MODULE 12: Network Components and Access Technologies

# Lecture 12.4
# Internet Access Technologies

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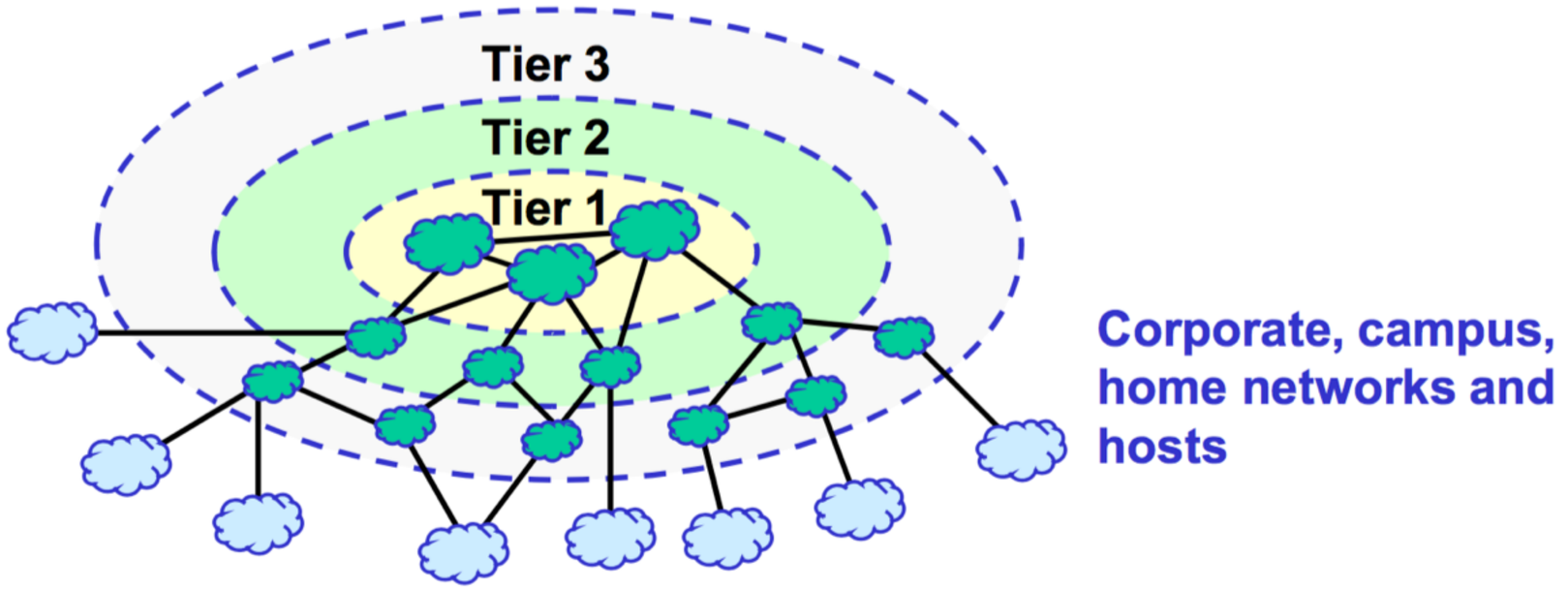
# Lecture 12.4 Objectives

- Describe the tiered organization of today's Internet
- Discuss the hierarchical structure of the Internet, including the role of autonomous systems
- Explain the need for three classes of link technology in the Internet
  - Local area networks (LANs)
  - "Carrier-grade" long-haul links
  - Internet access technologies (for the "last mile")
- Describe features of typical Internet access technologies

# Internet Built by ISPs

- The Internet is a decentralized structure, consisting of:
  - Home, campus, and corporate hosts and networks, and
  - Three tiers of Internet Service Providers (ISPs)

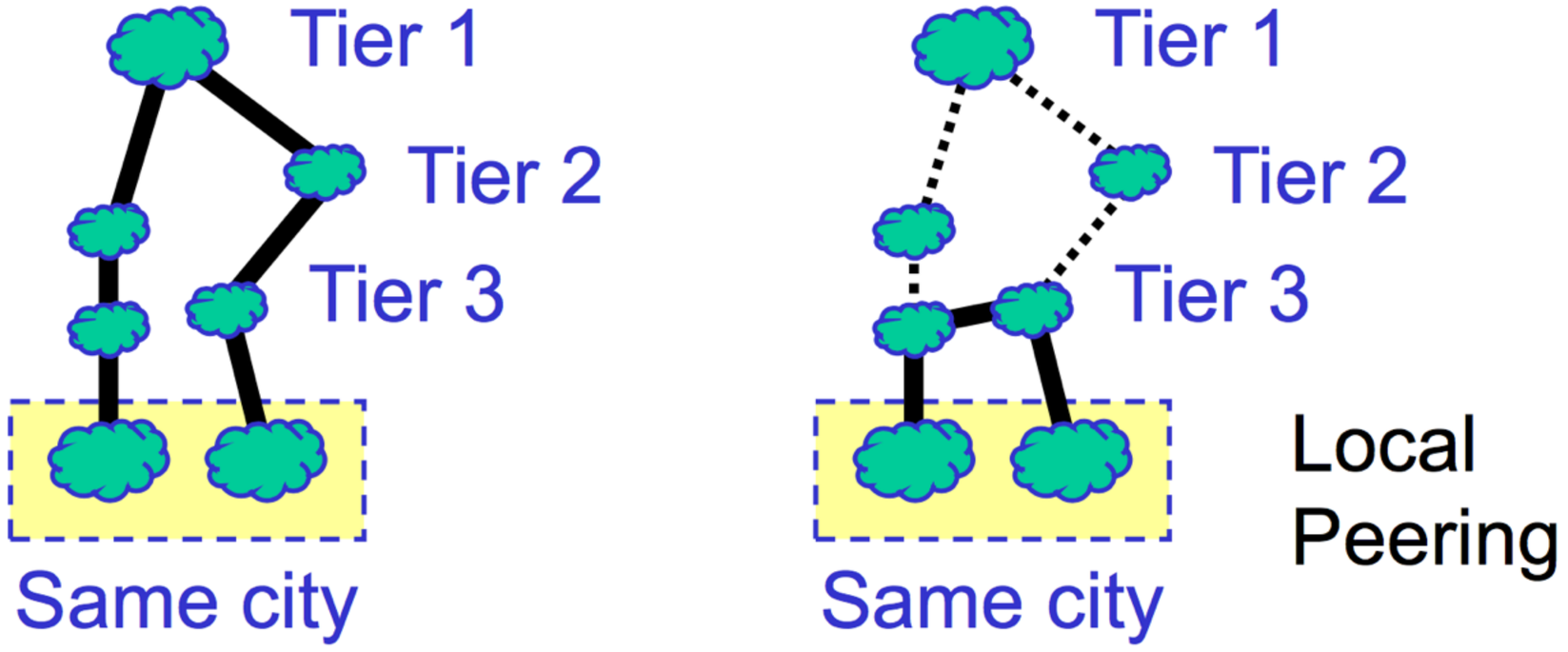


# Connections Between ISPs

- A point of presence (PoP) is the geographic location where an ISP offers physical connectivity
- Connectivity may be through:
  - Private peering points — by agreement between Provider X and Provider Y
  - Network access points (NAPs) — perhaps owned by a third party
- ISPs have peering agreements
  - Functionality
  - Quality of service
  - Cost

# Local Peering

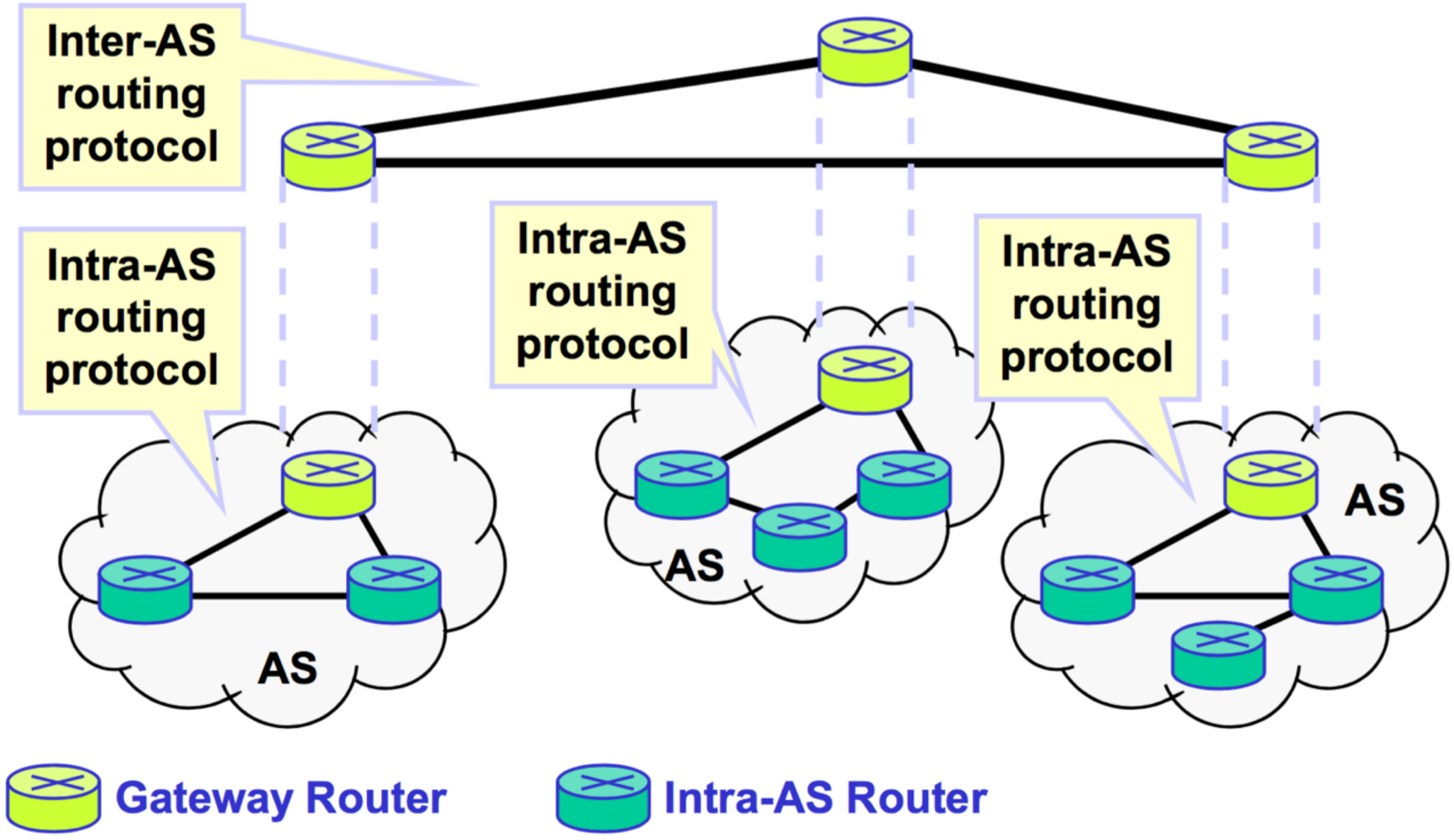
- The logical path between two users in the same city may be excessively long if the first common point between two Tier 3 ISPs is at a Tier 1 ISP
- Local peering can prevent these long paths for local accesses



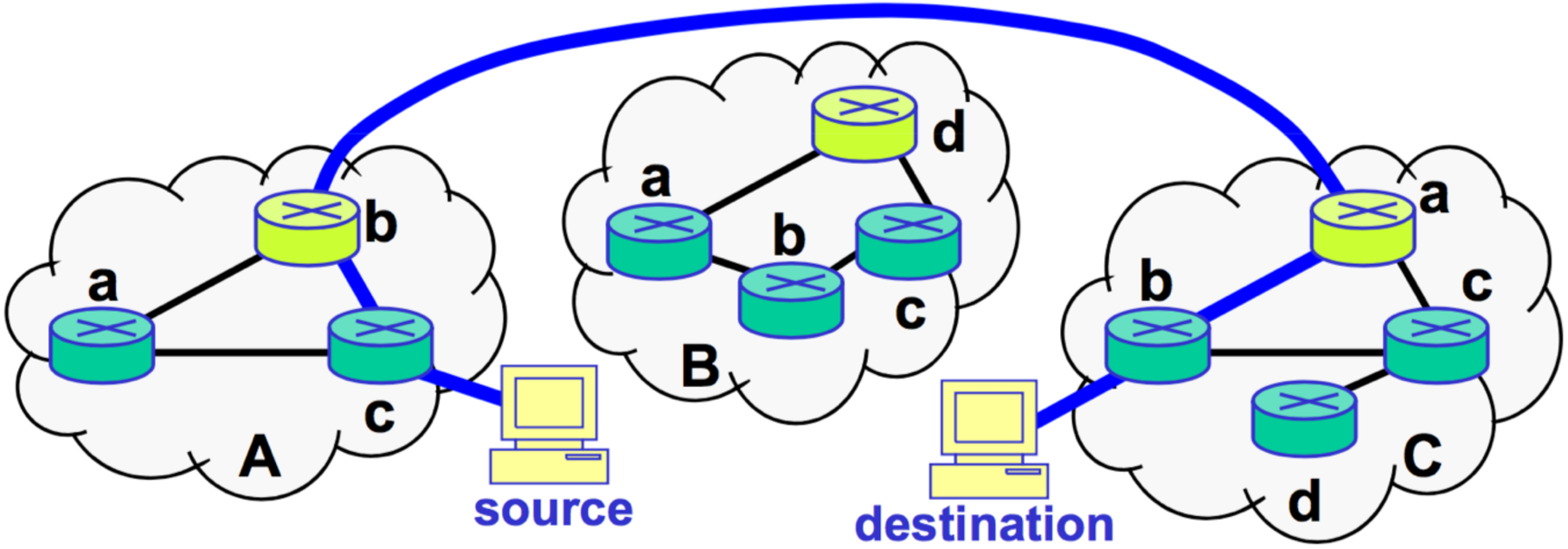
# Hierarchical Routing in the Internet

- Coordinated routing is needed throughout the Internet
  - Very large scale – How do routing algorithms deal with numbers of routers in the millions to hundreds of millions?
  - Multiple service providers needing autonomous administrations
- Hierarchical routing addresses these needs
- Hierarchical routing is realized in the Internet using the concept of interconnected autonomous systems (ASs)

# Autonomous Systems



# Example: Host on A.c → Host on C.b




- Intra-AS routing in AS A from A.c (source) to A.b (gateway)
- Inter-AS routing from A.b to C.a
- Intra-AS routing in AS C from C.a (gateway) to C.b (destination)

# CHECK POINT

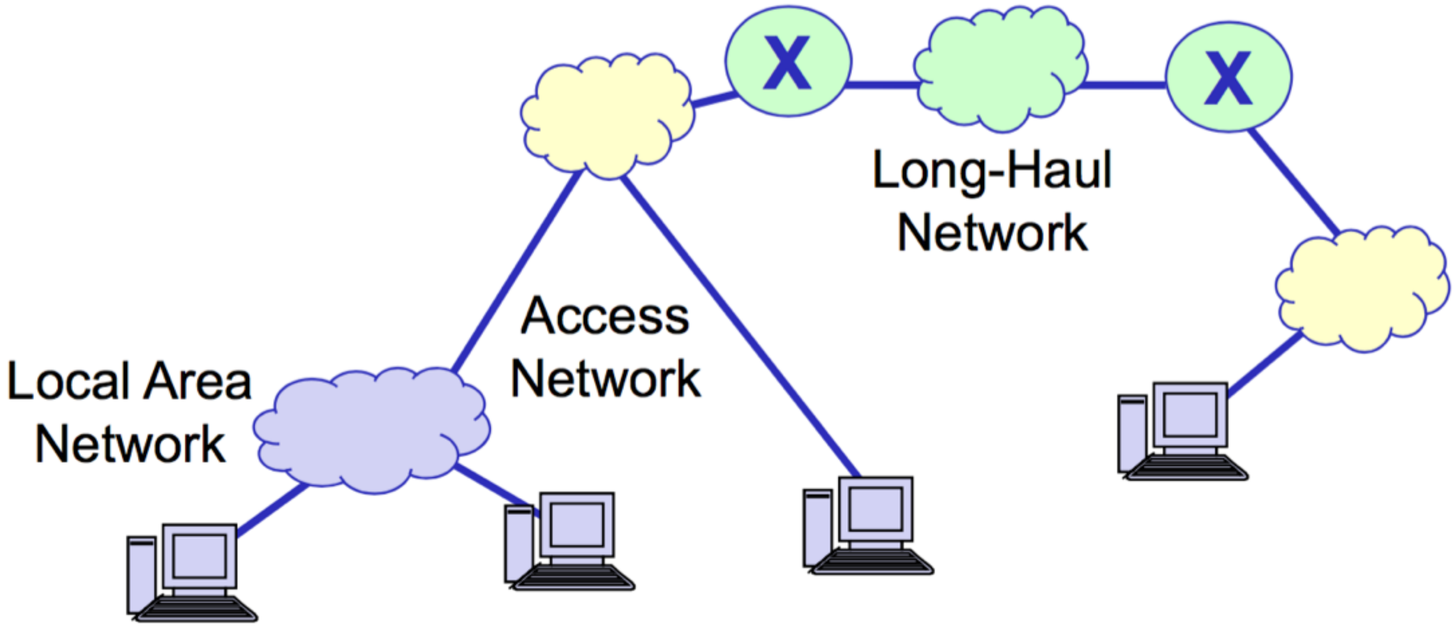
As a checkpoint of your understanding, please pause the video and make sure you can do the following:

- Describe the tiered organization of today's Internet
- Discuss the hierarchical structure of the Internet, including the role of autonomous systems

If you have any difficulties, please review the lecture video before continuing.

# Connectivity Needs in the Internet

- Connecting closely located computers and routers
- Connecting distant routers
- Connecting hosts and LANs to an ISP



# Internet Networking Technology

- Three classes of networking technology meet these different needs in the Internet
  - Local area networks (LANs)
  - “Carrier-grade” long-haul links
  - Internet access technologies (for the “last mile”)

# Local Area Networks in the Internet

- Applications
  - Low-end LANs provide connectivity between hosts in a home or small business
  - High-end LANs connect hosts in a large business or campus
  - High-end LANs connect routers within an ISP's facility
- LANs offer high performance at a low cost
- LANs do not allow the distances needed for backbone networks or access networks
- Examples include Ethernet and Wi-Fi (IEEE 802.11)

# Long-Haul Links in the Internet

- Long-haul links are needed
- “Carrier-grade” services are those services suitable for use by the ISPs themselves
  - Reliability must be high
  - Performance must be high (to extremely high)
  - Must be managed
  - Cost less important – resource shared by many users

# Access Technologies in the Internet

- Access networks enable end users to connect to the Internet
  - Reasonable data rate for Internet access
  - Reasonable cost for a resource dedicated to a single customer
  - Technology options to match density and scale
- Connection between end users and Tier 3 ISPs
  - Individual computer
  - Home or small business network
  - Mobile device

# Internet Access Technologies

- Dial-in modems
  - Leverages the existing voice telephone network
  - Limited data rates
  - Significantly different use characteristics for telephone switches leading to capacity problems
- Digital Subscriber Line (DSL)
  - Leverages telephone lines to the home, but not the full network
  - Advanced signal processing allows higher data rates over copper wire
  - Star topology – scales with growth

# Internet Access Technologies (cont'd)

- Cable Modem
  - Leverages existing cable connections to the home
  - Uses available bandwidth on the cable connection for data
  - Bus topology – requires partitioning to scale with increase in subscribers and use
- Optical Fiber
  - Eg: Ethernet Passive Optical Networks (EPON)
  - Uses new optical fiber infrastructure to connect homes to the service provider's central office
  - Compatible with data, voice, and video service over optical fiber

# Internet Access Technologies (cont'd 2)

- Cellular data services
  - Users are increasingly accessing the Internet via their cellular phones and other mobile devices
  - Early services carried data over circuits, which is not efficient
  - Typical today is packet-switched data, which is more efficient

# CHECK POINT

As a checkpoint of your understanding, please pause the video and make sure you can do the following:

- Explain the need for three classes of link technology in the Internet
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  - “Carrier-grade” long-haul links
  - Internet access technologies (for the “last mile”)
- Describe features of typical Internet access technologies

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# Summary

- Internet Service Providers enable Internet access by end users and networks
- Interconnections between ISPs form the global Internet
- The Internet uses a hierarchy of routing
  - Intra-autonomous system routing
  - Inter-autonomous system routing
- LANs provide connectivity at attractive costs within “local” distances
- Long-haul carrier-grade technology provide reliable and high data rate connectivity within the backbone, but are relatively expensive
- Access networks are needed to connect individual hosts and local area networks to Internet Service Providers, i.e., for the “last mile” at reasonable data rates and cost

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