Introduction to Internet #1

Introduction to Internet and Web

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정보컴퓨터공학부

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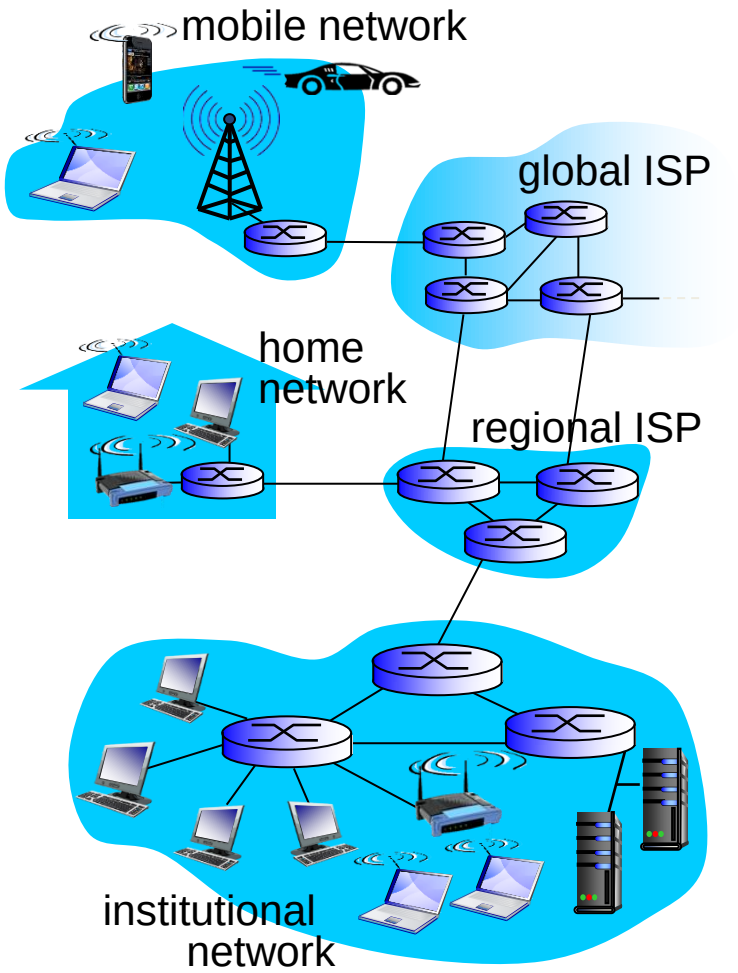
01. WHAT IS THE INTERNET?

What is the Internet?

- **Internet** = Inter- + net (work)
  - "network of networks"

- Various types of networks
  - Internet Service Provider (ISP)



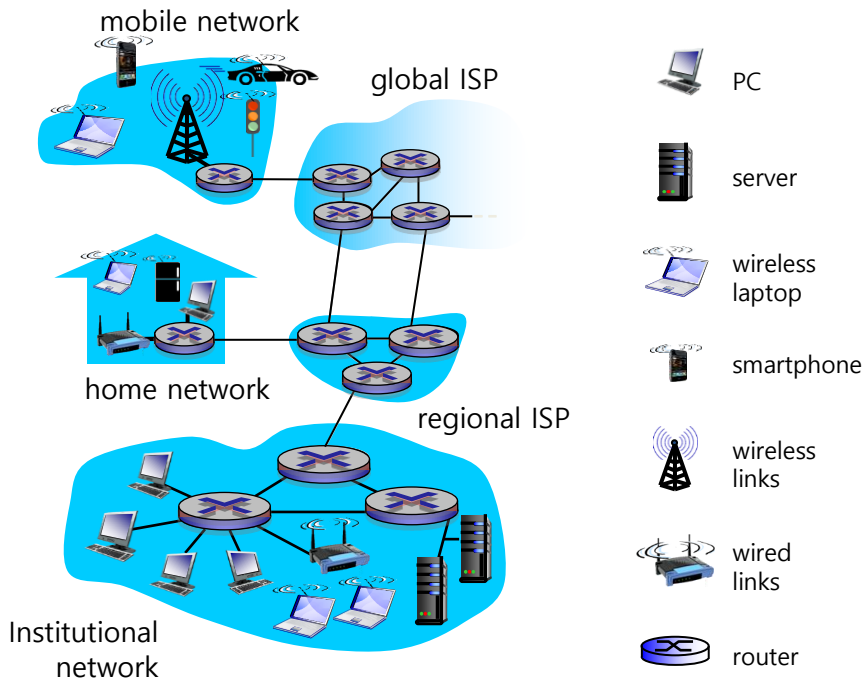
What Compose the Internet?

❖ HW components

- hosts (=end systems)
  - Packets (chunks of data)
- interconnection devices
  - Routers and switches
- links
  - copper, fiber, radio, satellite

❖ SW components

- operating software
- application programs
- protocols



Communication Protocol

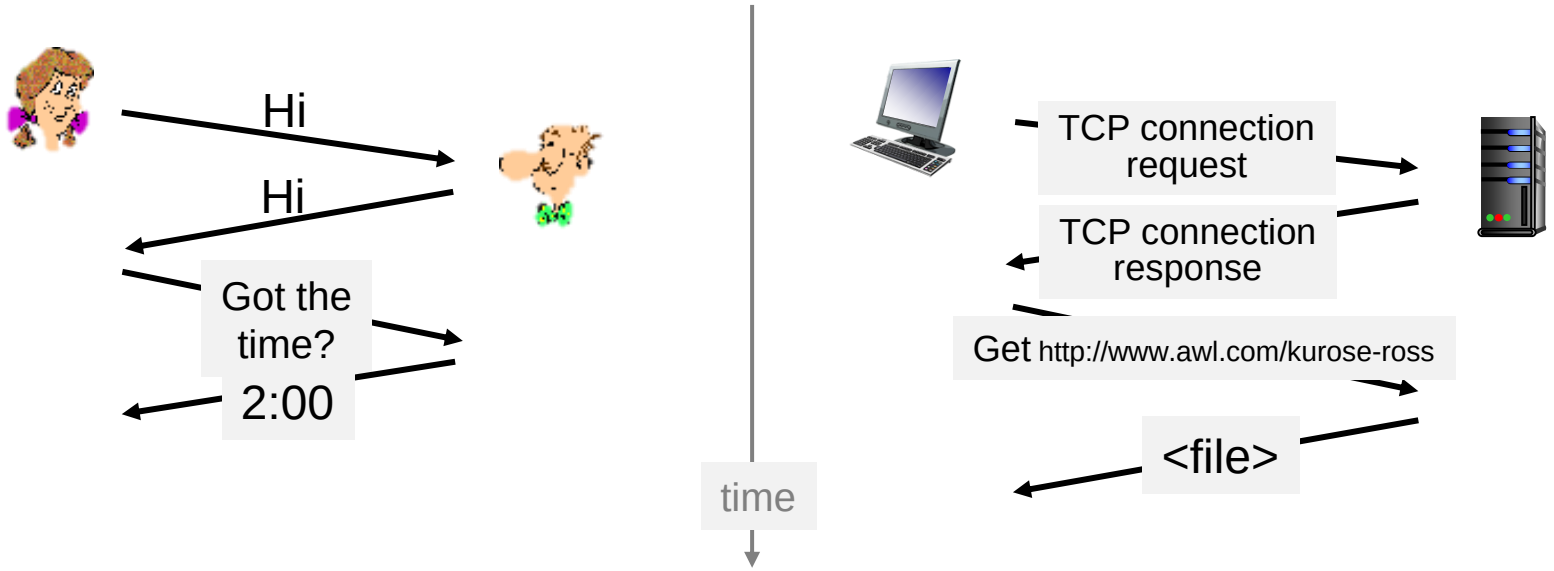
❖ Definition

- a defined set of rules and regulations that determine how data is transmitted in telecommunications and computer networking (from Wikipedia)

출처 - http://rtrfm.com.au/story/talk-the-talk-why-its-hard-to-learn-a-language/

Communication Protocol

❖ **Human protocol vs. Comm. protocol**



Communication Protocol

❖ **All communication activity in Internet governed by protocols**

❖ **Protocols define**

- message format
- order of messages sent and received among network entities
- actions taken on message transmission, receipt

02. NETWORK STRUCTURE

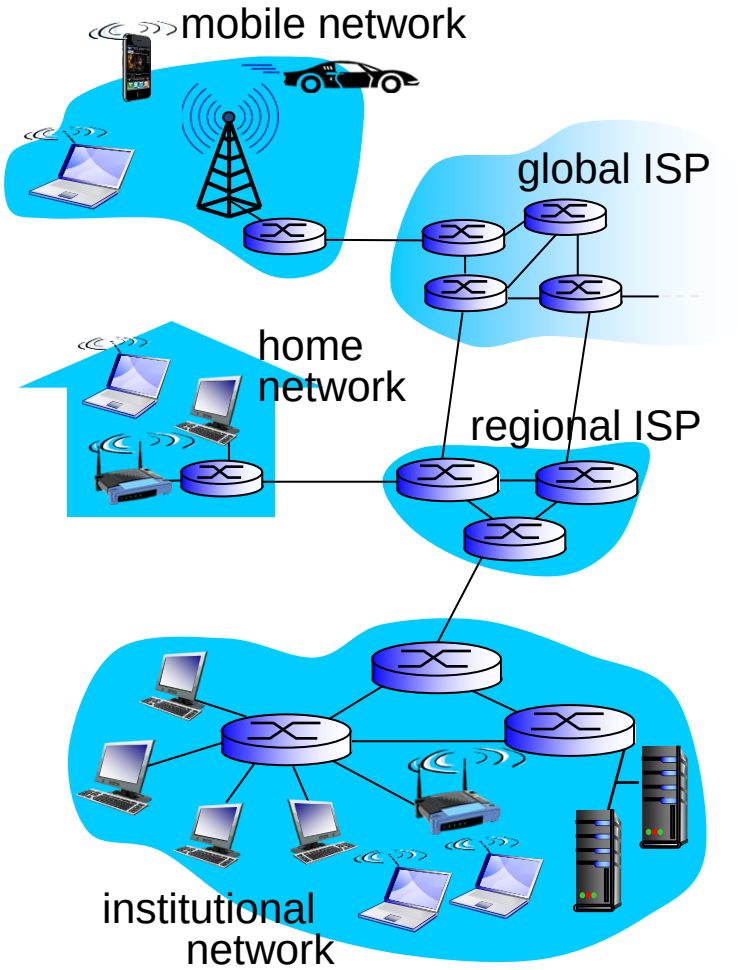
Network Structure

❖ Network edge

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

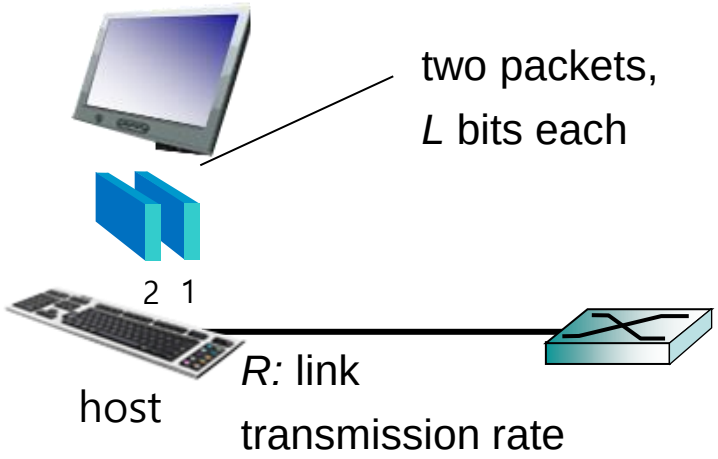
❖ Network core

- Interconnected routers or switches



Network Edge

- **Takes an application message**
- **Breaks it into smaller chunks, known as *packets*, of length less than MTU**
  - Maximum Transmission Unit (MTU)
- **Transmits packet into access network**
  - link transmission rate,
    a.k.a. link capacity or link bandwidth



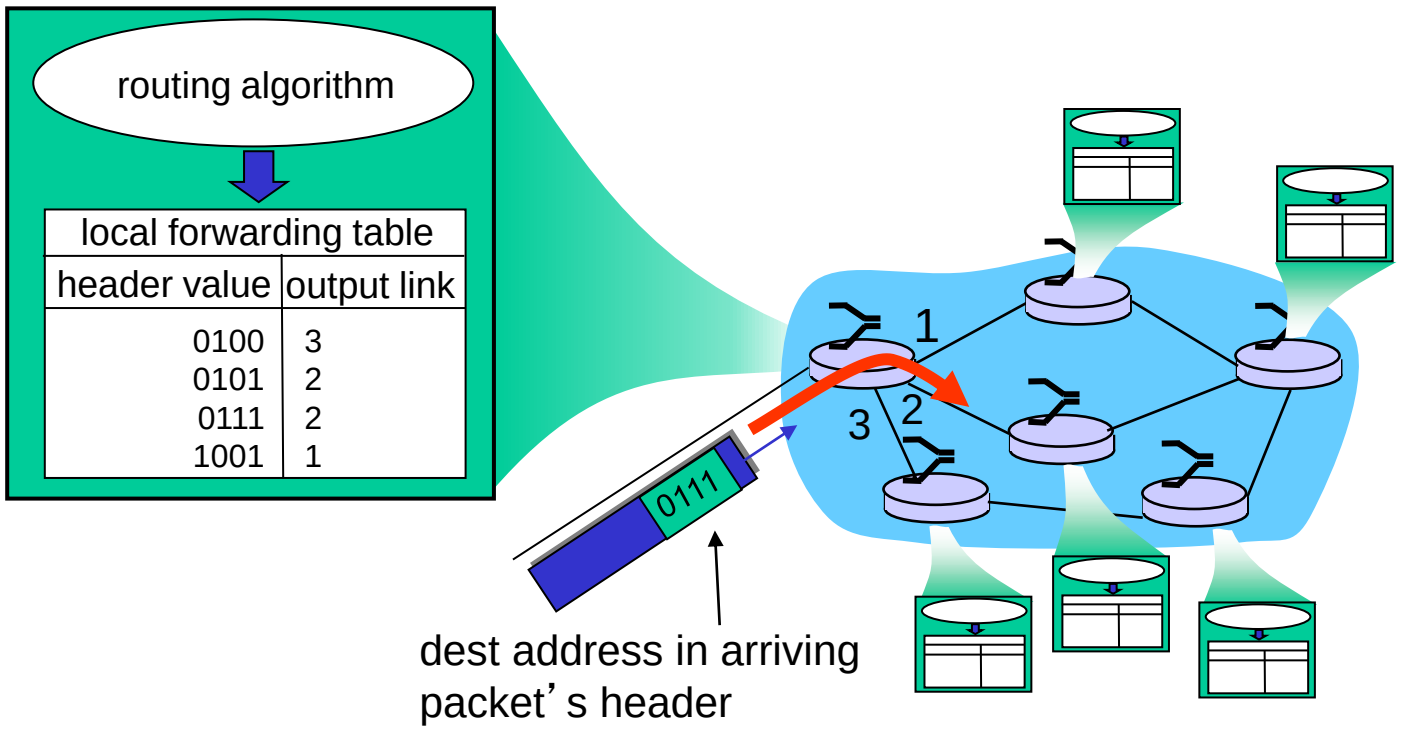
$$\text{packet transmission delay} = \text{time needed to transmit } L\text{-bit packet into link} = \frac{L \text{ (bits)}}{R \text{ (bits/sec)}}$$

Network Core

❖ Mesh of interconnected routers

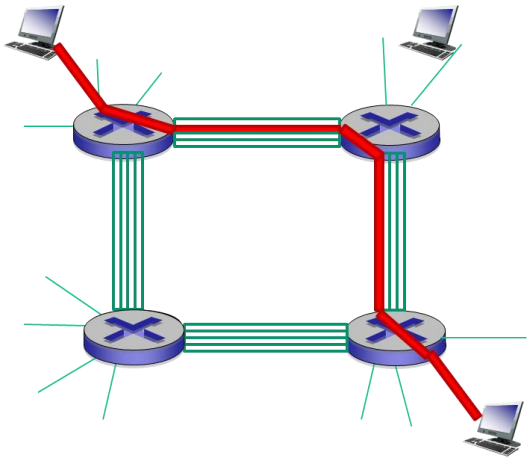
❖ Function

- packet forwarding from one router (or switch) to the next along the path from source to dest.



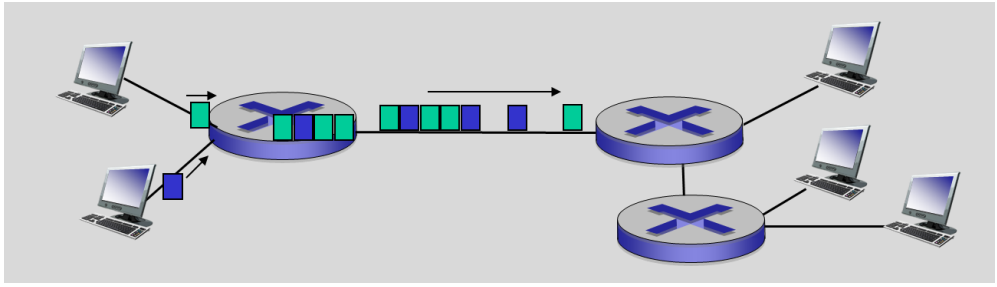
Switching Mechanisms

- **Circuit Switching**
  - End-end resources reserved for "call" between src. & dest.
  - Entire data flew along the path like water



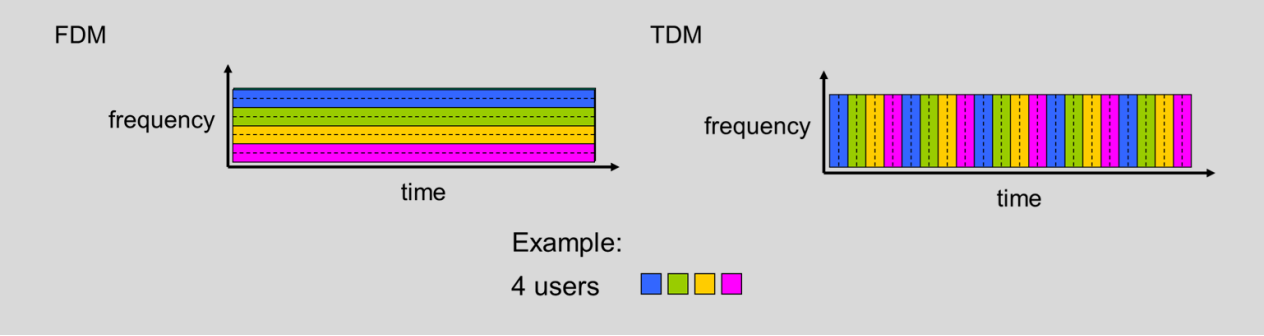
❖ Packet Switching

- Entire data broken into small packets
- Each packet has its destination address
- Each packet handled independently



Circuit Switching: Detail

- **Resources dedicated to each call**
  - circuit segment idle if not used by the call (no sharing)
- **Commonly used in traditional telephone networks**
- **Channel allocation methods: FDM, TDM**

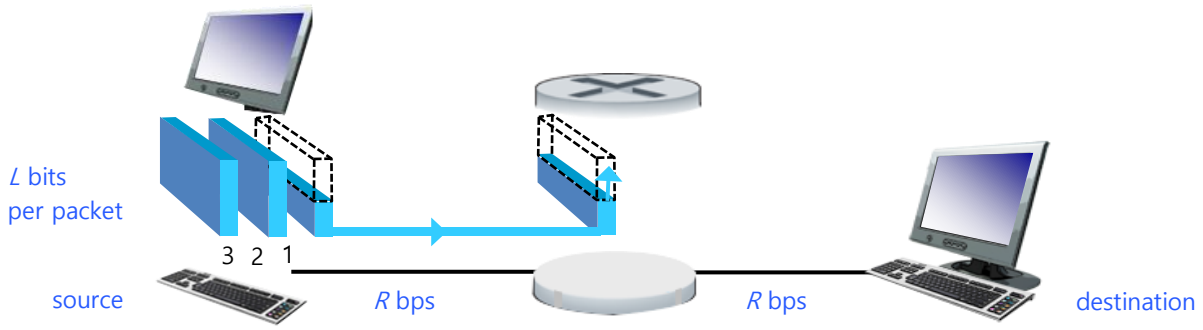


Packet Switching: Detail

- Packet transmitted at full link capacity
- Takes L/R seconds to transmit L-bit packet into link at R bps
- *Store-and-forward*: entire packet must arrive at router before forwarded to the next
- End-end delay ≈ 2L/R

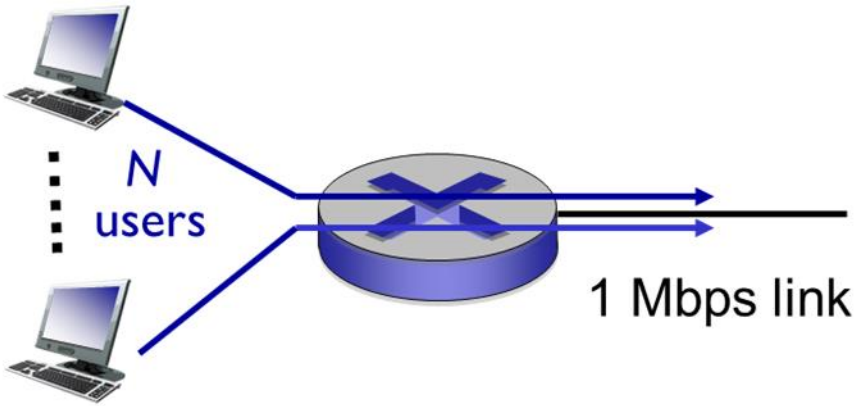
numerical example:

- L = 7.5 Mbits
- R = 1.5 Mbps
- One-hop transmission delay = 5s
- End-end delay ≈ 10s



Switching: Comparison

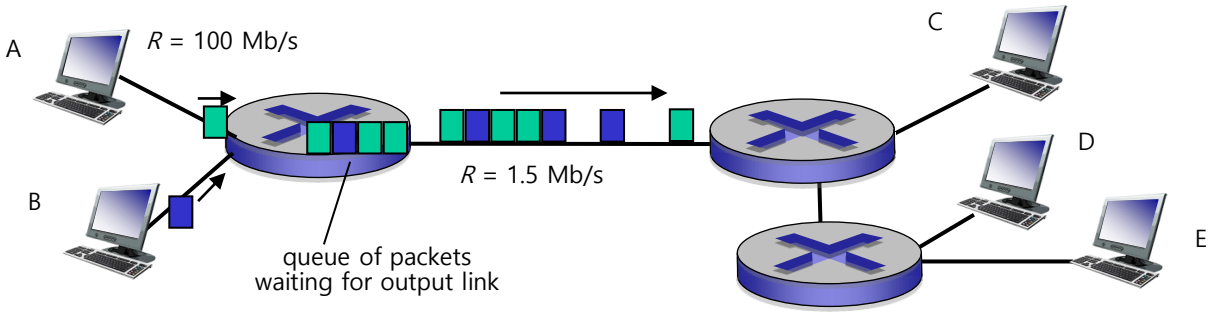
- **Packet switching allows more users to use network!**
- **Example**
  - 1 Mbps link
  - each user:
    - 100 kbps when "active"
    - only 10% of time active
  - circuit switching
    - 10 users
  - packet switching
    - with 35 users, probability of 10 users being active at the same time is about .0004



$$1 - \sum_{k=0}^{10} \binom{35}{k} \left(\frac{1}{10}\right)^{k} \left(\frac{9}{10}\right)^{35-k} = 0.0004243$$

Switching: Comparison

- **Circuit switching guarantees the quality of service for each call!**
- **On the other hand, packet switching may suffer from queuing and loss**
  - if arrival rate exceeds transmission rate of link
    - packet queued before being transmitted
    - can be dropped (lost) if memory fills up



03. INTERNET STRUCTURE

Internet Structure

❖ Who's in charge of the Internet?

Nobody! Or Everybody!

- Youtube link: https://youtu.be/Dxcc6ycZ73M?t=90
- independently operated networks

❖ End systems connect to Internet via access ISPs (Internet Service Providers)

- residential, company, and university ISPs

❖ Access ISPs in turn must be interconnected

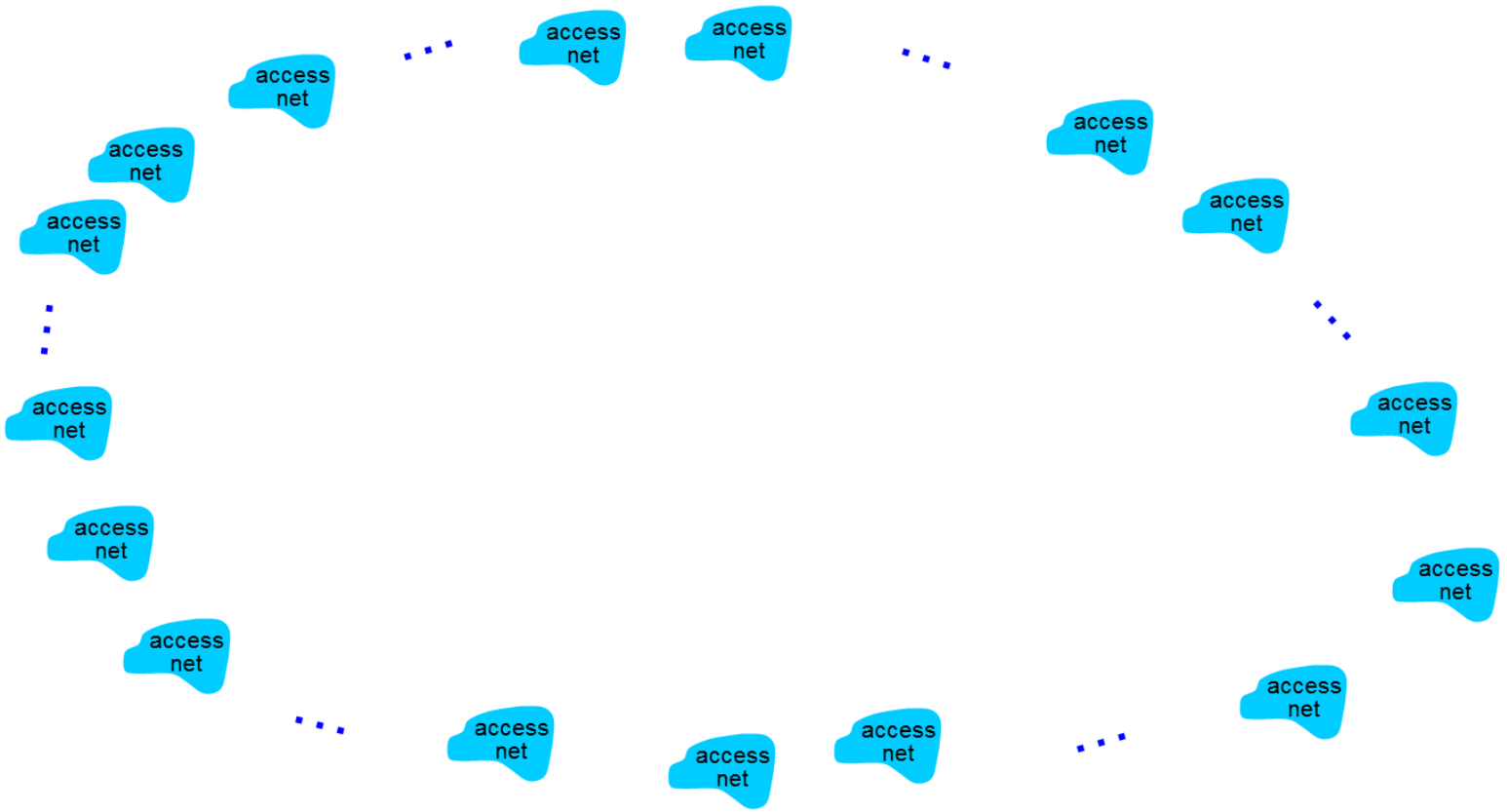
- so that any two hosts can be communicated

❖ Resulting network of networks is very complex

- evolution driven by economics and national policy

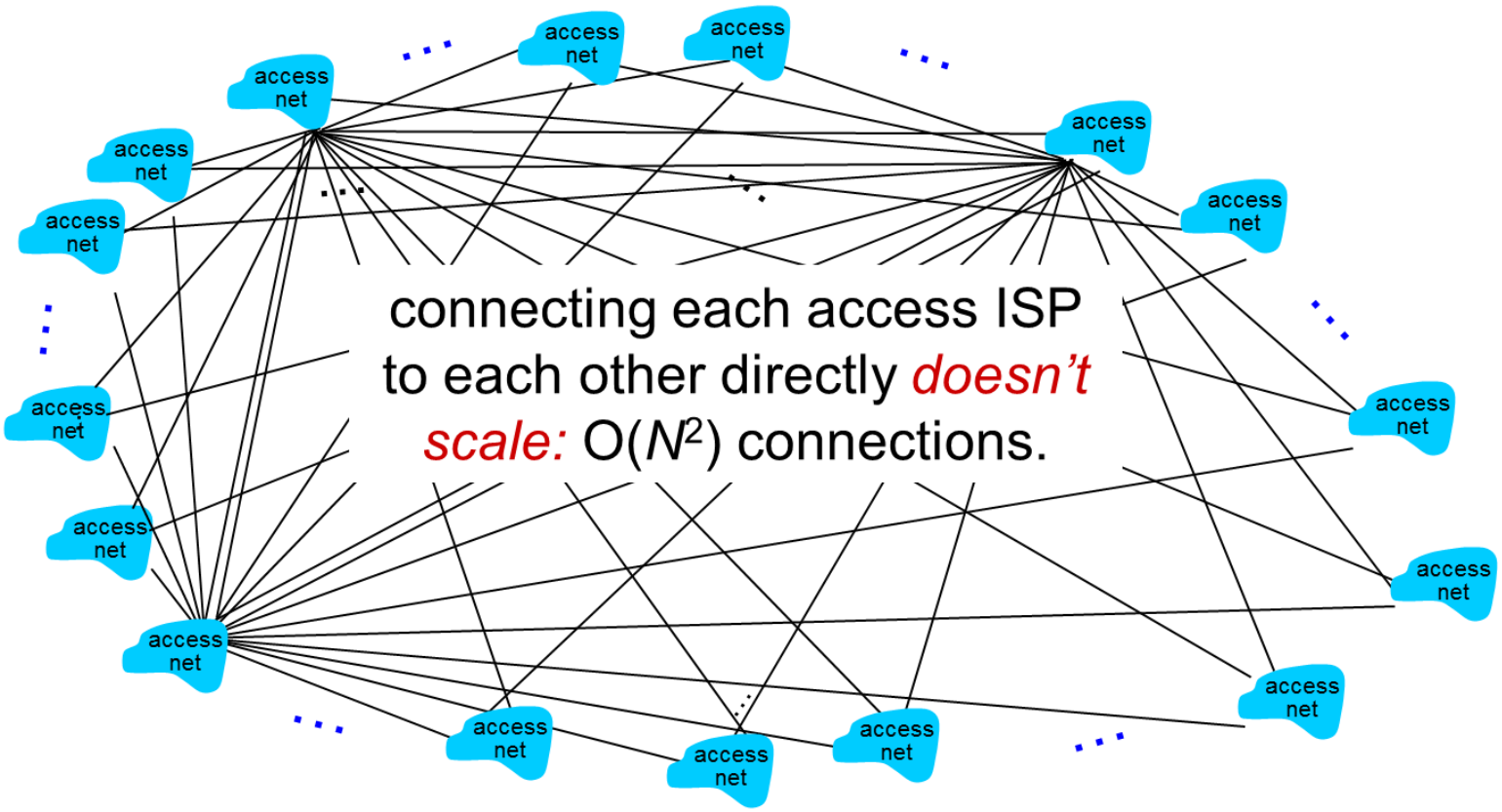
Internet Structure

❖ Question: given millions of access ISPs, how to connect them together?



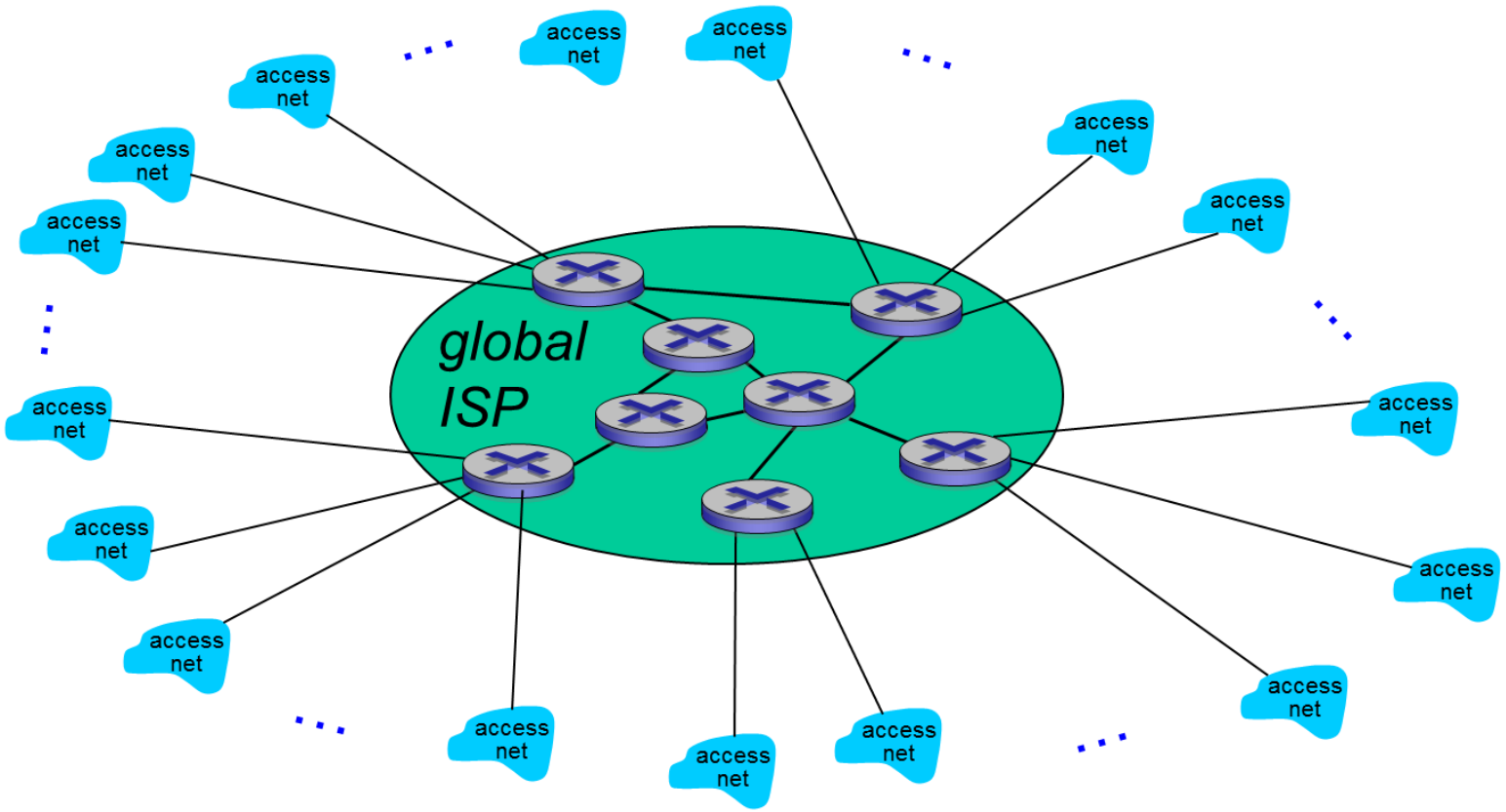
Internet Structure

❖ Naïve method: connect each access ISP to every other access ISP



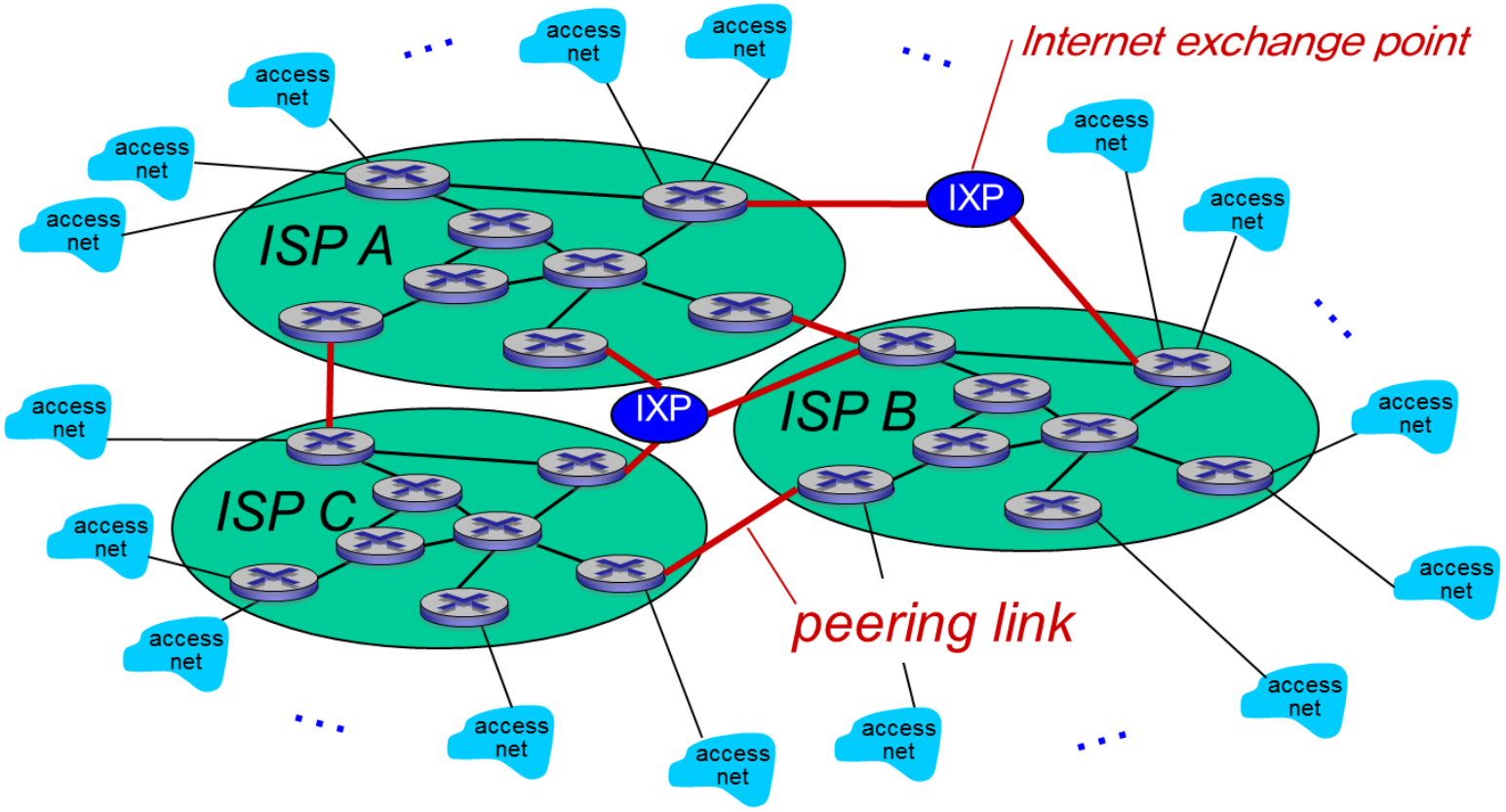
Internet Structure

❖ Scalable method: connect each access ISP to one global transit ISP



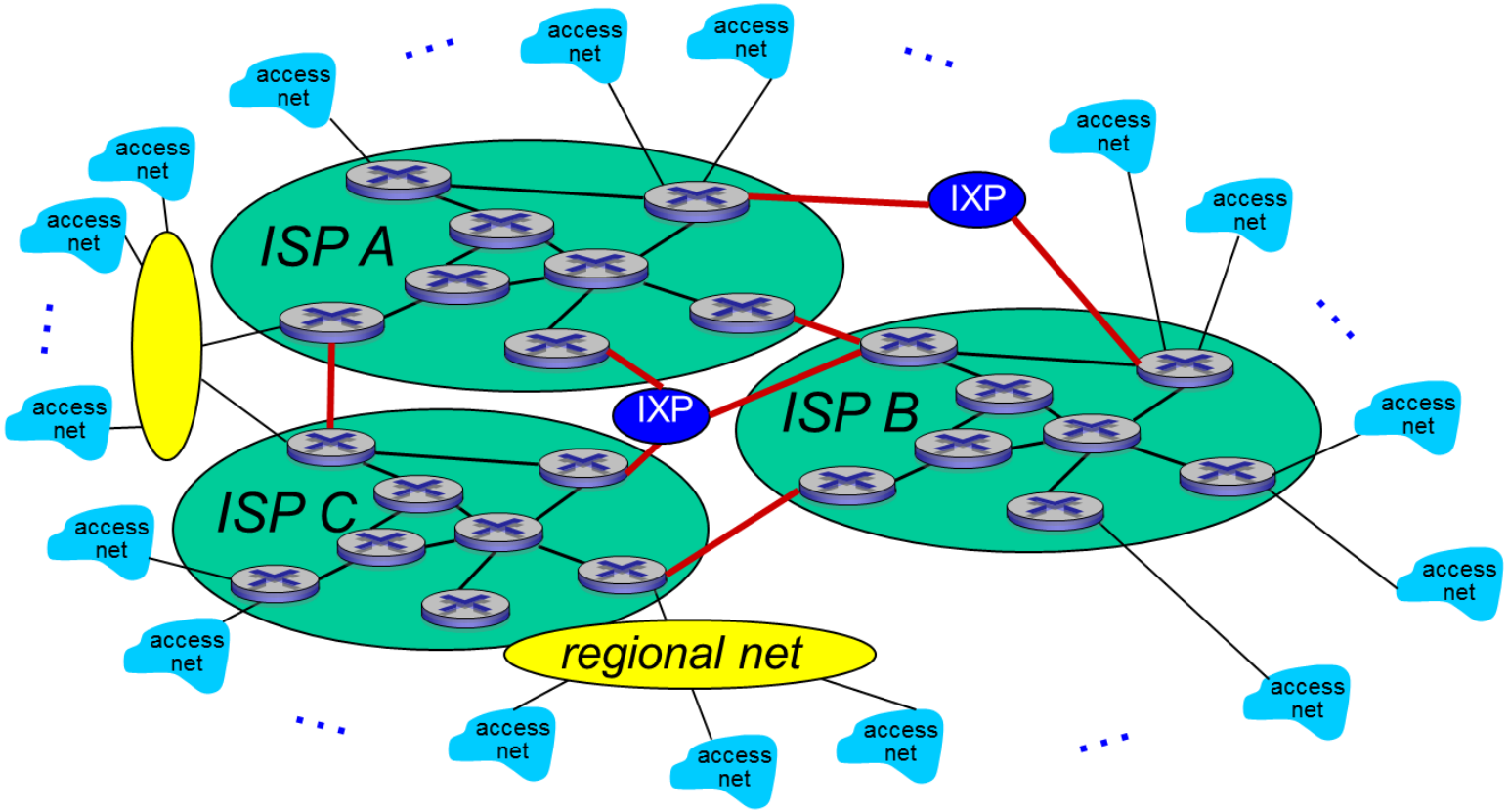
Internet Structure

❖ Competing ISPs appear… which must be interconnected



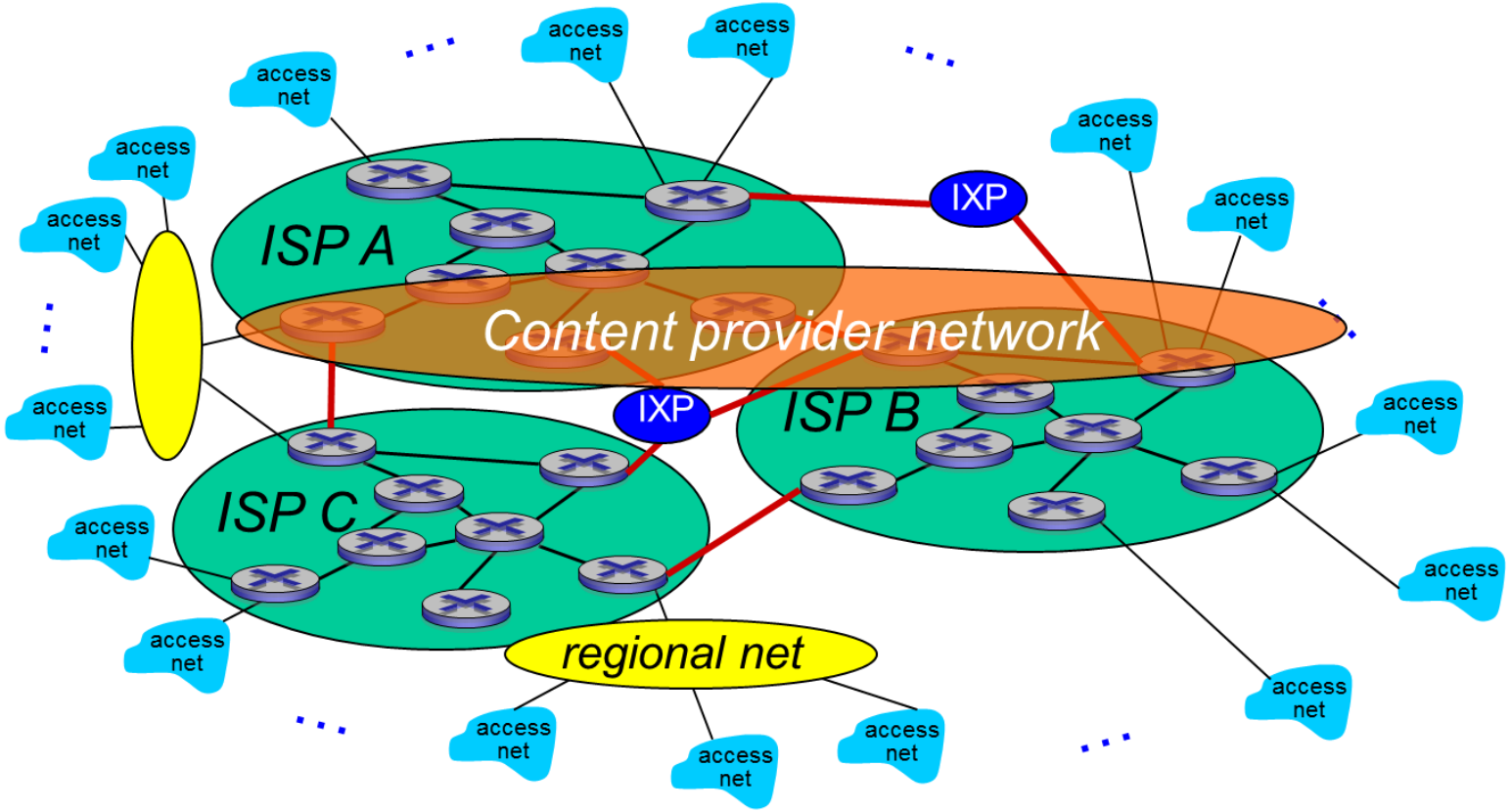
Internet Structure

❖ Regional networks arise to connect access networks to ISPs



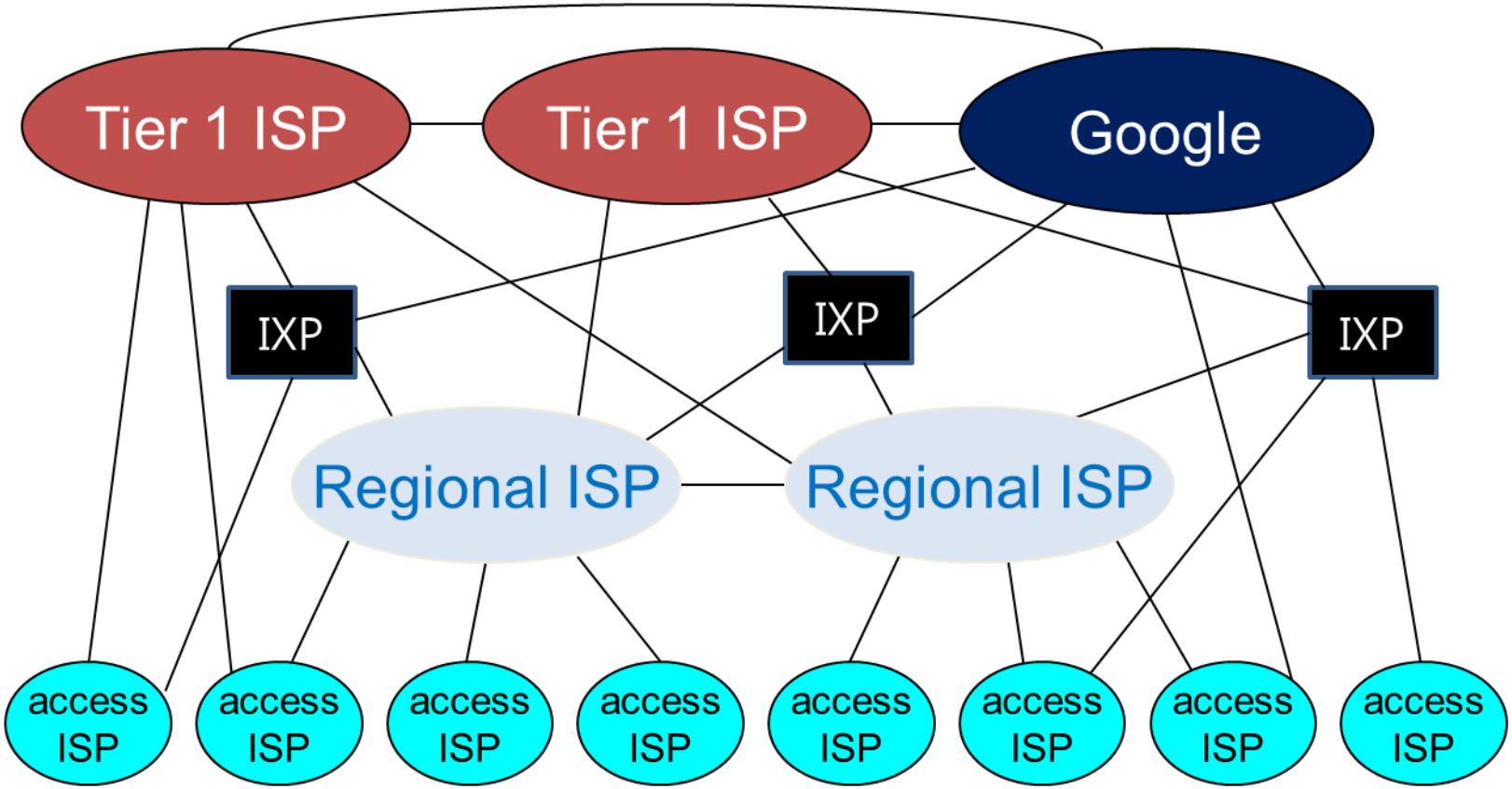
Internet Structure

❖ Content provider (e.g., Google, Microsoft, Akamai) run their own network to bring services and content close to end users



Internet Structure

❖ **Seen vertically as:**

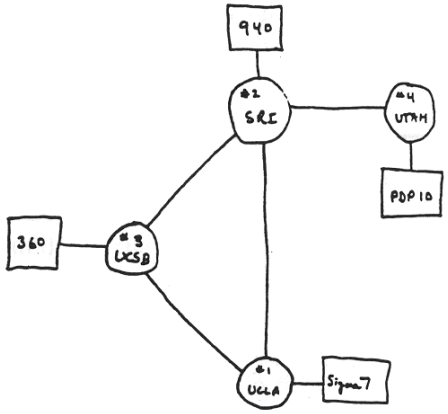


04. HISTORY OF THE INTERNET

Internet History (1961~1972)

❖ Early packet-switching principles

- 1961: Kleinrock - queueing theory shows effectiveness of packet-switching
- 1967: ARPAnet conceived by Advanced Research Projects Agency
- 1969: first ARPAnet node operational
- 1972
  - ARPAnet public demo
  - NCP (Network Control Protocol) first host-host protocol
  - first e-mail program
  - ARPAnet has 15 nodes



THE ARPA NETWORK

Internet History (1972~1980)

❖ Internetworking, new and proprietary nets

- 1974: Cerf and Kahn - architecture for interconnecting network
- 1976: Ethernet at Xerox PARC
- 1979: ARPAnet has 200 nodes

출저 - http://www.amongtech.com/unsung-heroes-internet-pioneers-youve-never-heard/

Cerf and Kahn's internetworking principles:

- minimalism, autonomy - no internal changes required to interconnect networks
- best effort service model
- stateless routers
- decentralized control

define today's Internet architecture

Internet History (1980~1990)

❖ New protocols, a proliferation of networks

- 1983: deployment of TCP/IP
- 1982: smtp e-mail protocol defined
- 1983: DNS defined for name-to-IP-address translation
- 1985: ftp protocol defined
- 1988: TCP congestion control
- new national networks: Csnet, BITnet, NSFnet, Minitel
- 100,000 hosts connected to confederation of networks

Bill Joy

출처 - http://fortune.com/2011/04/06/bill-joy-better-batteries-key-to-green-power-adoption/

Internet History (1990~2000)

❖ Commercialization, the Web, new apps

- 1991: NSF lifts restrictions on commercial use of NSFnet (decommissioned, 1995)
- Early 1990's: Web
  - HTML, HTTP: Tim Berners-Lee
  - 1994: Mosaic, later Netscape
  - Commercialization of the Web
- Late 1990's-2000's
  - more killer apps: instant messaging, P2P file sharing
  - network security to forefront
  - est. 50 million host, 100 million+ users

Internet History (Present)

❖ Present

- 5B devices attached to Internet (2016)
  - smartphones and tablets
- Aggressive deployment of broadband access
- Increasing ubiquity of high-speed wireless access
- Emergence of online social networks:
  - Facebook: ~ one billion users
- Service providers (Google, Microsoft) create their own networks
  - bypass Internet, providing "instantaneous" access to search, video content, email, etc.
- e-commerce, universities, enterprises running their services in "cloud" (e.g., Amazon EC2)

요 약

➢ Internet

- Network of networks
- Hots, interconnection devices, links

➢ Network structure

- Network edge and network core

➢ Internet structure

- Several tiers of internet service providers

➢ Internet history