CIS 375
CHAPTER 10

The Internet

Outline

- Background
- Internet Architecture
  - How the Internet Works
- Internet Access Technologies
  - DSL
  - Cable
  - Fiber to the Home
  - Wireless
- Internet Governance
- The Future of the Internet
- Implications for Cyber Security

The Internet

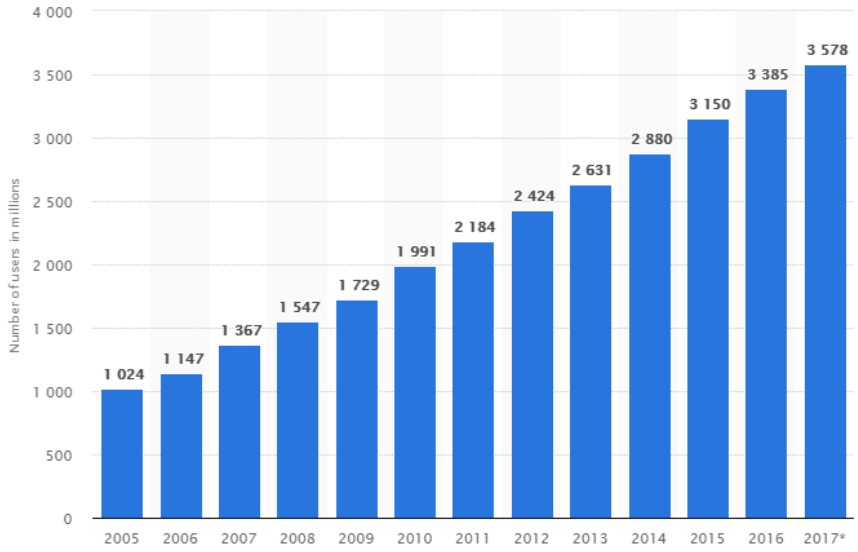
- Most used network in the world
- Network of networks
  - Various networks managed by for-profit, non-profit, and government organizations
- Organizations use standardized protocols to communicate
- Few controls over content and applications

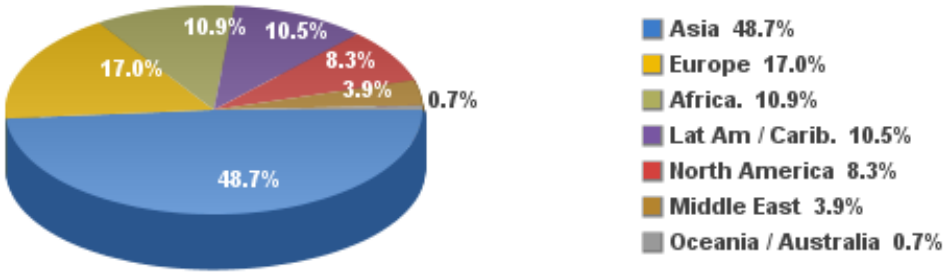
The Internet

- The **World Wide Web (WWW)** ≠ the **Internet**

- WWW is about content, specifically hyperlinked content
- The Internet is the transport mechanism that enables the WWW and other services

10.1 The Internet





Number of Internet Users Worldwide (in millions)

Internet Architecture

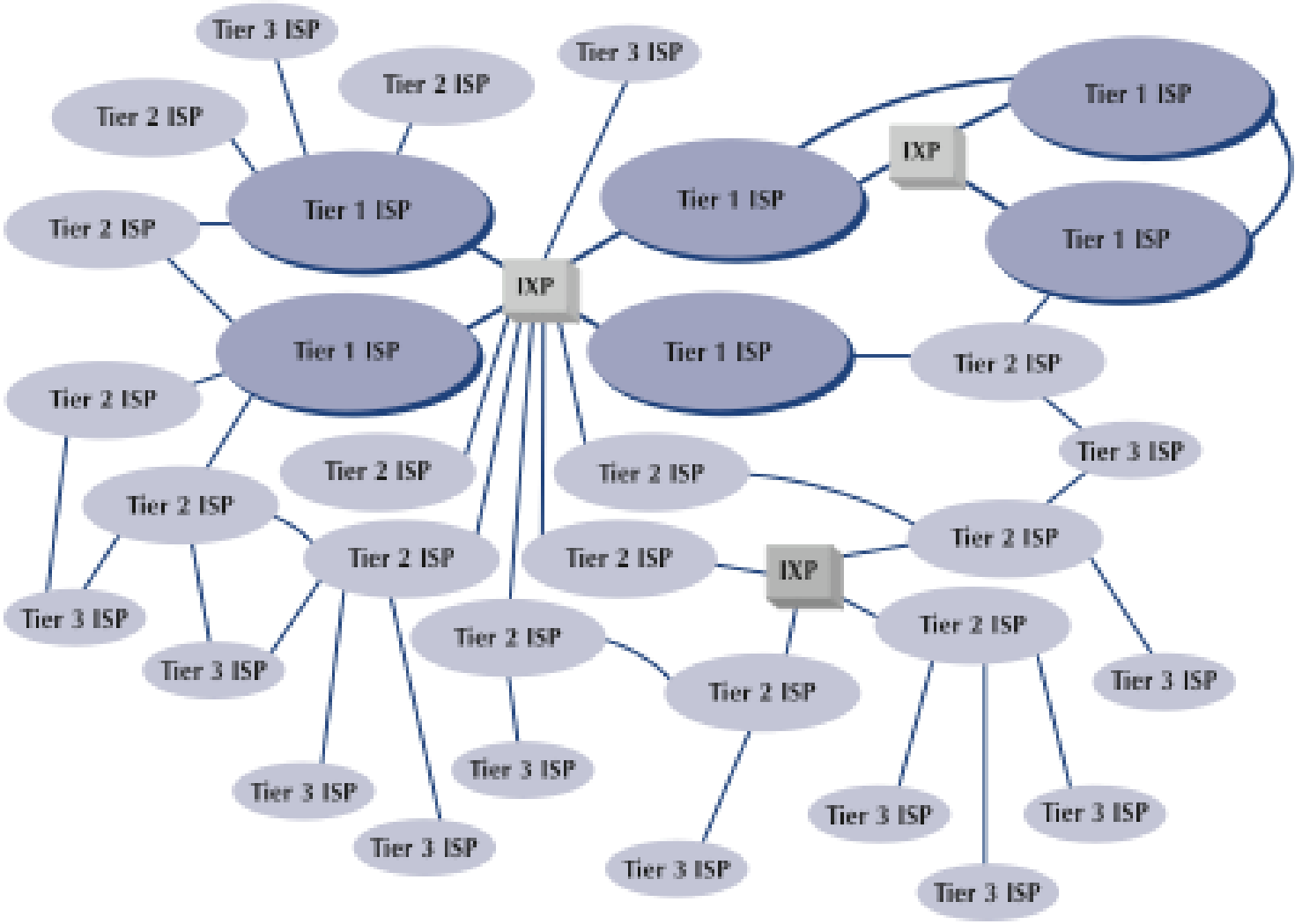
- **Internet service providers (ISPs)** connect the networks of their customers to the Internet
- Hierarchy of ISPs by size
  - Tier 1 - National ISPs
  - Tier 2 - Regional ISPs
  - Tier 3 - Local ISPs

Internet Architecture

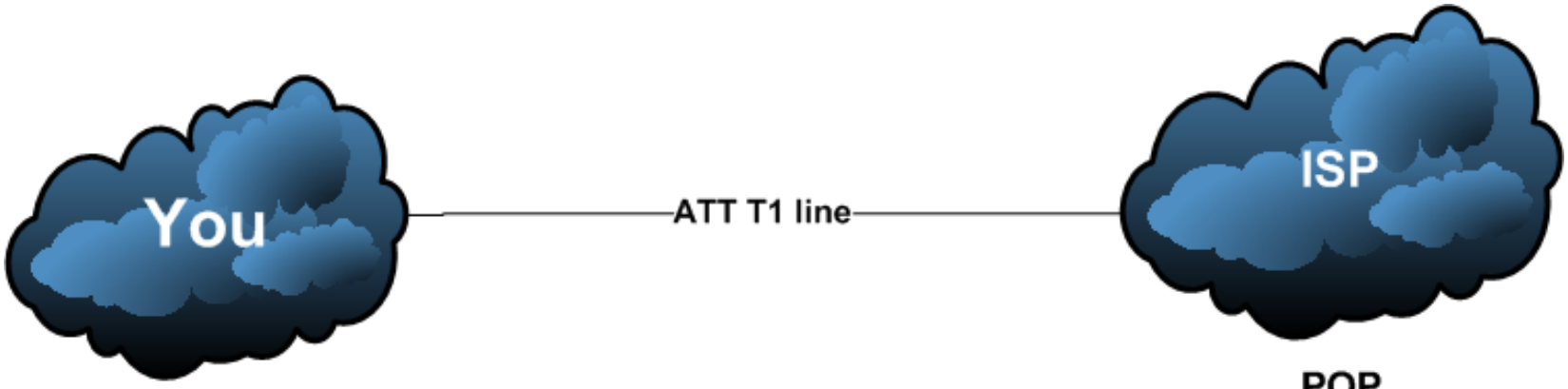
- Connections between ISPs
  - Historically, lower-tier ISPs purchased connections to higher-tier ISPs
  - Most interconnections between ISPs occurs at **Internet exchange points (IXPs)**

Internet Architecture

FIGURE 10-2 Basic Internet architecture.
ISP = Internet service provider and IXP = Internet exchange point



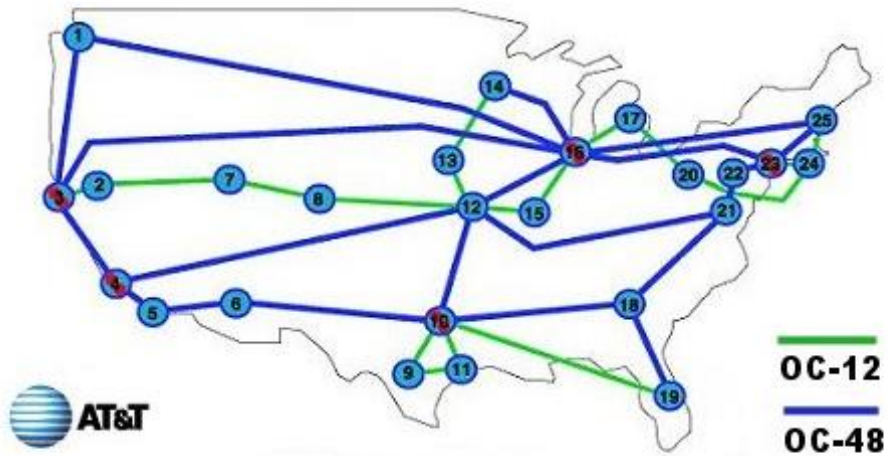
Connecting to the Internet



- Need to buy a circuit (from your local phone company)
- Pay the ISP for the data service

Internet Today

AT&T Internet Backbone Connection



1. Seattle	6. Phoenix	11. Houston	16. Chicago	21. Washington DC
2. Sacramento	7. Salt Lake City	12. Kansas City	17. Detroit	22. Philadelphia
3. San Francisco	8. Denver	13. Omaha	18. Atlanta	23. New York
4. Los Angeles	9. Austin	14. Minneapolis	19. Orlando	24. Hartford
5. San Diego	10. Dallas	**15. St. Louis**	20. Pittsburgh	25. Boston

Internet Architecture

- ISPs are **autonomous systems** and share routing info using BGP
- Service charges
  - Higher-tier ISPs charge lower-tier ISPs for data transfer
  - ISPs at the same tier typically do not charge each other
    - Called ***peering***
    - One of the primary reasons for IXPs

Internet Architecture

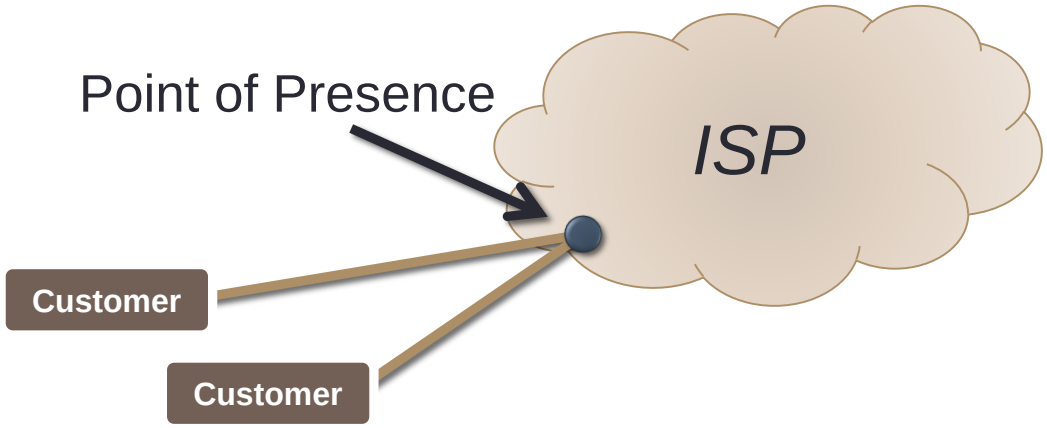
FIGURE 10-3 A typical Internet backbone of a major ISP

Internet Architecture

- ISP backbone
  - Larger backbone connections operating at OC-192 (10 Gbps) and experimenting with OC-768 (40 Gbps) and OC-3072 (160 Gbps)
  - Require faster backbone switches and routers
  - Internet peak traffic estimated to reach 1 Pbps by 2018

Connecting to an ISP

- A **point of presence (POP)** is the location where an ISP provides service to its customers
- The POP connects to the rest of the ISP's network
- Authentication is performed at the POP



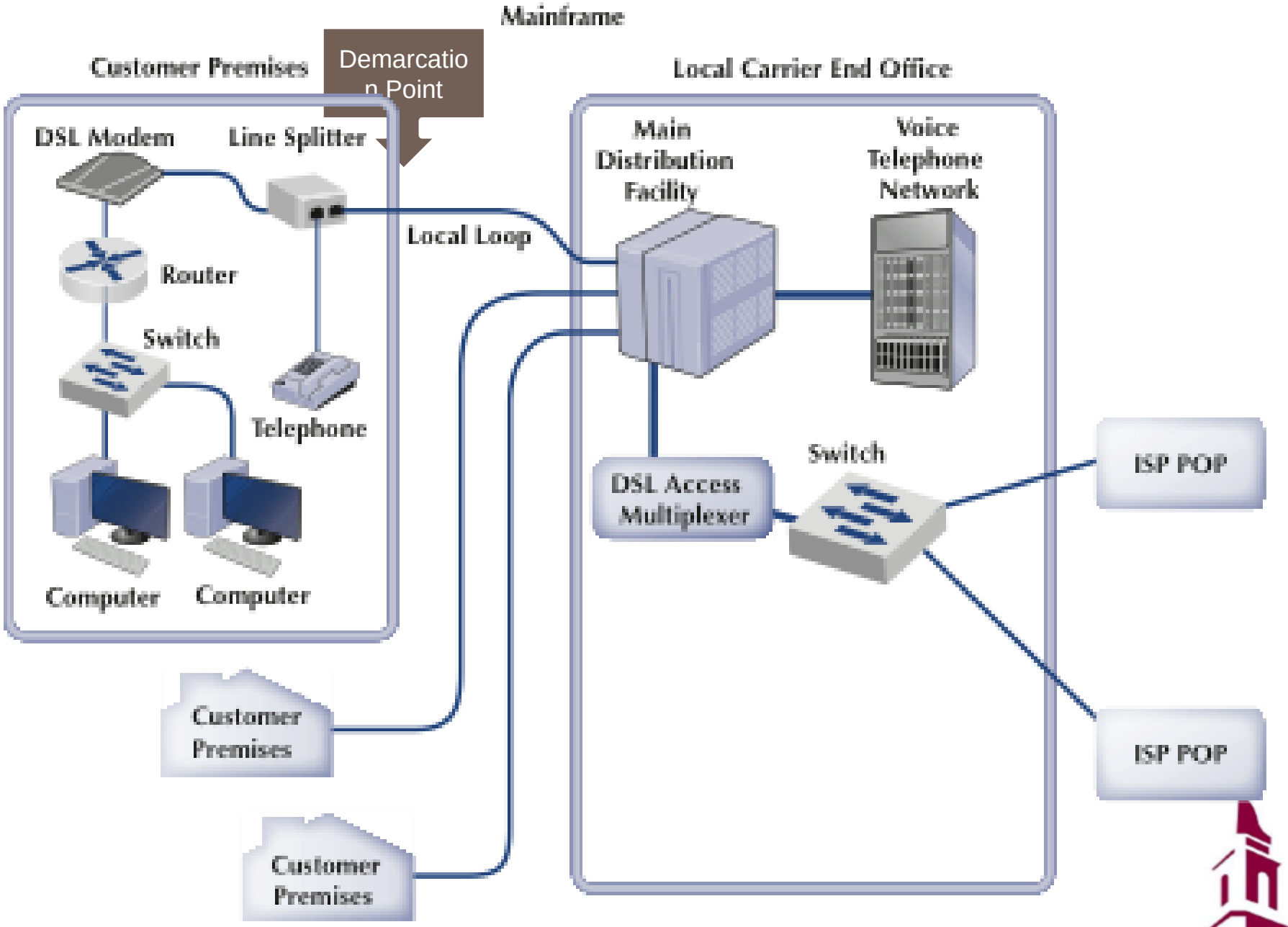
Internet Access Technologies

- Some organizations use WAN technologies to connect to their ISP
- Common **broadband technologies** to connect to ISPs include:
  - Digital subscriber line (DSL)
  - Cable
  - Fiber to the Home (FTTH)
  - Wireless (e.g., WiMAX)

Digital Subscriber Line (DSL)

- A family of point-to-point technologies usually offered by telephone companies
- Provides high-speed transmissions over traditional telephone wires
- **Customer premises equipment (CPE)** includes a **DSL modem** and **line splitter**
- The **local loop** (or last mile) is the circuit from the customer premises to the ISP's office containing the **main distribution facility (MDF)**

FIGURE 10-4 Digital subscriber line (DSL) architecture.
ISP = Internet service provider and POP = point of presence



Digital Subscriber Line (DSL)

- Many DSL technologies exist, but the most commonly implemented include:
  - **Asymmetric DSL (ADSL)**
    - 3 channels of different width (voice, downstream, upstream)
    - Downstream bandwidth greater than upstream
    - Bandwidth dependent on distance from equipment
  - **Very-high-data-rate DSL (VDSL)**
    - Similar to ADSL, but with higher data rates and shorter range
    - Often paired with fiber circuits to the node
    - May be used for high definition television in addition to data and voice transmission

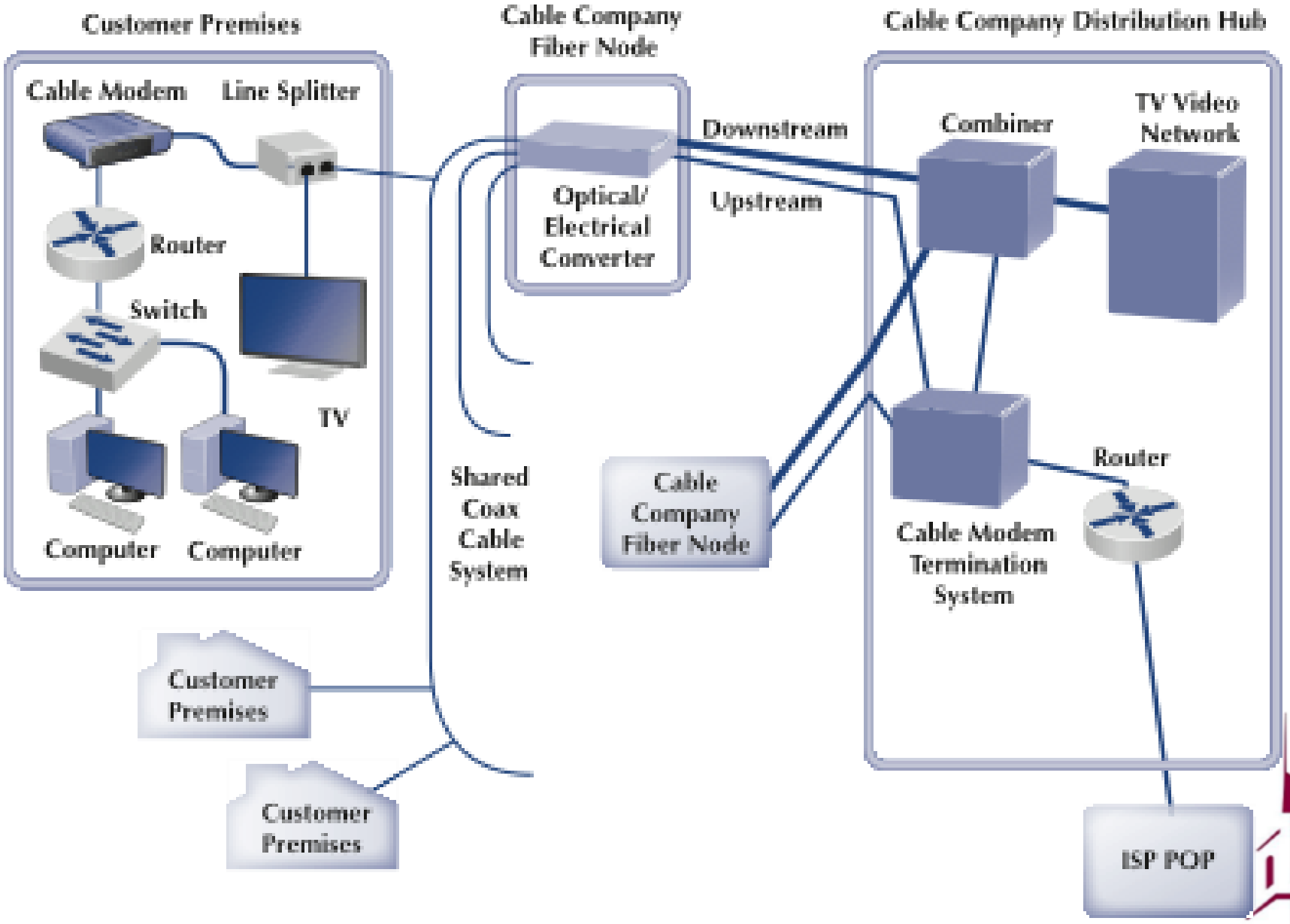
Cable

- Alternative to DSL offered by cable television companies
- Most cable ISPs use **hybrid fiber coaxial (HFC)** networks with coaxial cables in the customer premises
- Cable networks are multipoint (shared) while DSL is point-to-point
  - Shared bandwidth
  - Potential issues with security

Cable

- **Data over cable service interface specification (DOCSIS)** is a set of standards used by cable ISPs
- The newest DOCSIS standards support data rates over 1 Gbps, but few ISPs have deployments that support these speeds
- The **cable modem** at the customer's premises are configured to "cap" the bandwidth at a maximum rate specified by contract

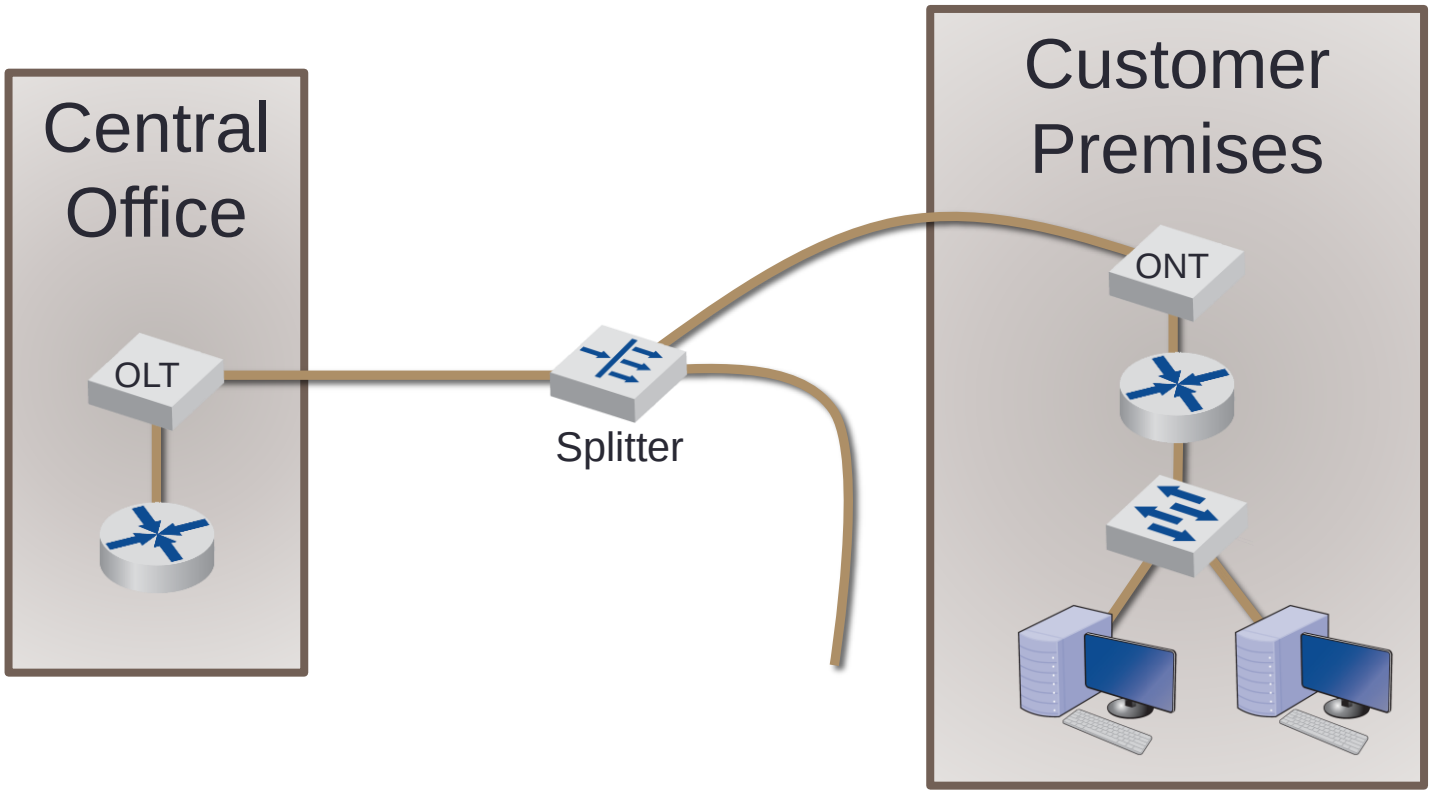
FIGURE 10-6 Cable modem architecture.
ISP = Internet service provider and POP = point of presence



Fiber to the Home (FttH)

- A dedicated point-to-point fiber optic service
- Architecturally similar to DSL and cable
- Expensive to deploy and these networks are emerging slowly

Fiber to the Home (FttH)



Wireless

- **Worldwide interoperability for microwave access (WiMax)**
  - 802.16 wireless standard fixed/mobile
  - Similar to the 802.11 WiFi standards, but with longer range
  - One implementation of 4G mobile wireless
  - Maximum theoretical range is ~30 miles
  - Maximum theoretical data rate is ~70 Mbps
  - The WiMax standard includes possible use 2-66 GHz frequency bands, but only 2.3, 2.5, 3.5, and 5.8 GHz bands are used in North America

Wireless

- **Long-term evolution (LTE)** and **LTE advanced**
  - A 3GPP wireless standard for mobile devices
  - Upgrade to GSM and CDMA data networks
  - Frequencies from 700 MHz – 2.7 GHz are used in various countries
- **Satellite**
  - Primarily used by rural customers
  - Issues of high latency and low data rates
  - Two-way vs. one-way

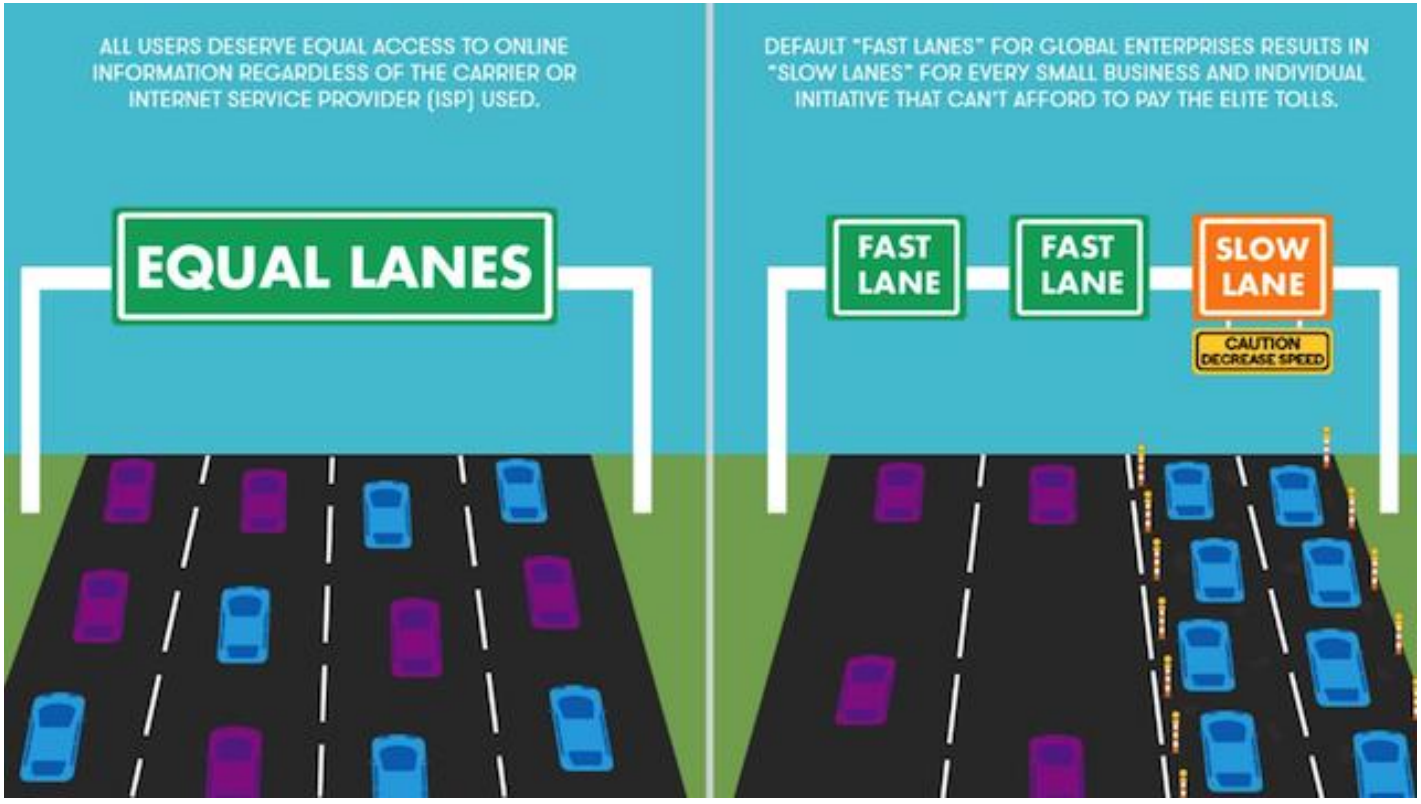
Internet Governance

- No single organization governs the Internet
- The Internet Society (ISOC)
  - Internet Architecture Board (IAB)
  - Internet Engineering Task Force (IETF)
  - Internet Engineering Steering Group (IESG)
  - Internet Research Task Force (IRTF)
- Internet Corporation for Assigned Names and Numbers (ICANN)
- Internet Governance Forum (IGF)
- International Telecommunication Union (ITU)

Internet Governance

- Issue of **Net neutrality**
  - Should all messages on the Internet be treated equally?
  - Can ISPs regulate (or discriminate) data that runs through their networks based on source, destination, protocol, or content?

Net Neutrality



What is Net Neutrality?

- **Net Neutrality** is the internet's guiding principle
  - It **preserves** our right to communicate freely online.
  - It **enables** and **protects** free speech
  - It **ensures** that **ISPs** provide us with open networks — and don't block or discriminate against any applications or content that ride over those networks

What Happens if Net Neutrality Goes Away?

- **ISPs** (AT&T, Comcast, Verizon) will be able to:
  - **Charge extra fees** to the few content companies that could afford to pay for preferential treatment
  - **Decide who is heard and who isn't**. They'd be able to block websites or content they don't like or applications that compete with their own offerings.

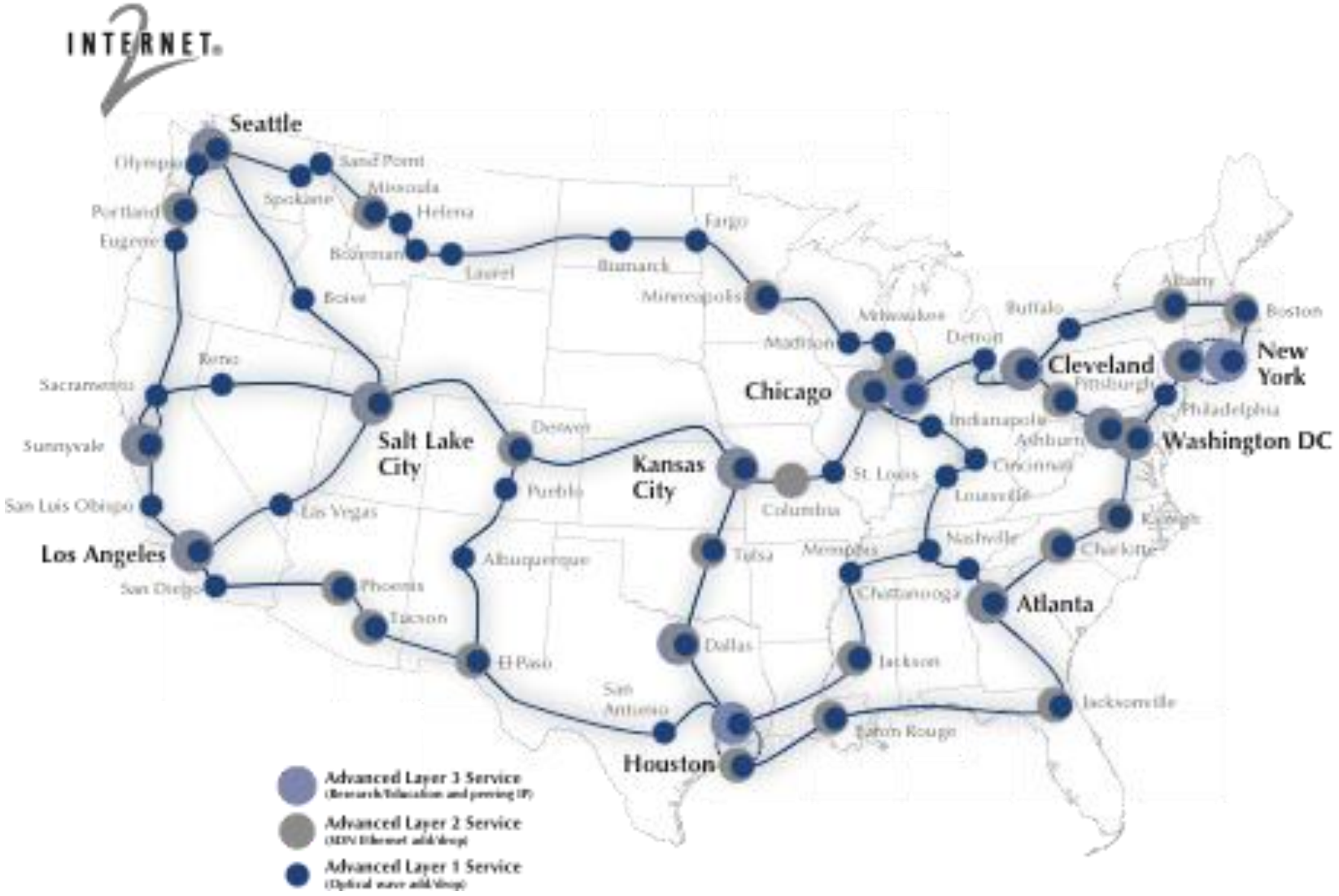

TELCO
ADSL
Your email. Your world wide web. Your imagination.
$29.95
Includes 500 MB of free transfers to non-peering websites at full speed. Limited to 128 kbps thereafter.
YouTube
Broadcast Yourself
hulu
tv.com
joost
NETFLIX
ESPN
Includes free Hulu subscription. Enjoy exclusive content from your favourite networks.
$10
hollywood
$15 after September
Google
YAHOO! SEARCH
WordPress.com
flickr
Blogger
bing
YouTube
Broadcast Yourself
Ask
Wikipedia
$5
pathfinder
Includes a massive extra 1000 MB a month to non-peering and non-elected websites. Limited to 256 kbps thereafter.
twitter
facebook
AOL
bebo
msn
myspace.com
a place for friends
YAHOO!
friendster
All social networks. All your friends. Includes all your dating sites.
$0
the social
Just $5 after three months
Baidu 百度
Яндекс
Найдётся всё
WEB.DE
BBC
indiatimes
news.com.au
Includes the top 200 services from over 30 countries.
$5
international
last.fm
Spotify
emusic
PANDORA
napster
Rhapsody
Listen to your favourite music. Includes three months of emusic.
$10
the beat
digg
The New York Times
msnbc
THE WALL STREET JOURNAL.
CNN
Los Angeles Times
FOX NEWS channel
THE HUFFINGTON POST
News Freak? Get your fix. Includes free online access to your local news site.
$5
news
amazon.com
newegg
PayPal
Overstock.com
skype
eBay
Save money. Shop online. All your favourite things, secure and fast.
Includes Internet Banking from over 20 financial institutions.
$5
marketplace
Access to services not pictured here may incur additional costs.
STEAM
ELECTRONIC ARTS
WORLD WARCRAFT
realArcade
FULL TILT POKER
GAMETAP
Gamer? We hear you. Unwind, relax and play hard.
$5
playground
Recharge
Your full-speed quota wasn't enough?
A massive 2000 MB for access to your company's VPN at full speed.
For accessing your friends' non-peering websites at full speed.
For getting your emails faster and the included limit didn't cut it.
Or if you're a web designer and need some extra buffer.
Whether it be the world wide web, VPN or email, we have you covered.
$5
recharge

Building the Future Internet

- Internet continues to evolve and improve, often through a combination of commercial and governmental research projects
- Internet2
  - US National Science Foundation (NSF) project started in 1996
  - Used by more than 500 organizations to develop advanced networks and network management tools

Building the Future Internet

FIGURE 10-7 Internet2 network map. Reproduced by permission of Internet2®



Implications for Management

- The Internet continues to increase its capacity
- Broadband Internet data rates continue to increase
- Mobile Internet access is rapidly growing, disrupting the ISP market

10.5 Implications for Cyber Security

- DDOS is much more real
  - IoT
  - University students are targets

https://www.techrepublic.com/article/ddos-attacks-increased-91-in-2017-thanks-to-iot/