the services and applications landscape

# Increased connectivity



# Increased connectivity and increased complexity





# Why Internet(-)working?

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The Internet has become a major driver in all aspects of communications

- IT, telephony, broadcast, consumer applications
- Convergence of technologies
- Very fast evolution

**Reliability and Quality of Service: Still open**

**AND**

***Security and Privacy: Still open***

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- IP Routing - how do packets get where they are supposed to (most of the time anyway)?
- Multicast IP - how do multi-sender multi-receiver communications work?
- Real-Time Protocol - how to send real-time content over the internet?
- Congestion and QoS in the Internet - (how to ensure certain quality of the communication?)
- Wireless Networking - Ad-hoc networking in wireless networks.

Books will provide basic reading  
(material partially used for slides too):

- *Computer Networking: A Top Down Approach Featuring the Internet, 2nd ed., Kurose, J & Ross, K.*

or

Computer Networks, 3d/4th ed., Tanenbaum, A.

or

Computer Networks, 2nd Ed., Peterson, L., & Davie., B.

- Multicasting on the Internet and its Applications, Paul, S.
- Selected papers for each part of the lecture series.
- Where book references are given, the relevant chapters will be identified for each part.

- Exam
  - Blackboard Exam **(NOT CONFIRMED YET!)**
  - Details to be circulated later

# What is the Internet: several viewpoints

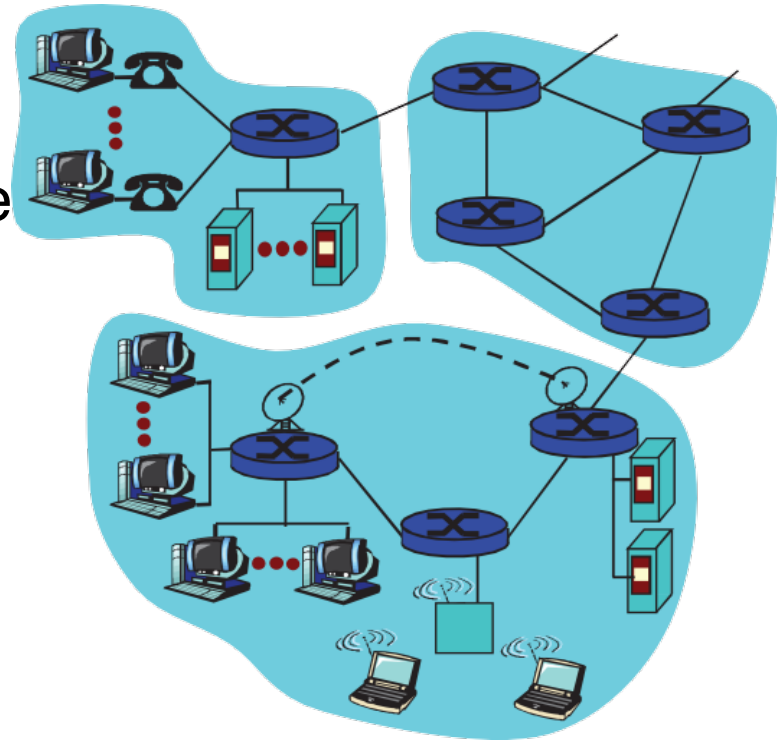
## A communication infrastructure

- Enables distributed applications:
- Web, email, games, e-commerce, database, voting, file (MP3) sharing

## Providing communication services to applications:

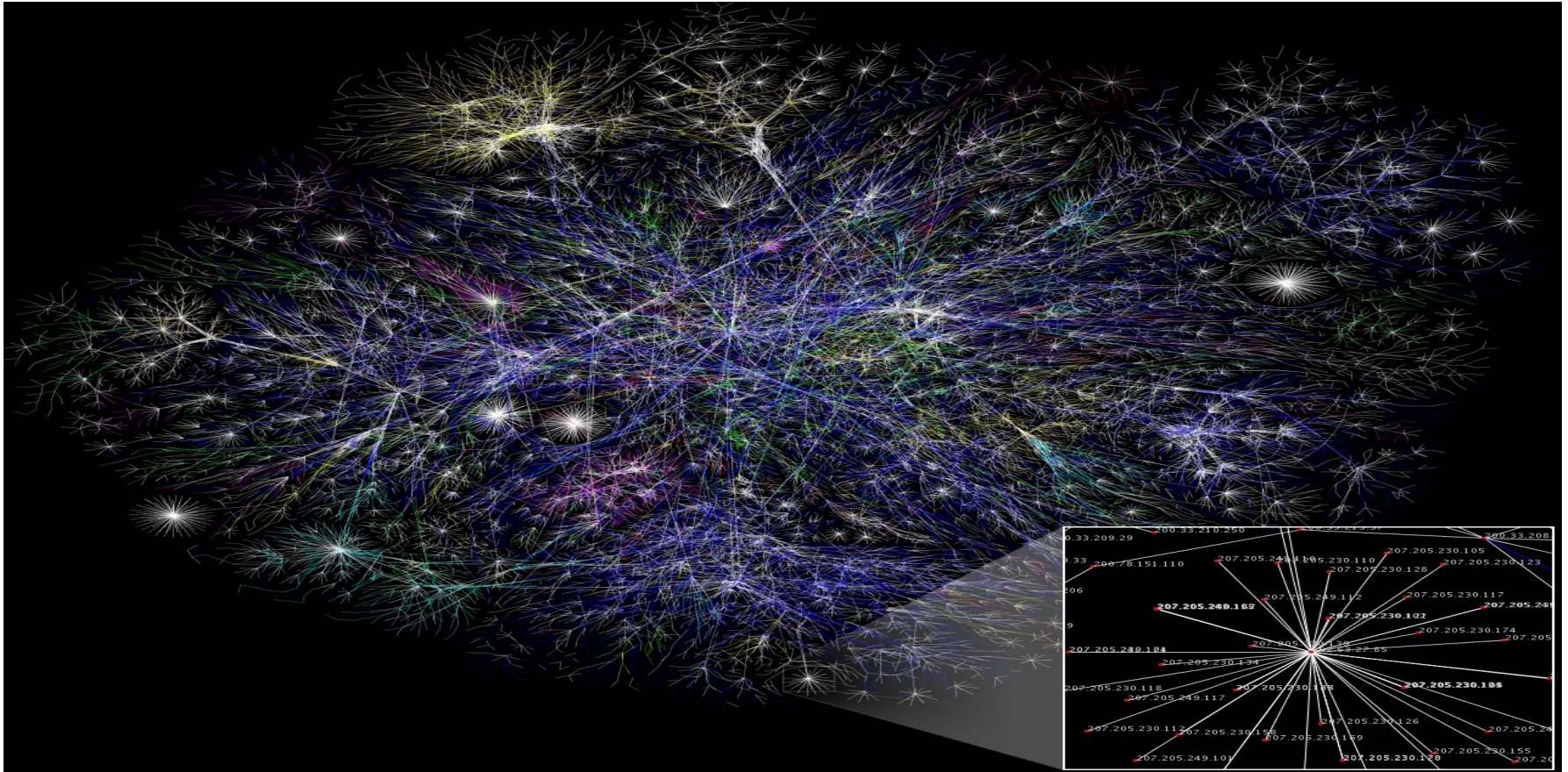
- Connectionless
- Connection-oriented

*"a consensual hallucination experienced daily by billions of operators, in every nation, ...."*





# An Internet Map



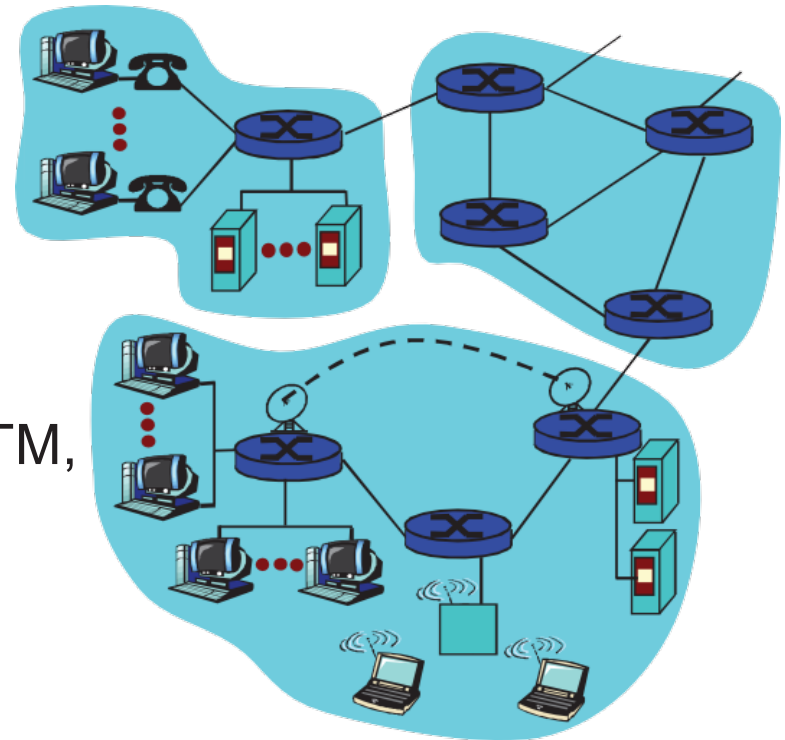
<https://internet-map.net>

<https://www.infrapedia.com/app>

bristol.ac.uk

# Internet: the system structure

- **Network edge:**  
Applications and hosts
- **Network core:**  
Routers  
Network of networks
- **Access networks, physical media:**  
Communication links: satellite, ATM,  
Ethernet, 802.11a/b/g, Bluetooth,  
IrDA,  
...



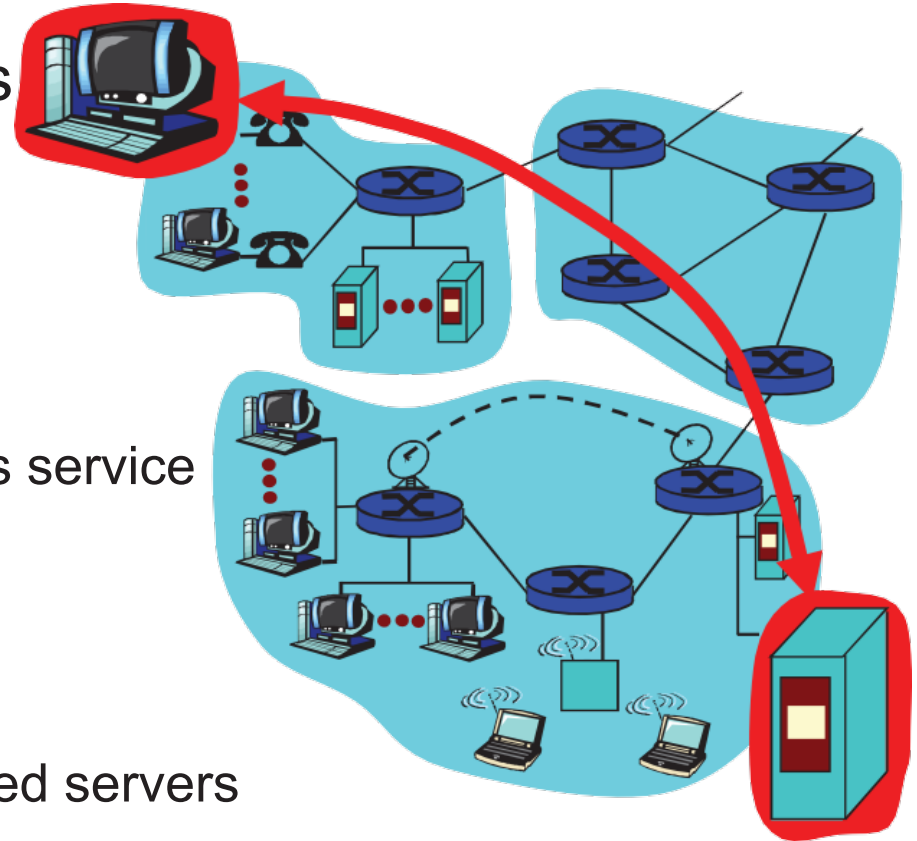
# The network edge

## End systems (hosts):

- Run application programs
  - » e.g., Web, email, file sharing
- At the "edge of network"

## Interaction models:

- **client/server**
  - » Client hosts requests, receives service from always-on server
  - » e.g., Web browser/server; email client/server
- **peer-2-peer**
  - » Minimal (or no) use of dedicated servers





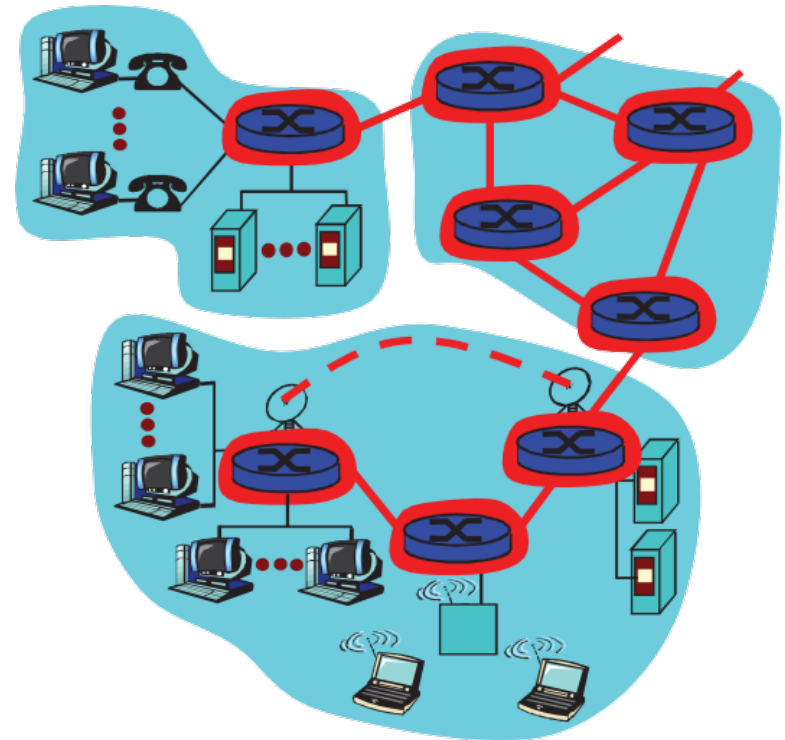
# Questions

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- 1. Which interaction is the one we have now?*
- 2. Which one is better to provide 'better' Quality of Service (QoS), P2P or C-S?*
- 3. Name some problems that both might have?*

# The Network Core

- Mesh of interconnected routers: network of networks
- **The fundamental question:** how is data transferred through the network system?
  - **circuit-switching:** dedicated circuit per call: telephone net
  - **packet-switching:** data sent through the net in packets (discrete chunks)



# Questions

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- 1. What would be the best example of circuit and packet switching?*
- 2. When you use WhatsApp or WeChat through WiFi, then?*
- 3. When you use WhatsApp or WeChat through your cellular Internet, then?*
- 4. How about 5G?*

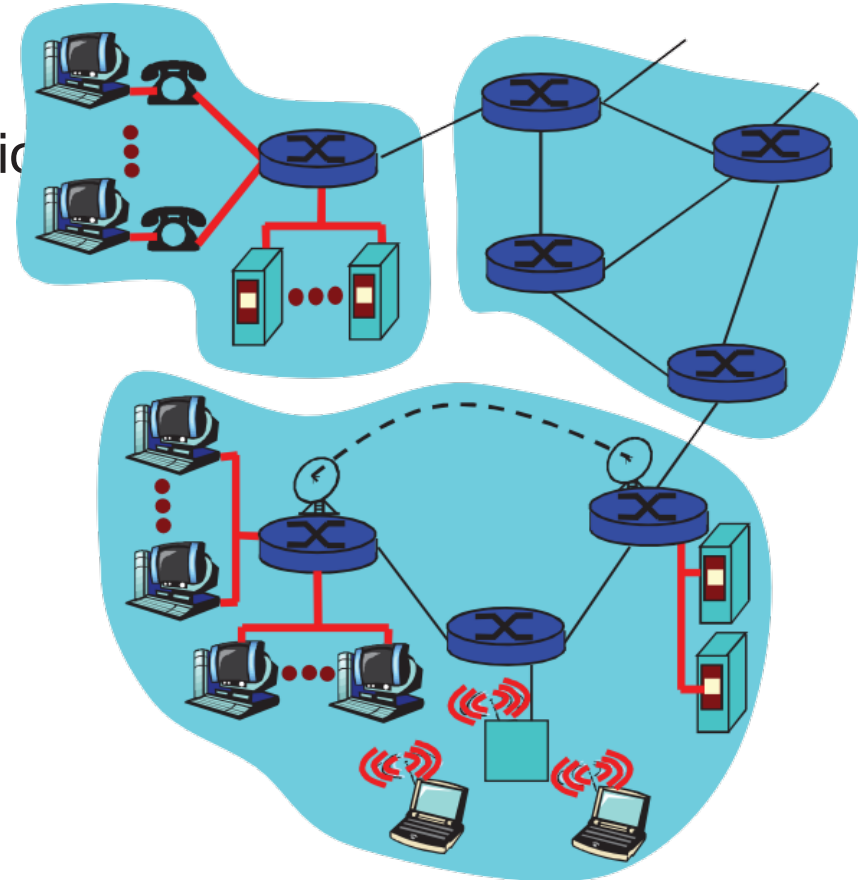
# Access networks and physical media

## *How are end systems connected to edge router?*

- residential access nets
  - » xDSL, cable modem, PSTN modem, ISDN, fixed radio, satellite, power line . .
- institutional access networks (school, company)
  - » Leased line of some sort (min. ISDN or xDSL)
- mobile access networks
  - » *any examples?*

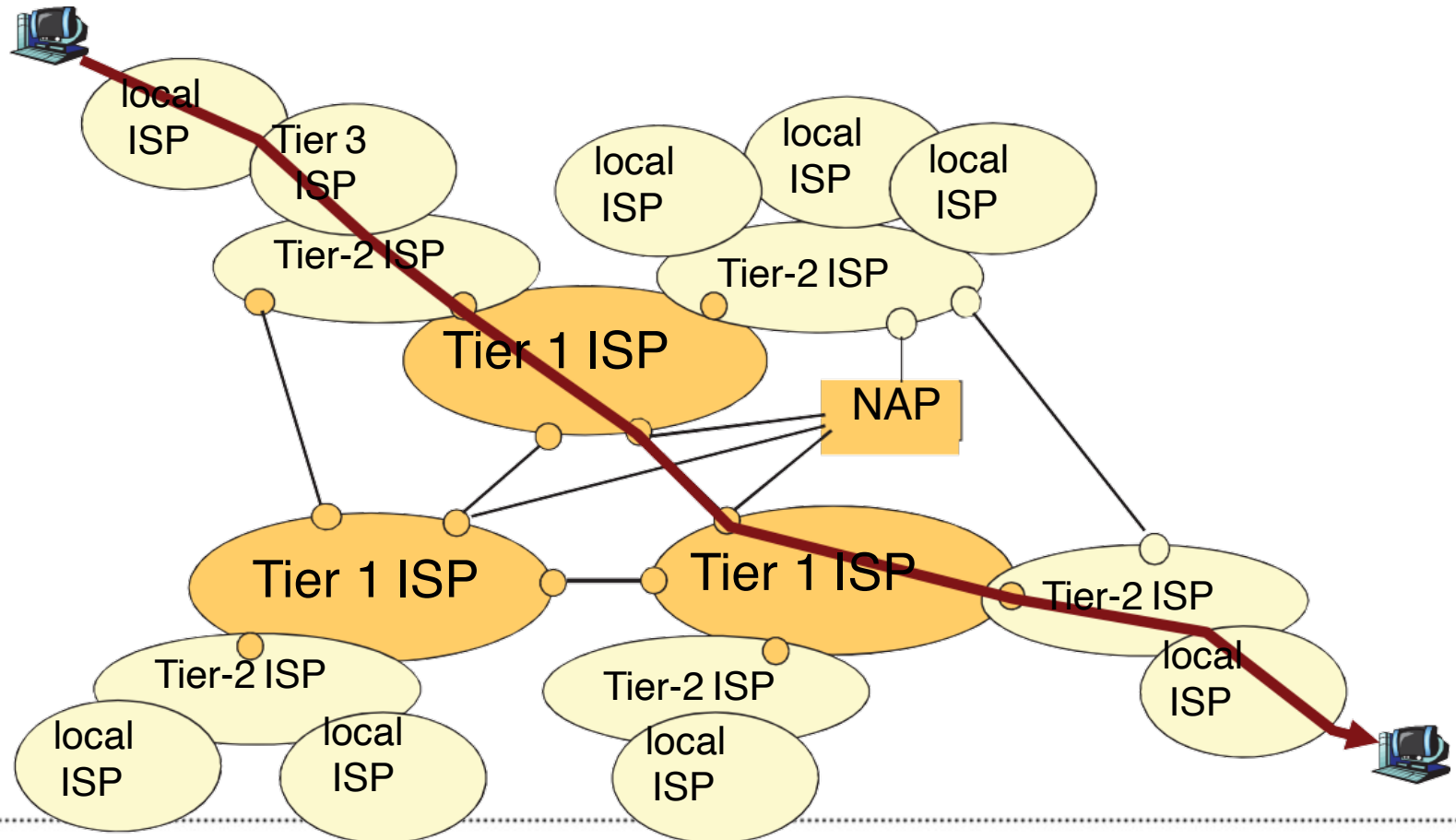
## *Keep in mind:*

- bandwidth (bits per second) of access network?
- Is it shared or dedicated?



# Internet structure: network of networks

- A packet passes through many networks!



## Networks are complex systems!

- Hosts
  - Routers
    - Including dual-role nodes (e.g., in some wireless networks)
  - Links of various media
  - Applications
  - Protocols
  - Hardware & software
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1. Introduction
- 2. Internet Routing and Switching**
3. IP Multicast
4. Networking for Realtime Applications
5. Routing in Wireless Networks
6. Quality of Service