

Introduction to Computer Networks



Lecture 1

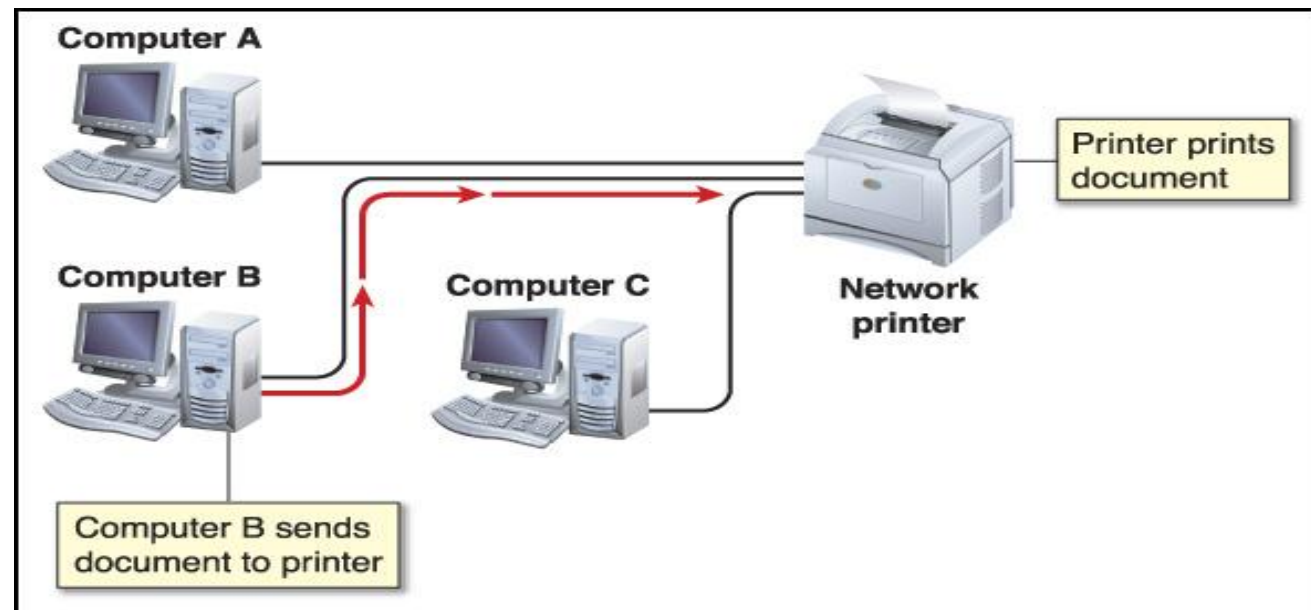
Textbooks



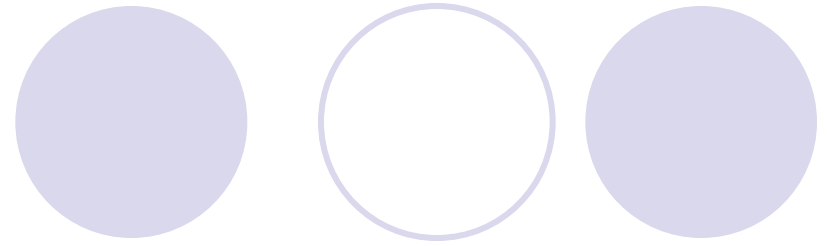
- Introduction to Networks and Networking, Hector J. Caban, by McGraw-Hill 2005
- *Computer Networks and Internets* 5th Edition, Douglas Comer, Prentice Hall, 2011.
- Kurose and Ross, Computer Networking: A Top-Down Approach, 4th Edition, Addison-Wesley, 2008
- More important, Lecture notes

Why Networks

- Increases efficiency and cost-effectiveness
 - File sharing
 - Share resources
- Overcome geographic limits
- Access remote data
- Separate clients and server



How to connect?



● Link

- **DSL, cable, wireless,...**

- Characterized by

- Capacity or bit-rate (1.5 Mb/s, 100Mb/s, ...)
- Propagation delay (10us, 10ms, 100ms, ..)

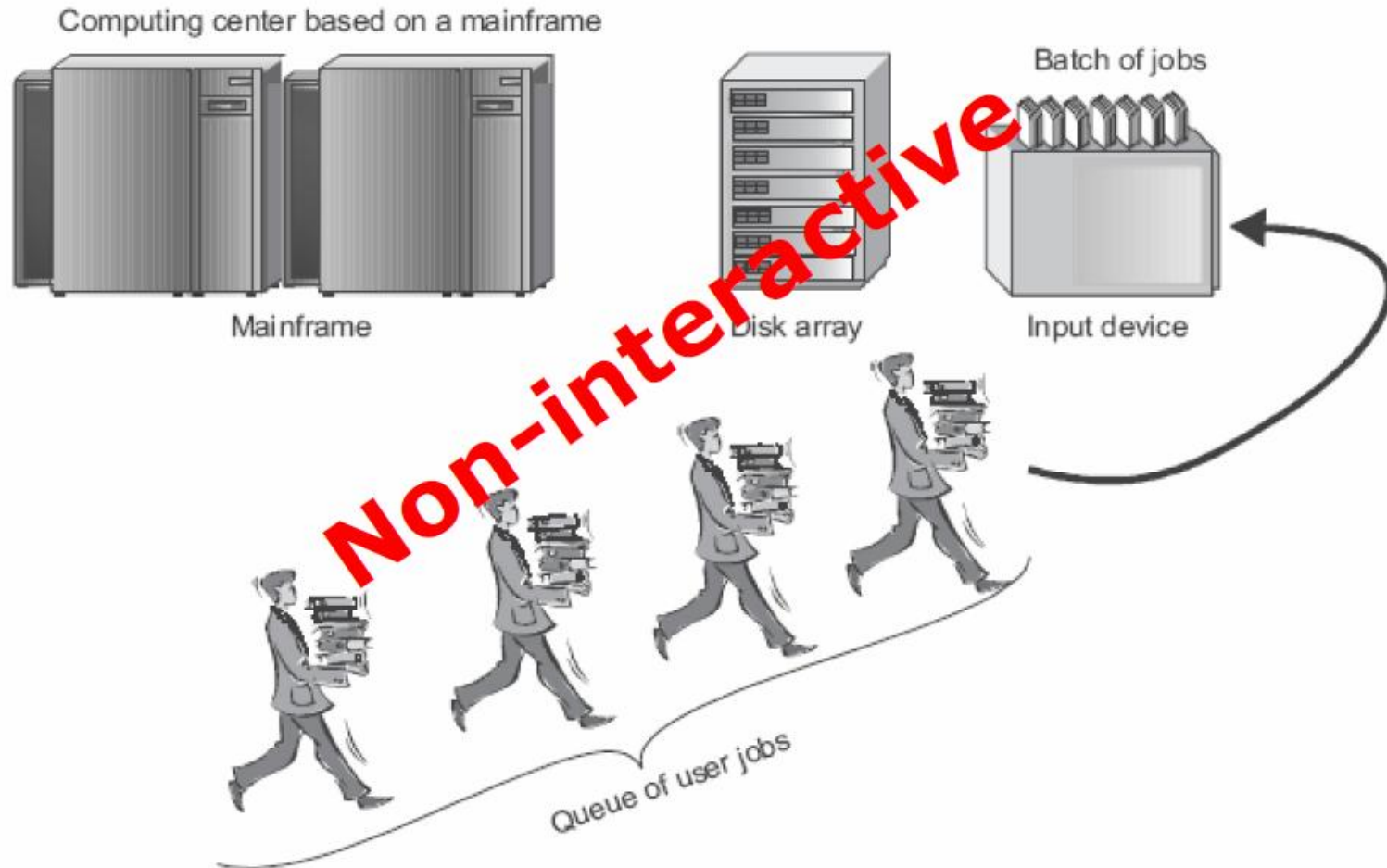




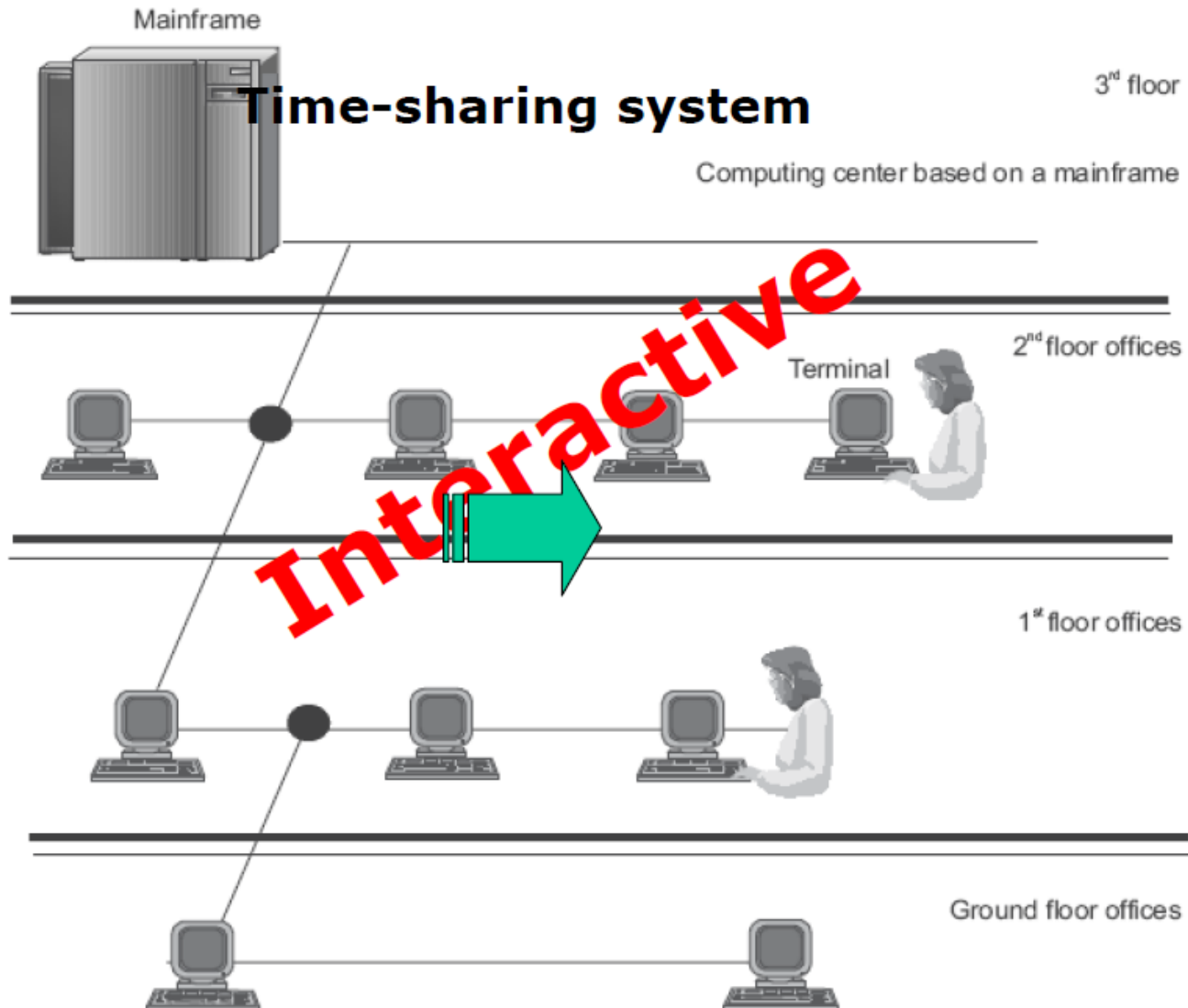
Services

- Distributed processing
- Communicating among people (electronic mail, conferencing)
- Increasing system reliability
- We are evolving into Internet-based enterprises, Internet-based home services, and an Internet society

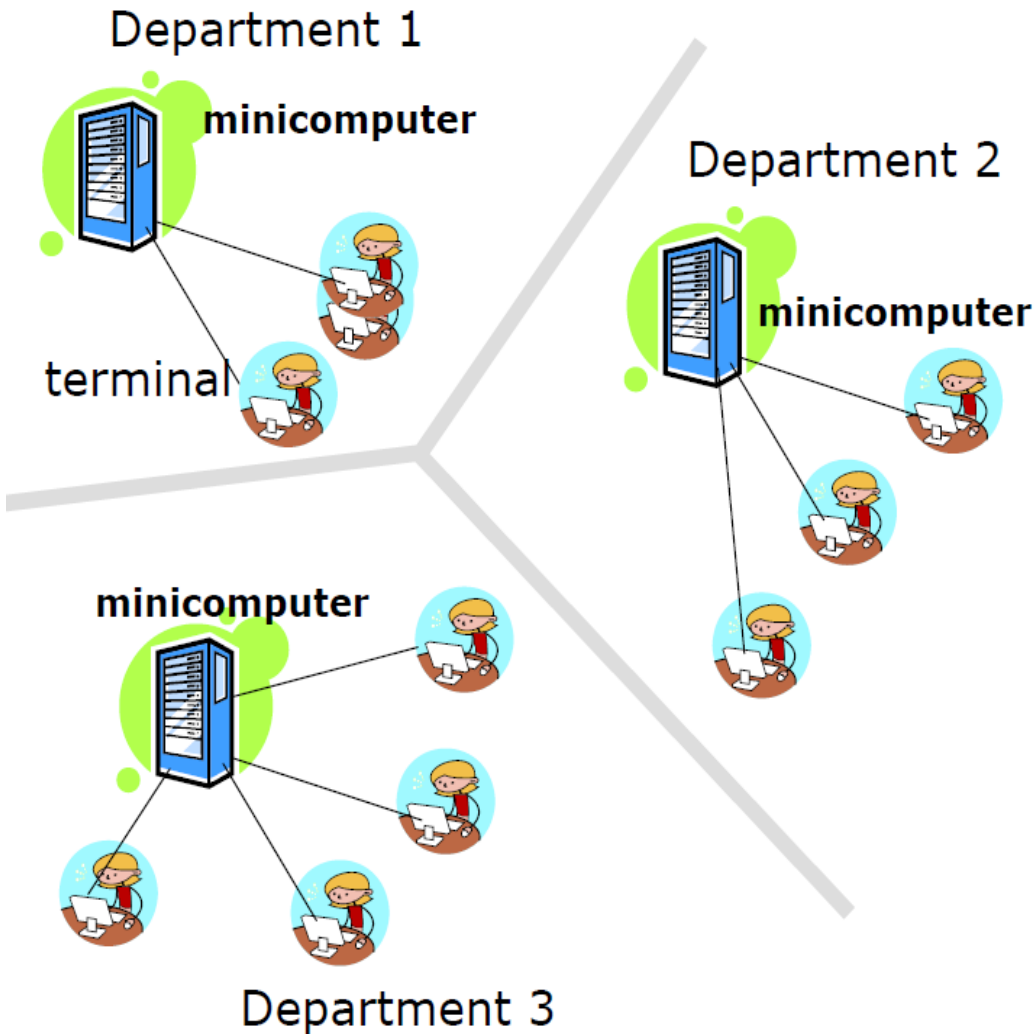
Evolution of Computer Networks: 1950s (batch processing)



1960s:multi-terminals



1970s: First Local Area Networks



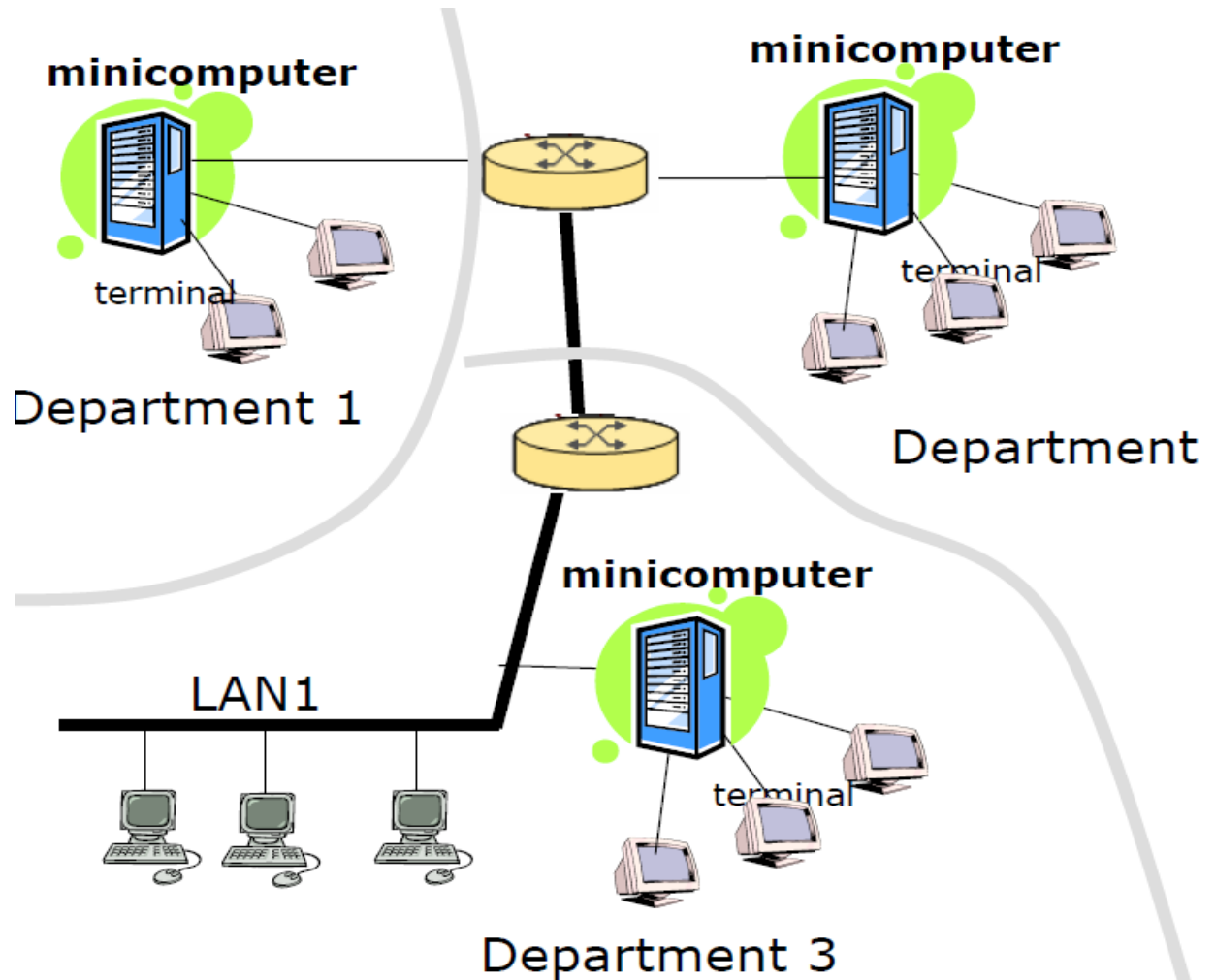
Driving forces for LANs

- Lowering cost, LSI
- Cheaper and powerful computers - PCs
- Need for better resource sharing

What is LAN?

- Groups of computers connected in a small region
- owned by an organization

Cont



Characteristics

- high speed
- low delay
- Eg. Ethernet, token ring, FDDI, etc
- Ethernet(10-1000 Mbps), has become the de facto LAN by late 90s

1970s: Wide Area Networks



➤ **WAN connects geographically distributed computers together**

➤ **Earlier Networks (DECNET, SNA, ARPANET) development has contributed to:**

- ★ Layered Network architecture
- ★ Packet switching technology
- ★ Packet routing in heterogeneous networks
- ★ Network OS
- ★ TCP/ IP

Brief history

- 60s : First experiments with batch-processing networks – terminal oriented network
- 1970s: began as a US Department of Defense network called ARPANET
- 1972-80: propriety networks and internetworking growing
 - ALOHAnet(packet radio), Telenet(BBN commercial packet switching network), Cyclades (French), Tymnet, IBM's SNA...
- 1980s: OSI (open system interconnection) reference
- 1983: official deployment of TCP/IP in ARPANET/MILNET
- 1980-85: Standardization of LANs (Ethernet, token ring, FDDI)

Brief history

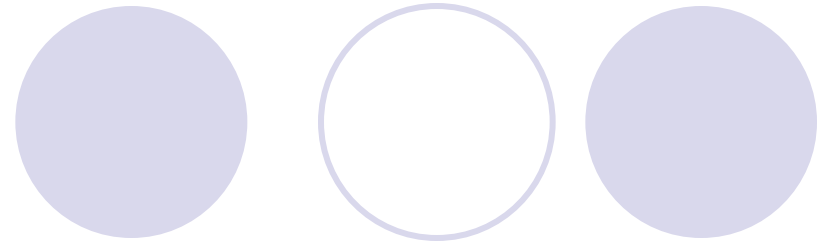
- 1980s late: Commercial use of internet
- 1990s: ATM evolves; does not replace IP
- WWW created in 1989-91 by [Tim Berners-Lee](#)
- popular web browsers released: Netscape 1994, IE 1995
- Early 2000 –dot com crashed
- Wireless bloom, P2P
- Ad-hoc wireless networks; self-configuring nets
- Networked sensors and appliances

Brief history



- Network convergence (Telecommunication and Computer networks) Multiservice networks: telephone, TV, video, radio, web apps, business, healthcare)
- Network-based community computing
 - Grid computing
 - Cloud computing

Internet/WWW



- **The Internet**

- Wikipedia: <http://en.wikipedia.org/wiki/Internet>
- Networks of computer networks

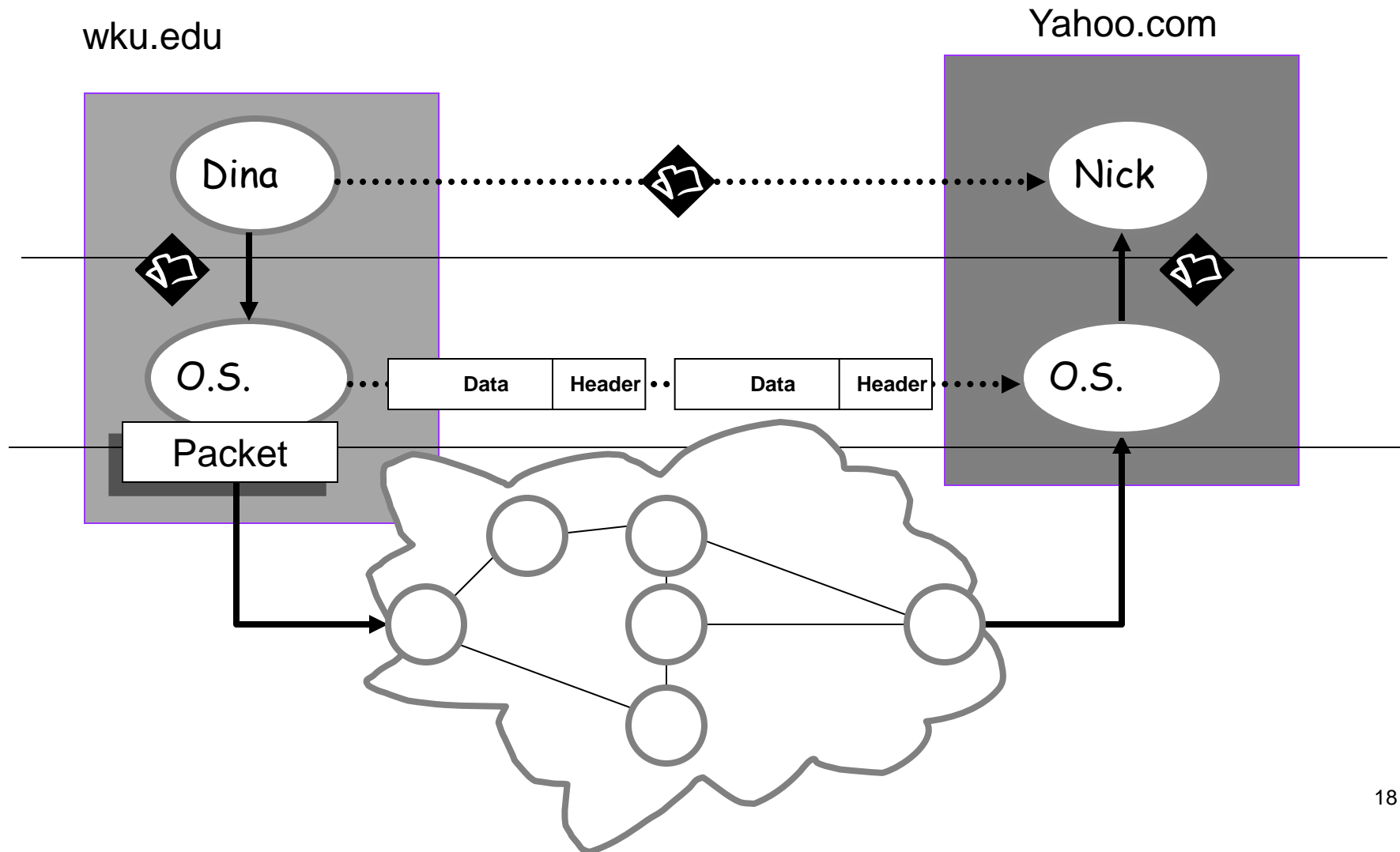
- **The World Wide Web (WWW)**

- http://en.wikipedia.org/wiki/World_Wide_Web
- A collection of interlinked hypertext document

People and organizations

- Internet Engineering Task Force ([IETF](#)): internet protocol standards
- Internet Corporation for Assigned Names and Numbers ([ICANN](#)): decides top-level [domain names](#)
- World Wide Web Consortium ([W3C](#)): web standards

The Internet as an Example

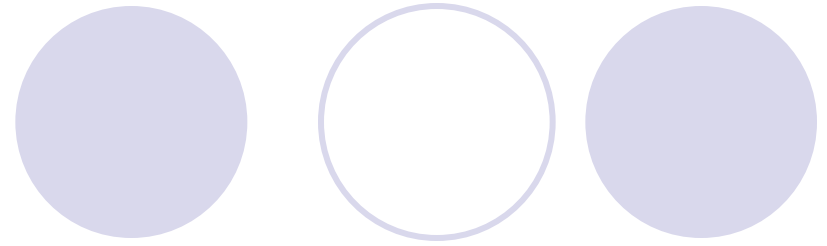




Characteristics of the Internet

- Each packet is individually routed
- No time guarantee for delivery
- No guarantee of delivery in sequence
- No guarantee of delivery at all!
 - Things get lost
 - Acknowledgements
 - Retransmission
 - ❖ How to determine when to retransmit? Timeout?
- If packet is re-transmitted too soon → duplicate

Best Effort

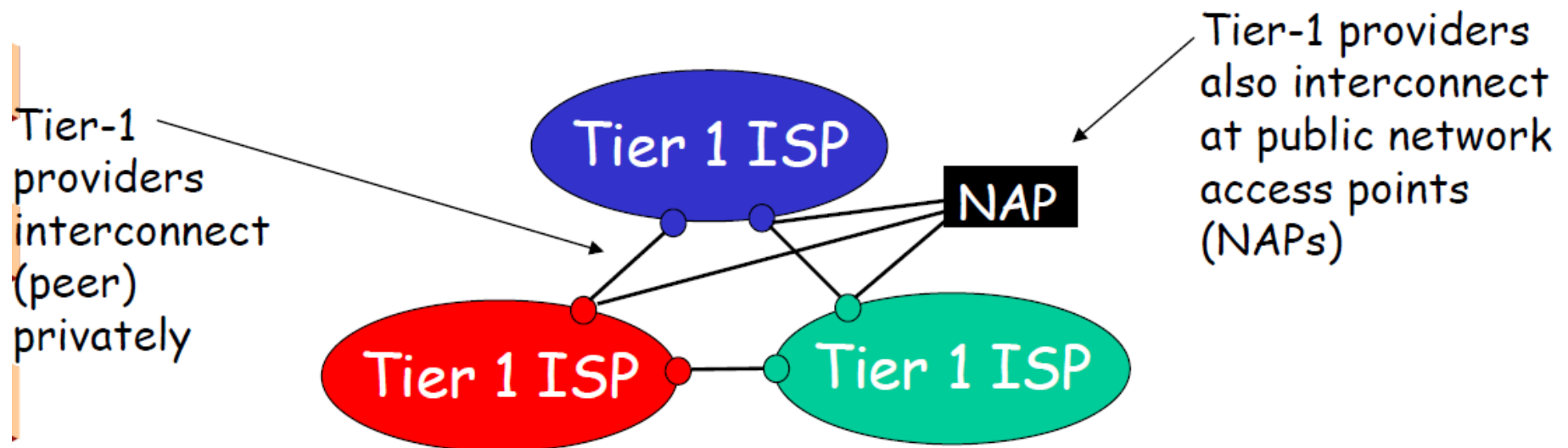


No Guarantees:

- Variable Delay (jitter)
- Variable rate
- Packet loss
- Duplicates
- Reordering
- (notes also state maximum packet length)

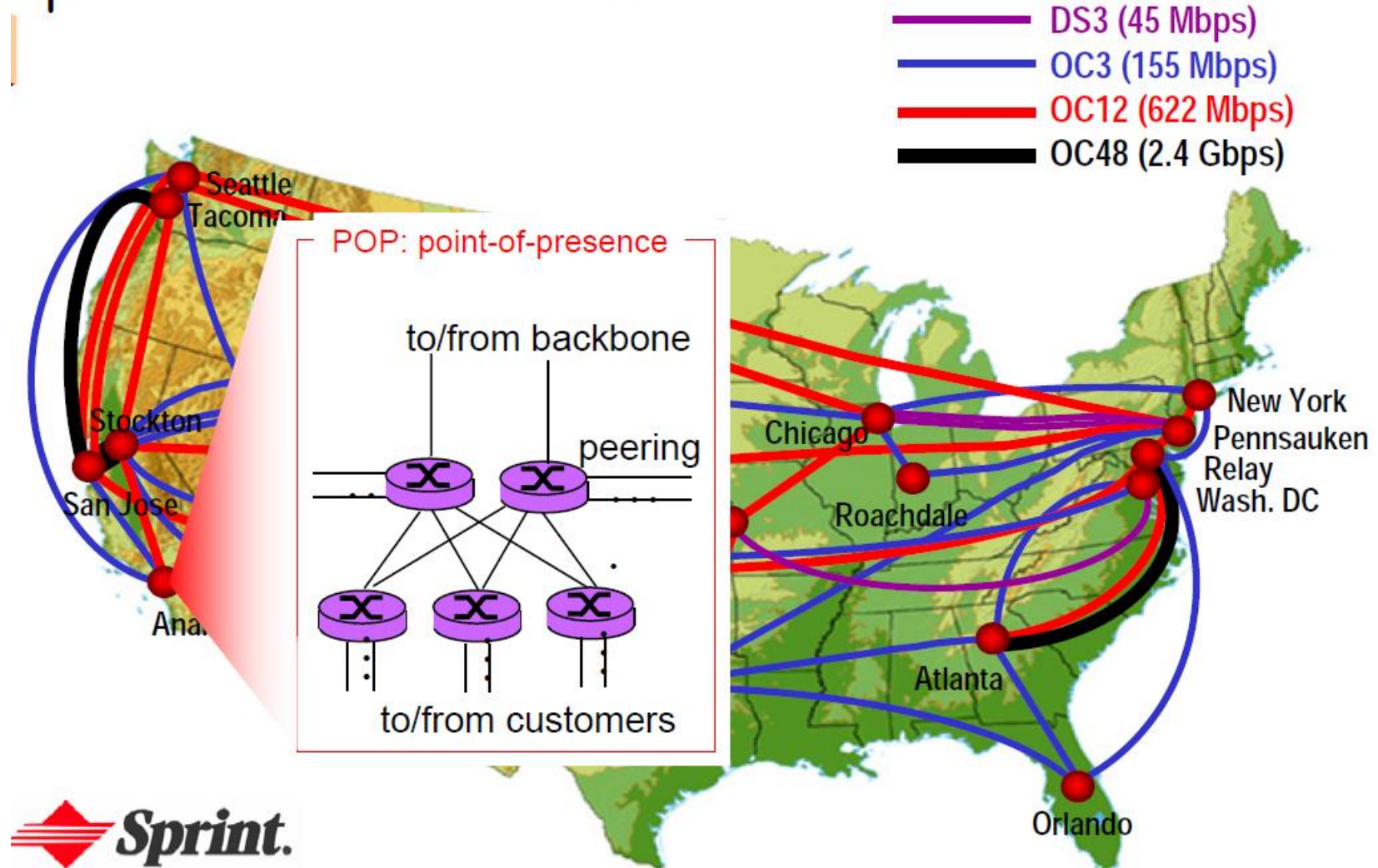
Internet Structure

- roughly hierarchical
- at center: "tier-1" ISPs (e.g., MCI, Sprint, AT&T, Cable and Wireless), national/international coverage
 - ★ treat each other as equals



Tier 1---Sprint

Sprint US backbone network

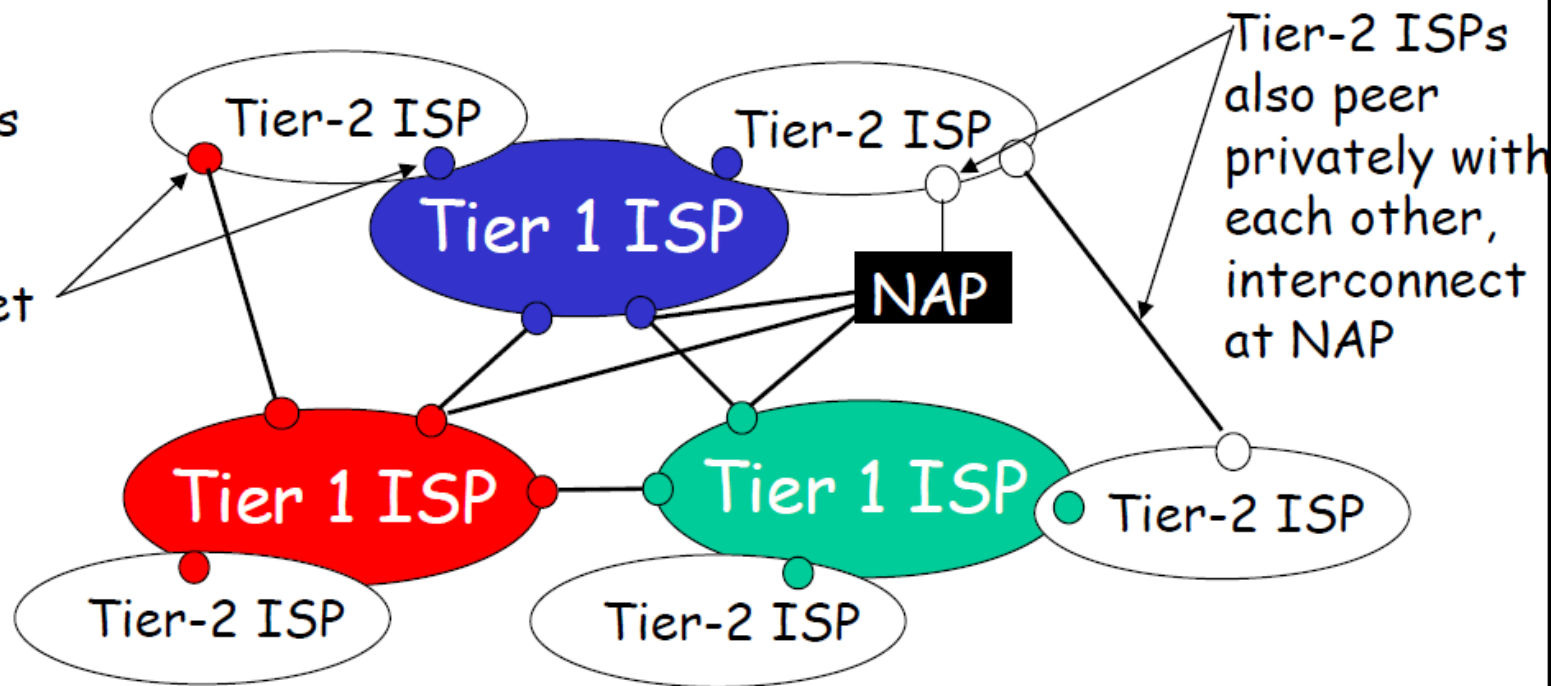


Tier-2

➤ "Tier-2" ISPs: smaller (often regional) ISPs

★ Connect to one or more tier-1 ISPs, possibly other tier-2 ISPs

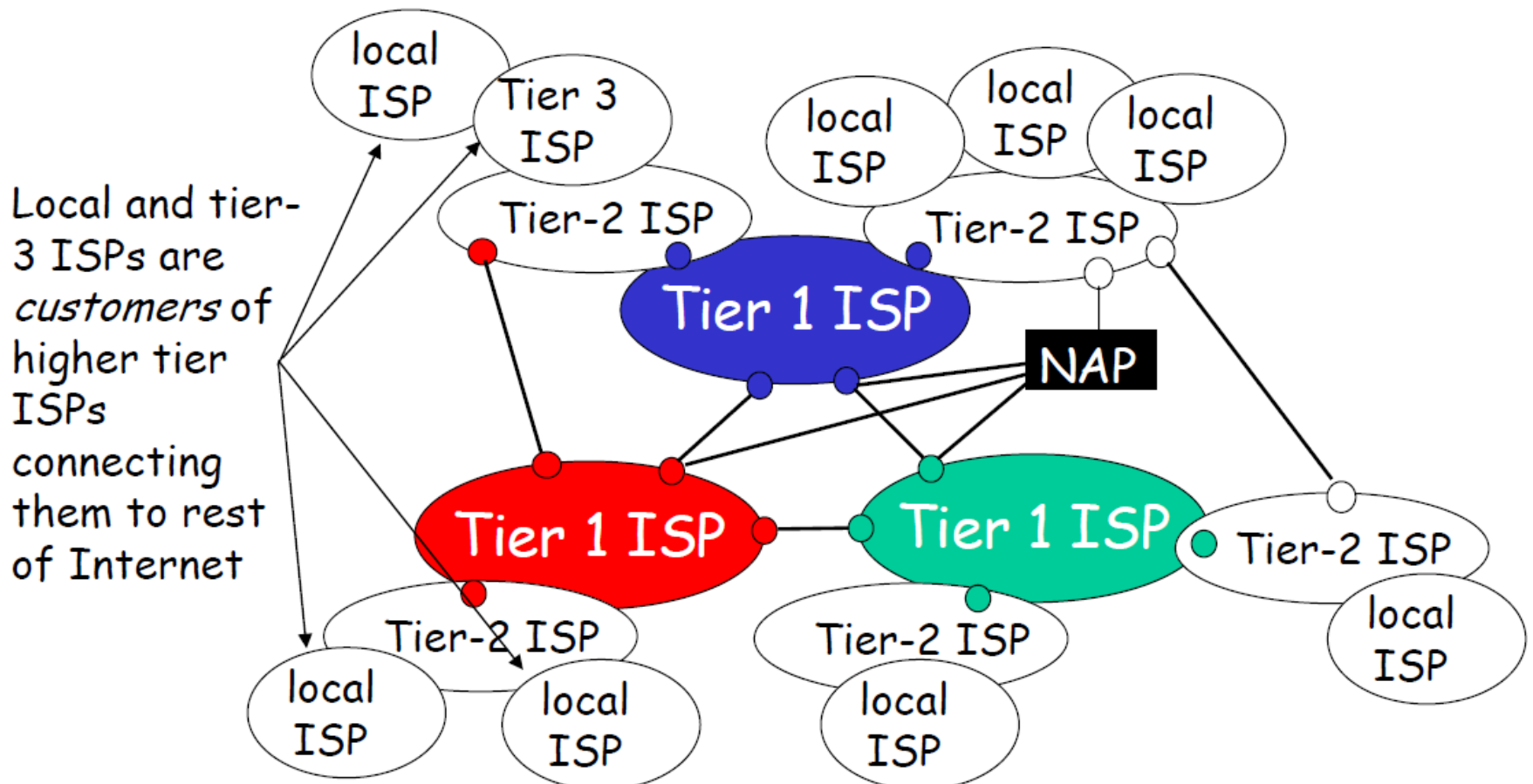
Tier-2 ISP pays tier-1 ISP for connectivity to rest of Internet
□ tier-2 ISP is customer of tier-1 provider



Tier-3

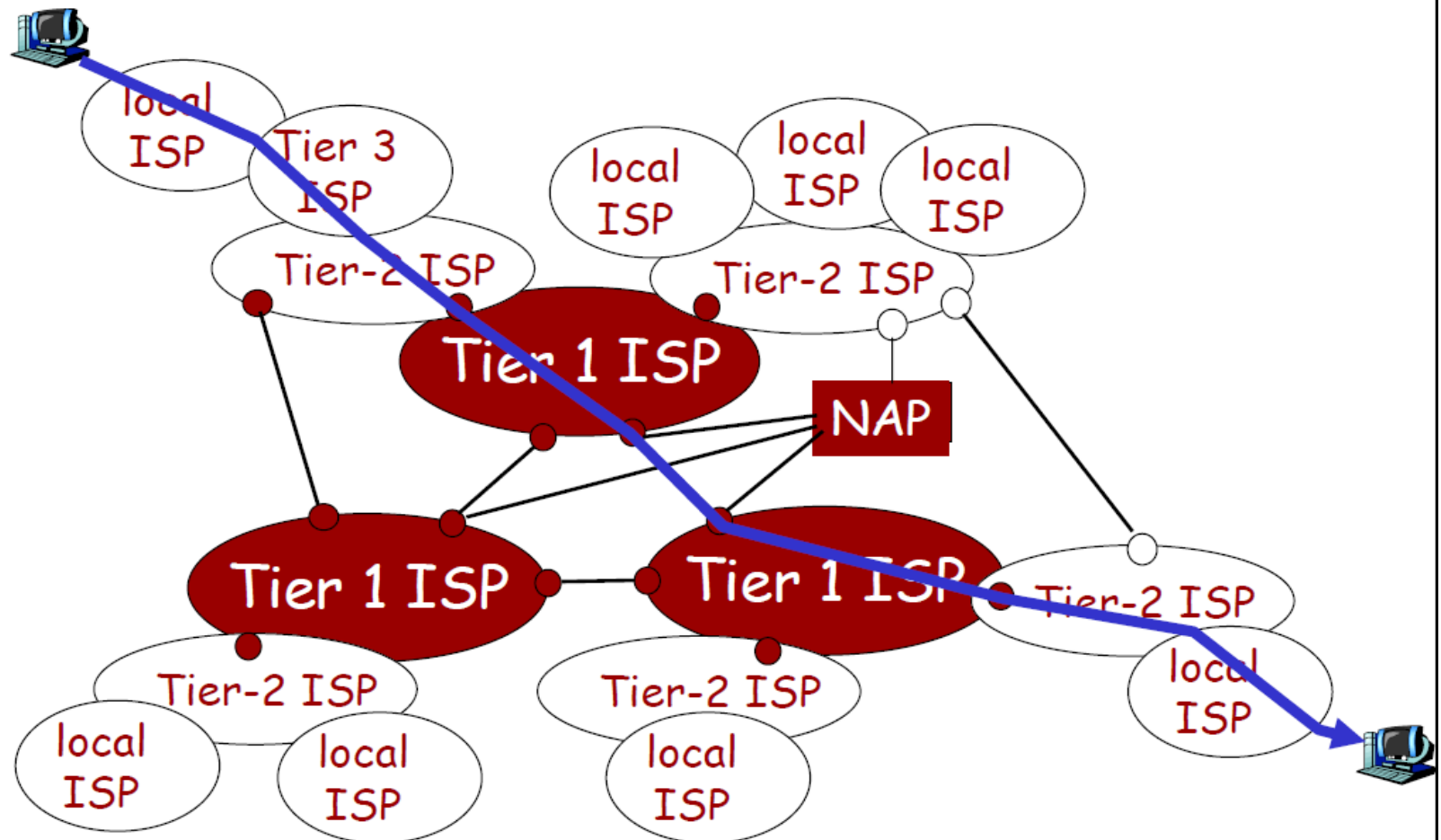
➤ "Tier-3" ISPs and local ISPs

★ last hop ("access") network (closest to end systems)



Internet Structure

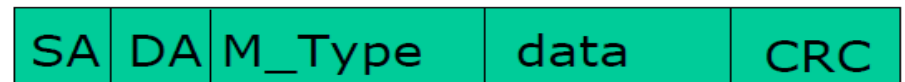
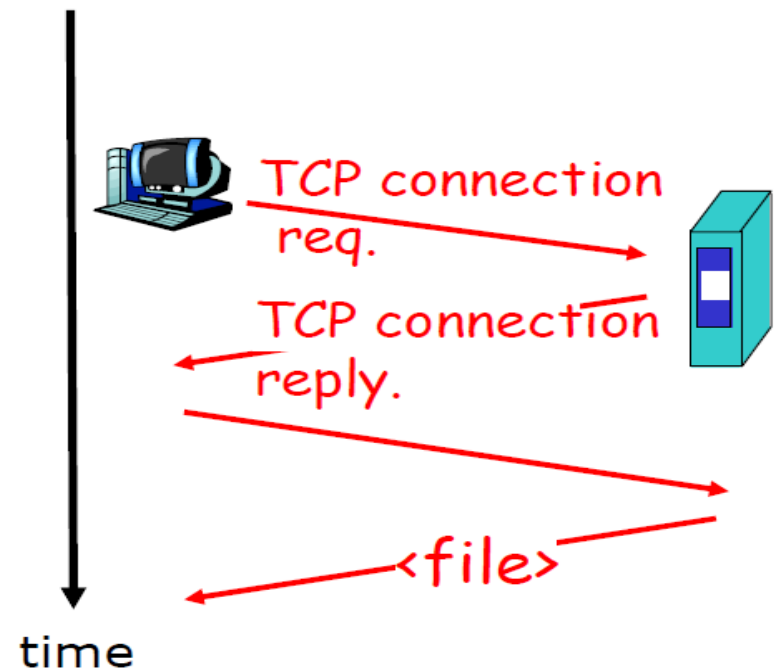
➤ a packet passes through many networks!



Layered Architecture of Protocols

➤ What is protocol?

- ★ define **format** and **order** of messages sent and received among network entities, and **actions** taken on message transmission and receipt
- ★ Govern all **communication activities** in a network
 - control sending and receiving of messages
- ★ e.g., TCP, IP, HTTP, FTP, PPP



Eg of a message format