Protocoles internet

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Introduction

Protocoles et services internet

Sommaire (prévision):

- Introduction et rappels réseau
- Protocoles: couche application
  - Html-http
  - ftp
  - smtp
  - Dns
- Rappels java
- Réseaux Pair à pair
- Grands réseaux et petits mondes
- Sécurité
- Mobilité
- Serveur web

PROTOCOLES

Organisation

Note finale= 50% exam +50% projet

TP: 3 groupes
GR1 mercredi 13h30 à 16h30
GR2 jeudi 10h30 à 13h30
GR3 jeudi 13h30 à 16h30

Inscription aux groupes *moodle*:
https://moodlesupd.script.univ-paris-diderot.fr

- Pas de cours les 16 octobre, 30 octobre et 6 novembre
- prolongation des cours du 23 octobre, 13, 20 et 27 novembre, 4 et 11 décembre
- TP:
  - 25 et 26 oct
  - 15 et 16 nov
  - 6 et 7 déc
  - 13 et 14 déc

Bibliographie

- Java Network Programming, 3rd Edition Elliotte Rusty Harold O'Reilly Media, Inc..
- Computer Networking: A Top Down Approach, 6 th edition J.F. Kurose K.W. Ross Addison Weslay.
- Computer Networks, A.S. Tannenbaum, D.J. Wetherall,Pearson
- ….

Certains transparents proviennent de:

- *Computer Networking: A Top Down Approach*,
  Jim Kurose, Keith Ross
  Addison-Wesley

- Documents sur moodle

Chapitre 1

- Introduction (rappels réseau)
  - Hôtes, réseaux d'accès, liens physiques
  - Commutation par circuits, par paquets, structure du réseau
  - Pertes et délais
  - Protocoles et modèle en couches
  - Sécurité
  - Historique…

Les composants…

PC

server

wireless laptop

cellular handheld

- millions of connected computing devices:
  hosts = end systems
  - running network apps

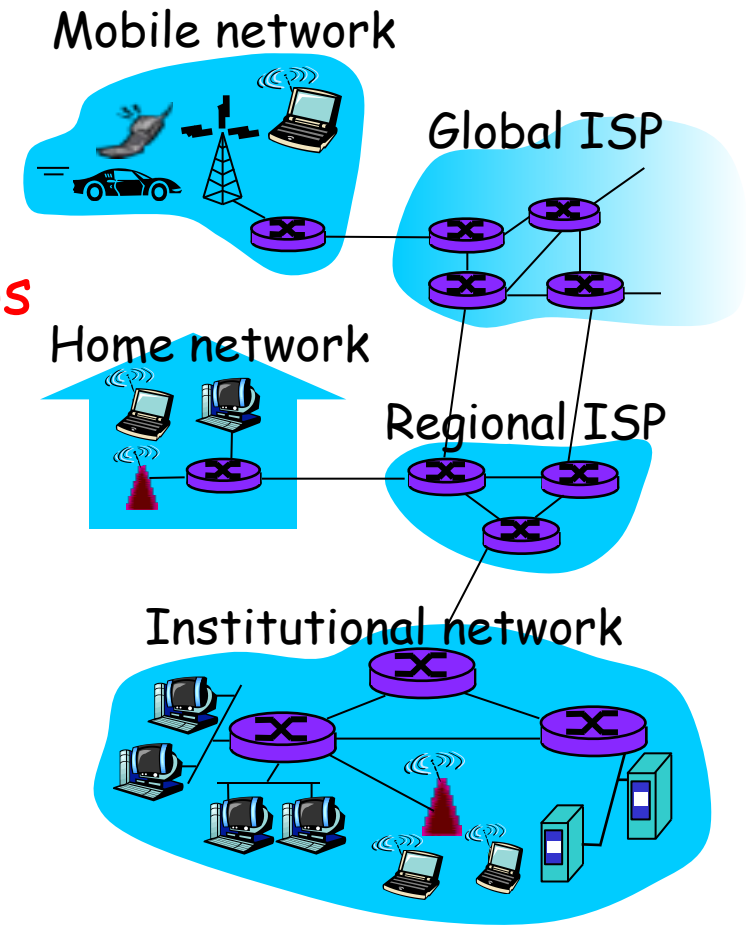
- communication links
  - fiber, copper, radio, satellite
  - transmission rate = bandwidth

access points

wired links

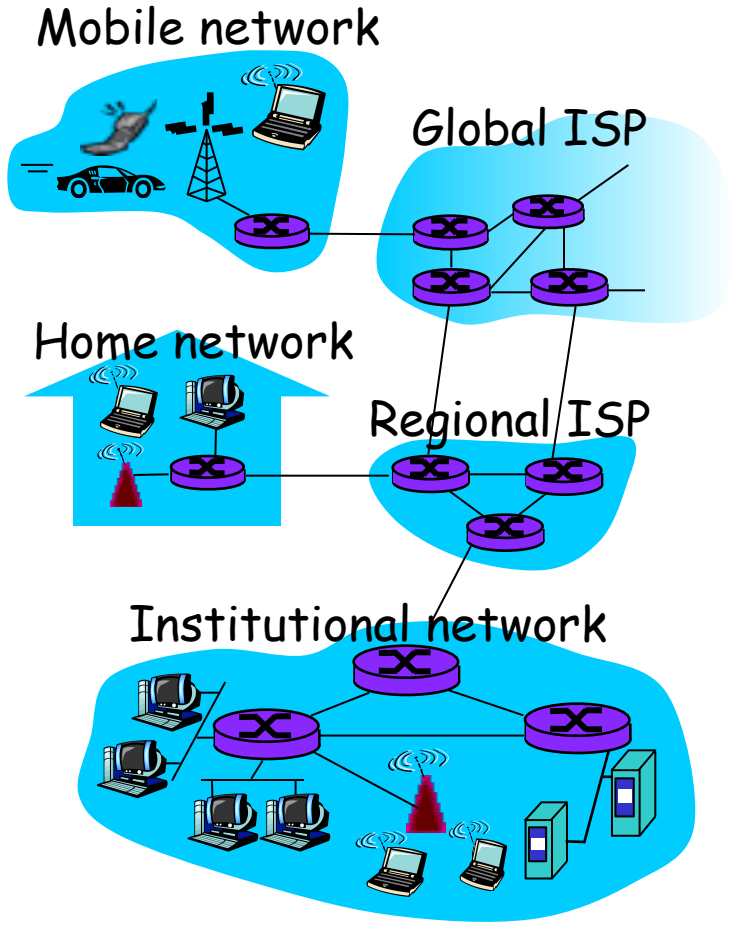
router

- routers: forward packets (chunks of data)



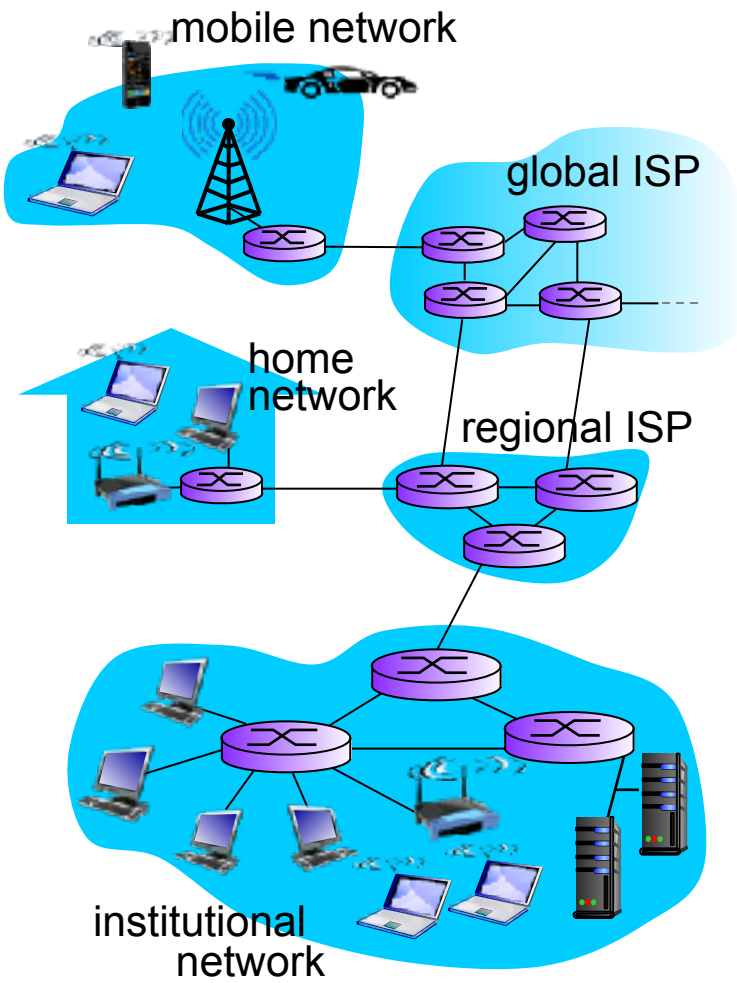
Internet:

- protocols control sending, receiving of msgs
  - e.g., TCP, IP, HTTP, Skype, Ethernet
- Internet: "network of networks"
  - loosely hierarchical
  - public Internet versus private intranet
- Internet standards
  - RFC: Request for comments
  - IETF: Internet Engineering Task Force



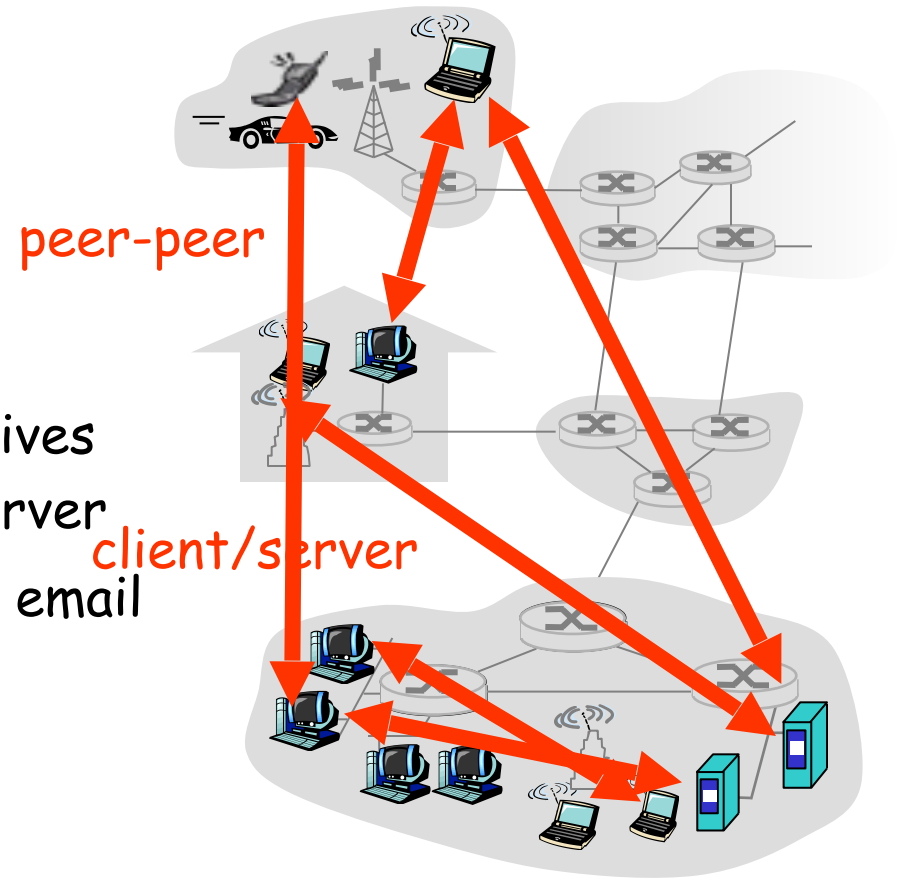
What's the Internet: a service view

- communication infrastructure enables distributed applications:
  - Web, VoIP, email, games, e-commerce, social network, file sharing…
- communication services provided to apps:
  - reliable data delivery from source to destination
  - "best effort" (unreliable) data delivery



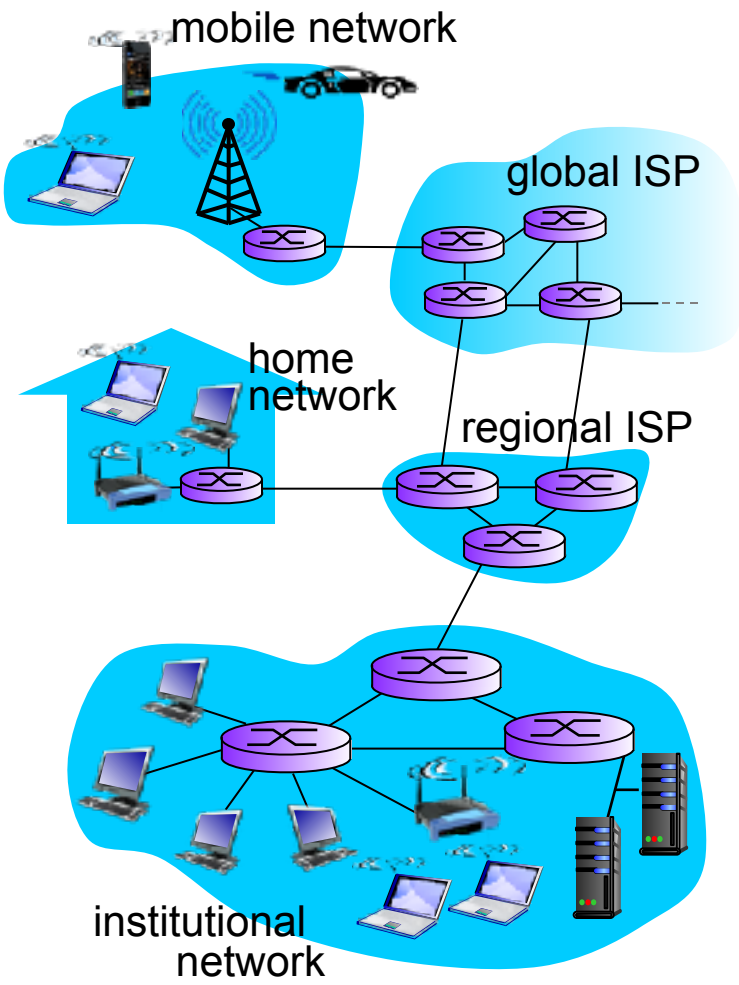
The network edge:

- end systems (hosts):
  - run application programs
  - e.g. Web, email
  - at "edge of network"
- client/server model
  - client host requests, receives service from always-on server
  - e.g. Web browser/server; email client/server
- peer-peer model:
  - minimal (or no) use of dedicated servers
  - e.g. Skype, BitTorrent



A closer look at network structure:

- network edge:
  applications and hosts
- access networks, physical media:
  wired, wireless communication links
- network core:
  - interconnected routers
  - network of networks



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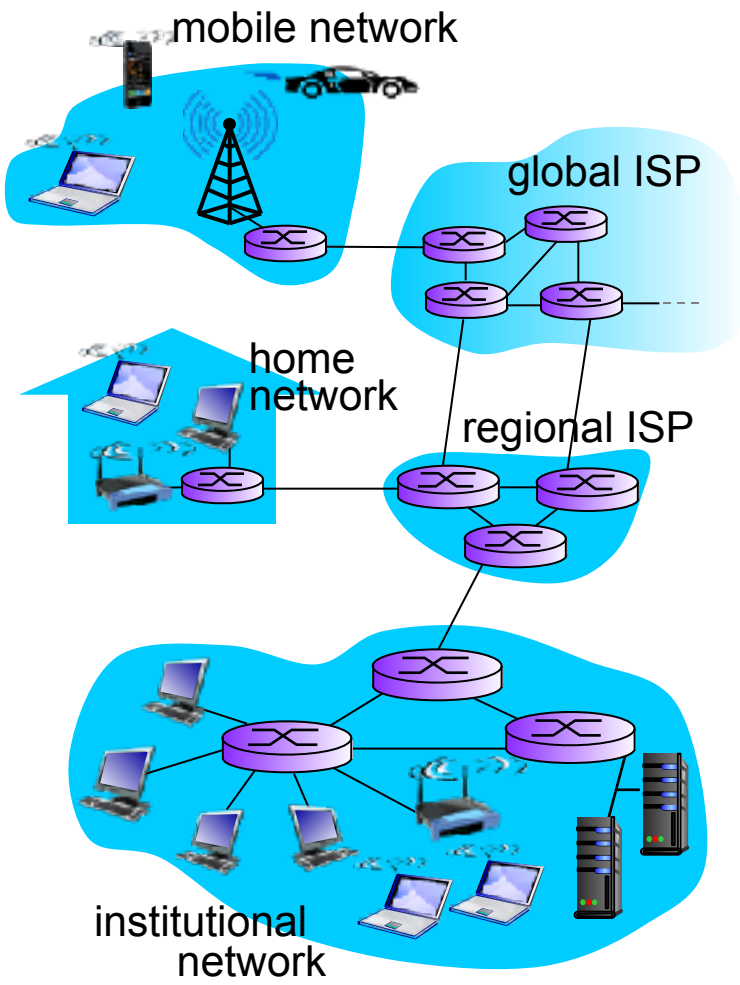
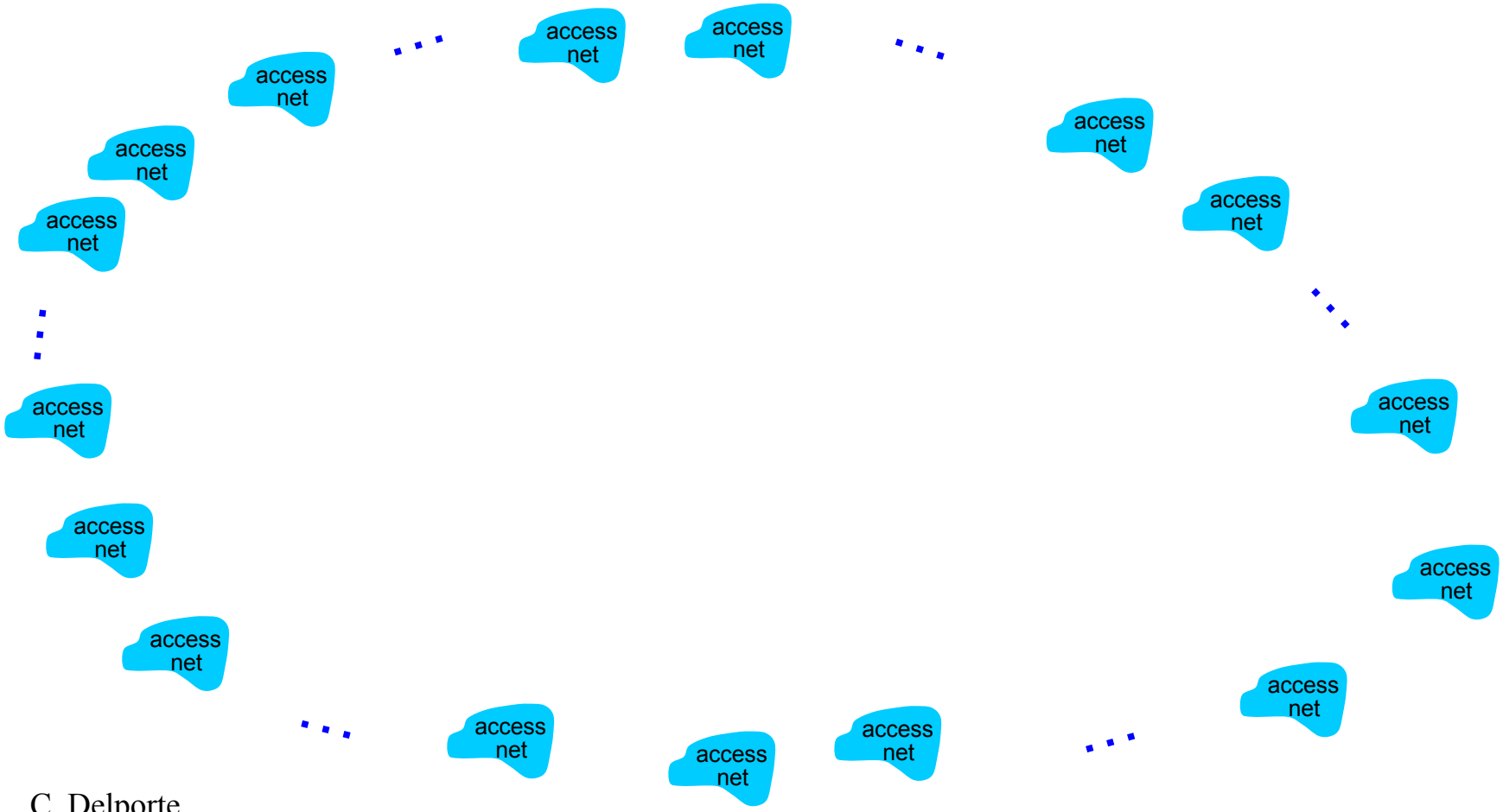


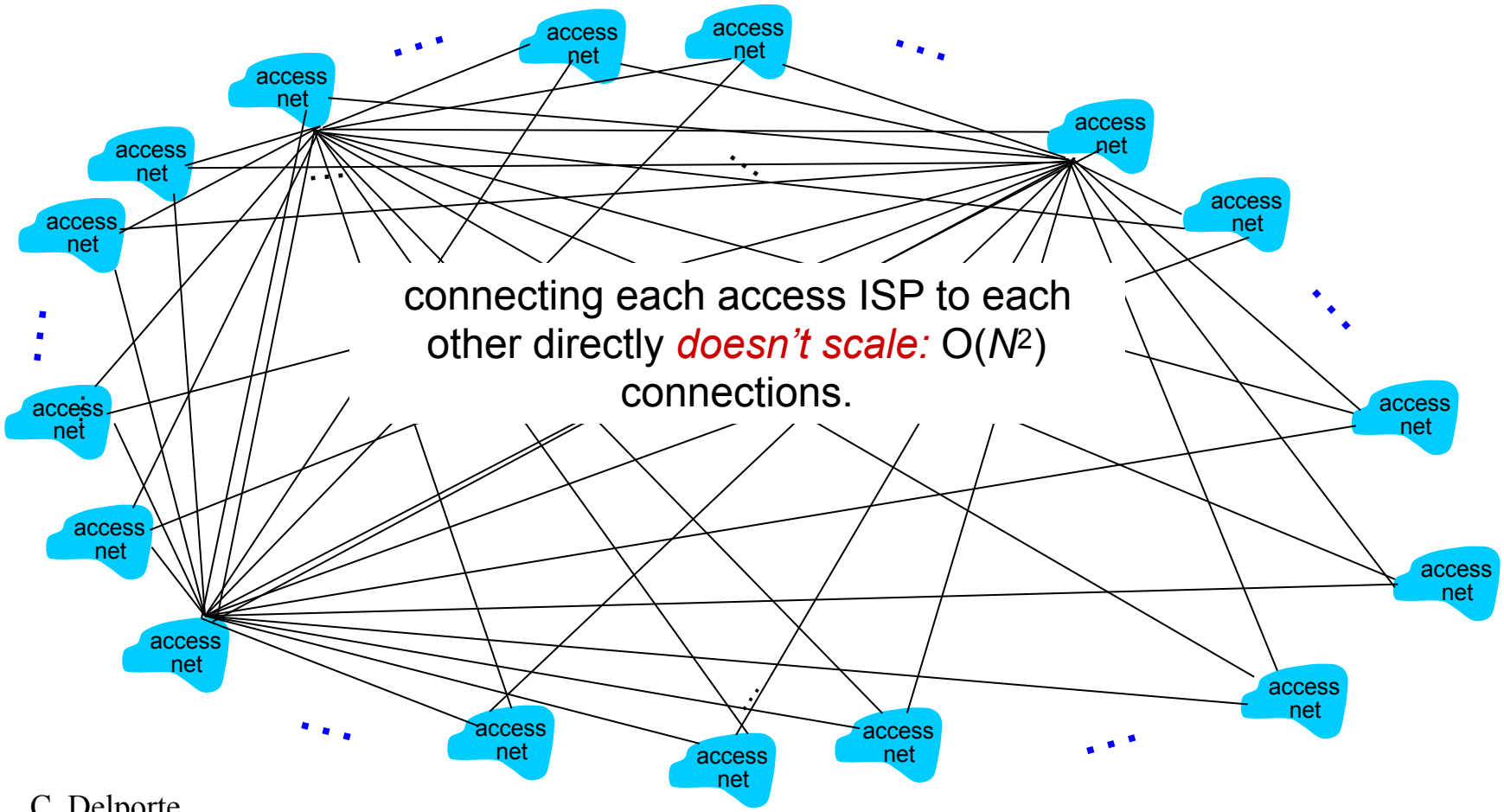
Internet structure: network of networks

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



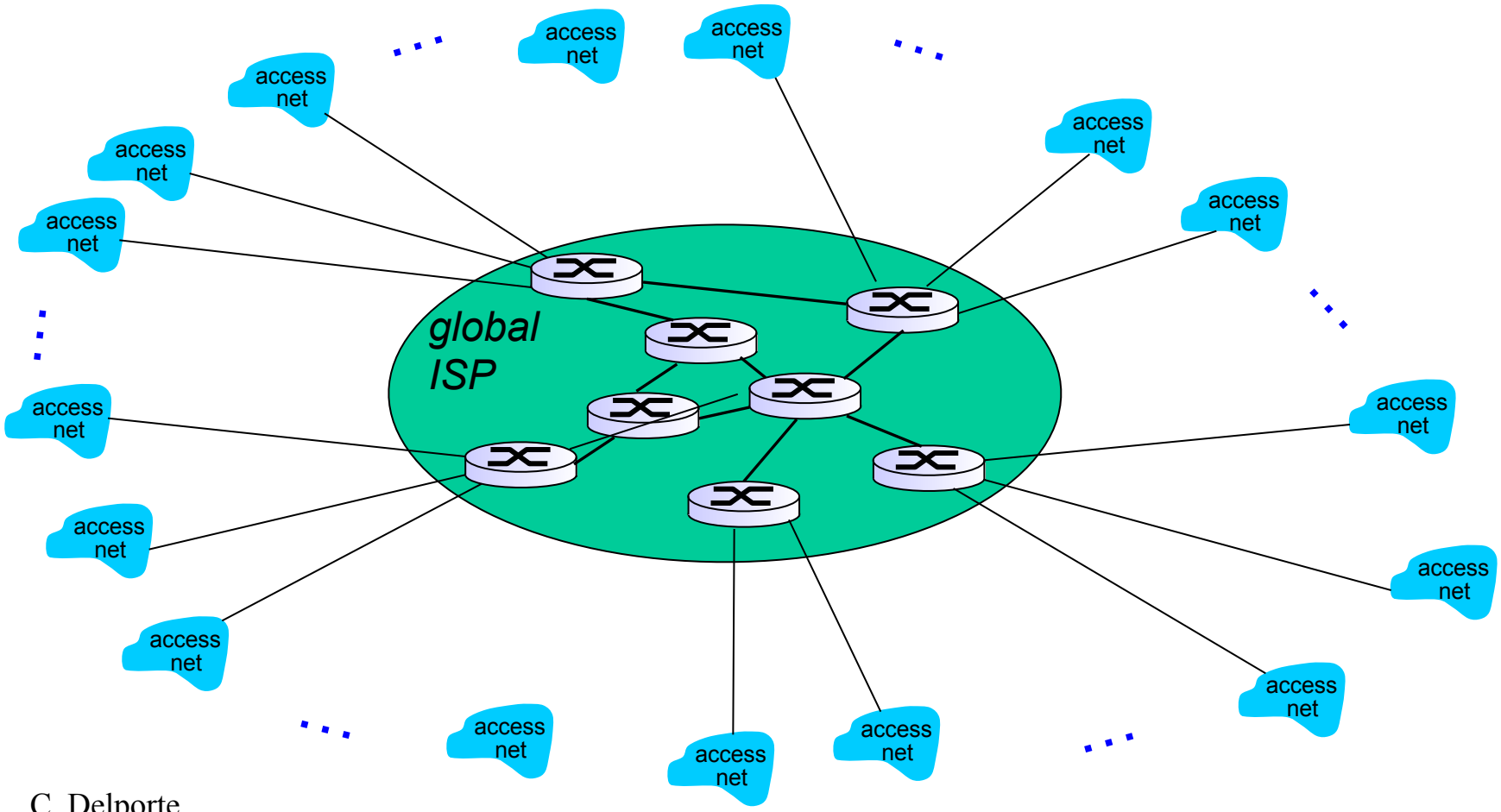
Internet structure: network of networks

Option: connect each access ISP to every other access ISP?



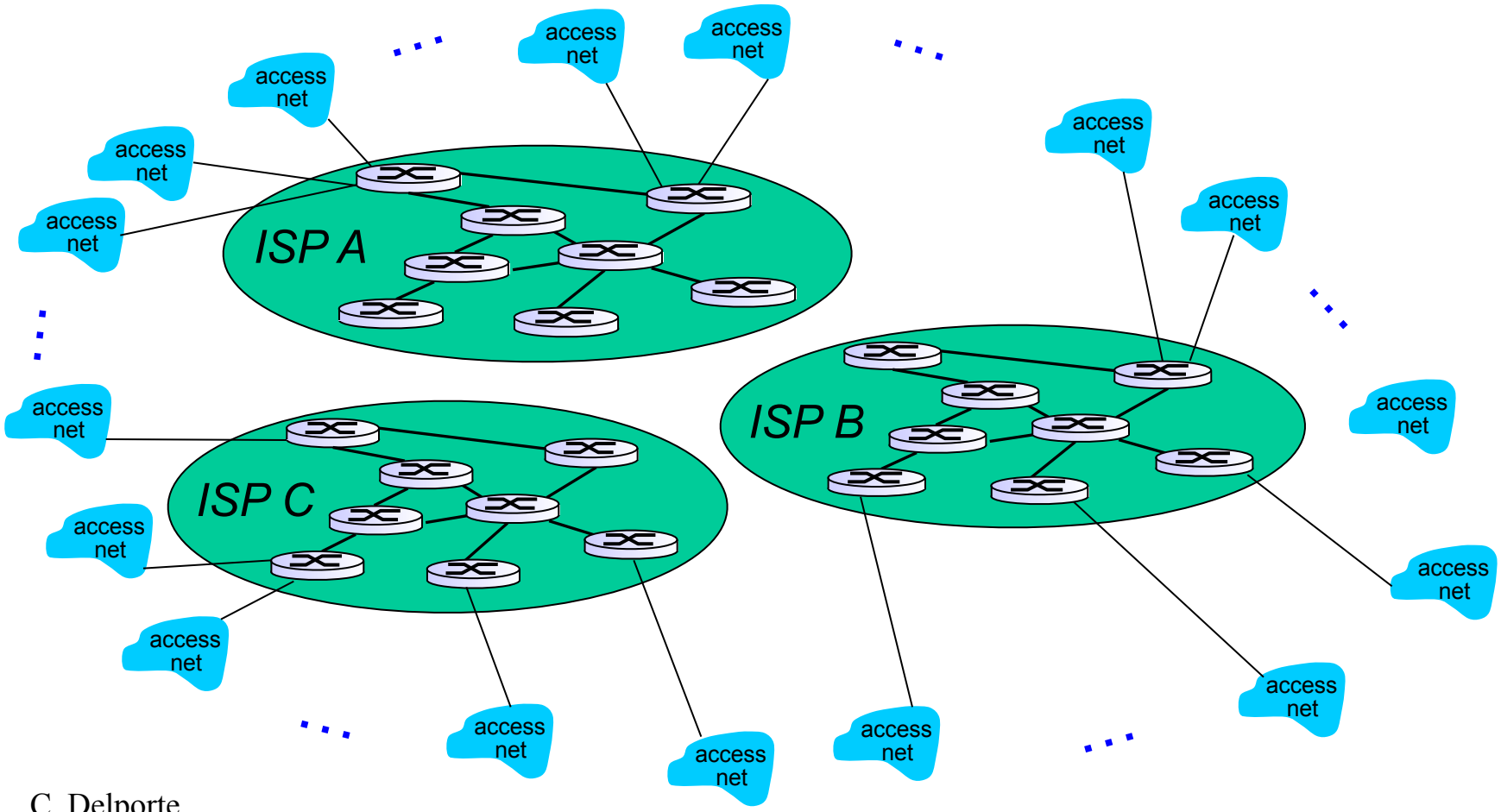
Internet structure: network of networks

Option: connect each access ISP to a global transit ISP? Customer and provider ISPs have economic agreement.



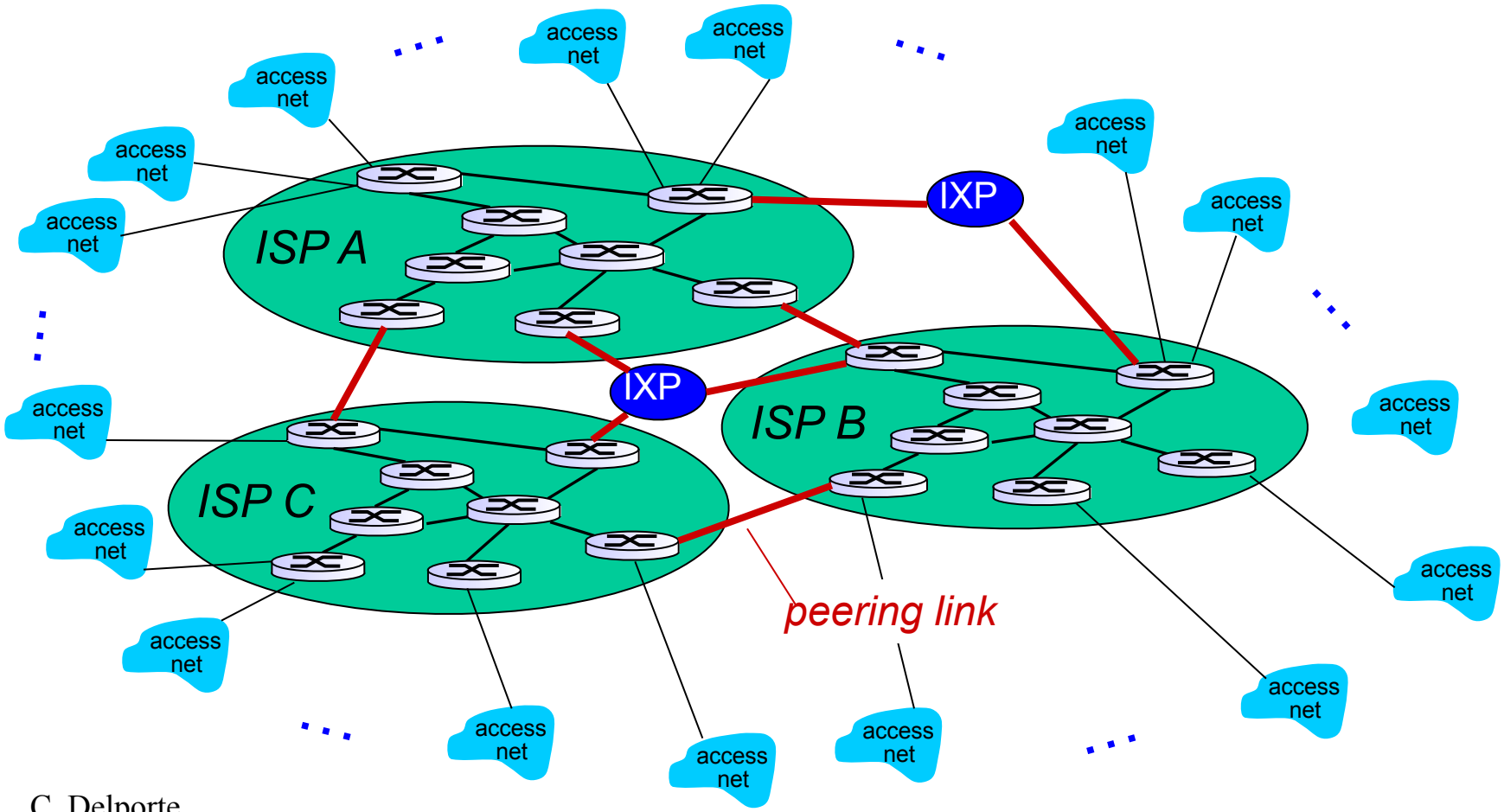
Internet structure: network of networks

But if one global ISP is viable business, there will be competitors ….



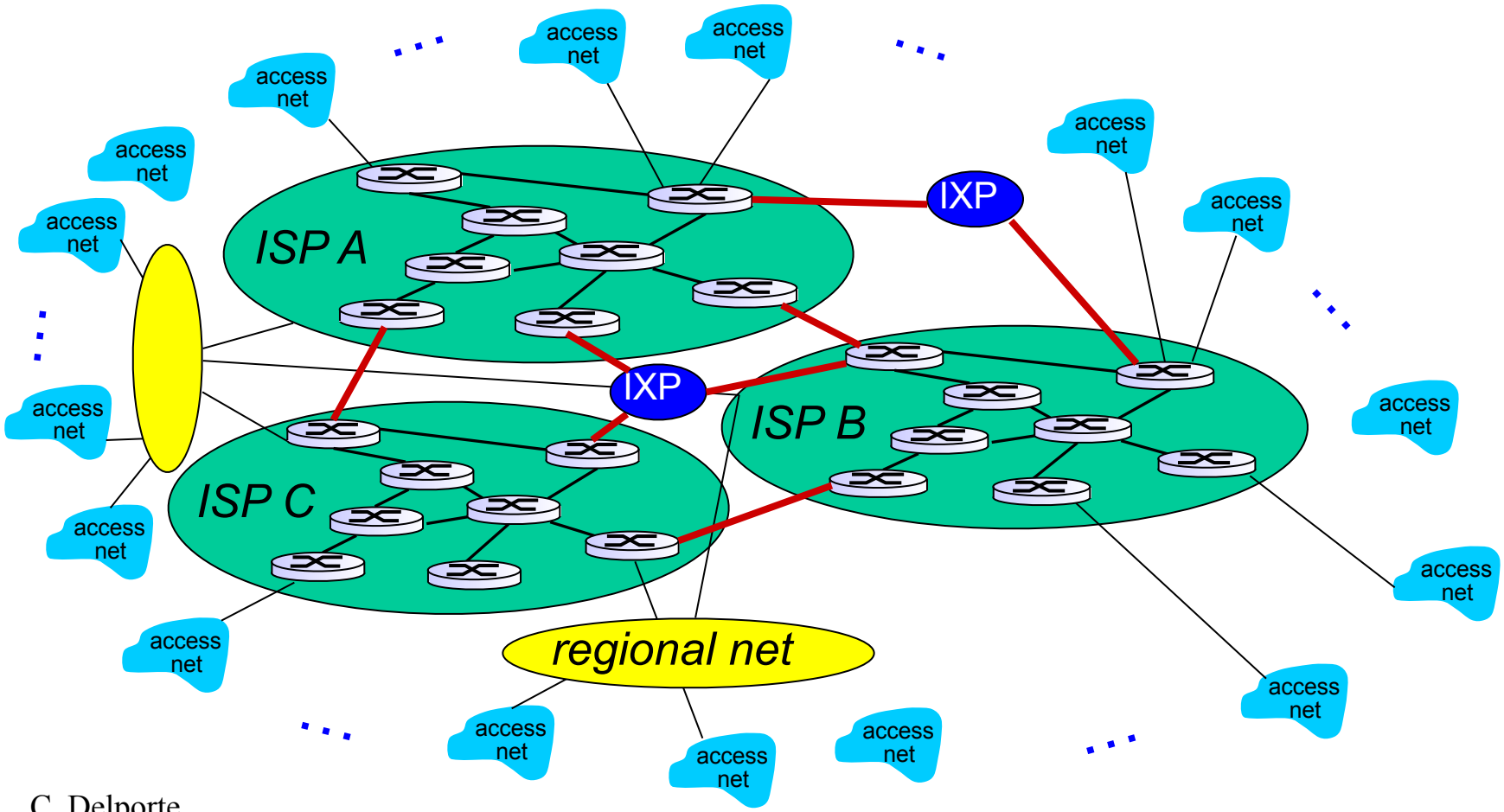
Internet structure: network of networks

But if one global ISP is viable business, there will be competitors …. which must be interconnected



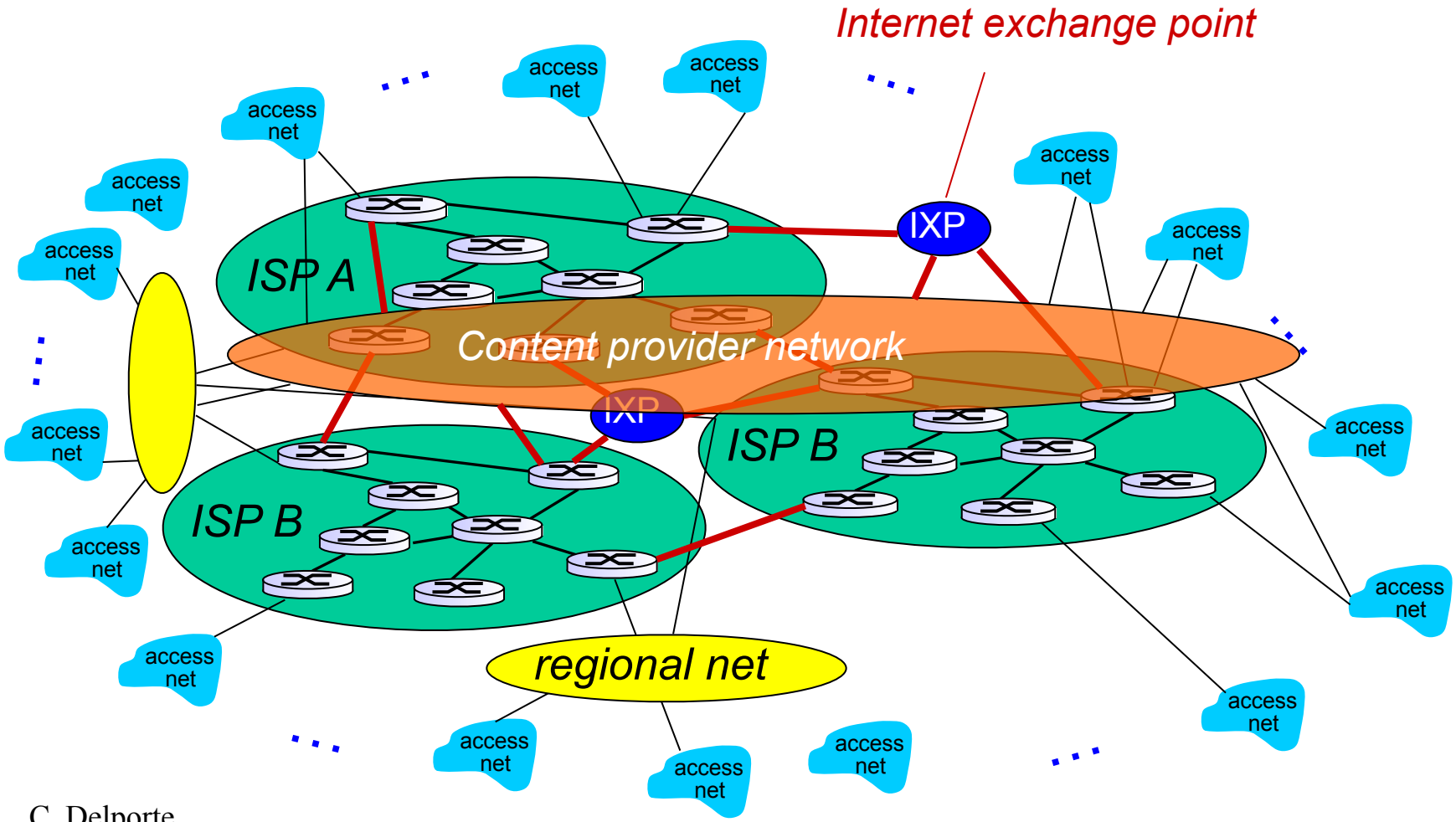
Internet structure: network of networks

… and regional networks may arise to connect access nets to ISPS



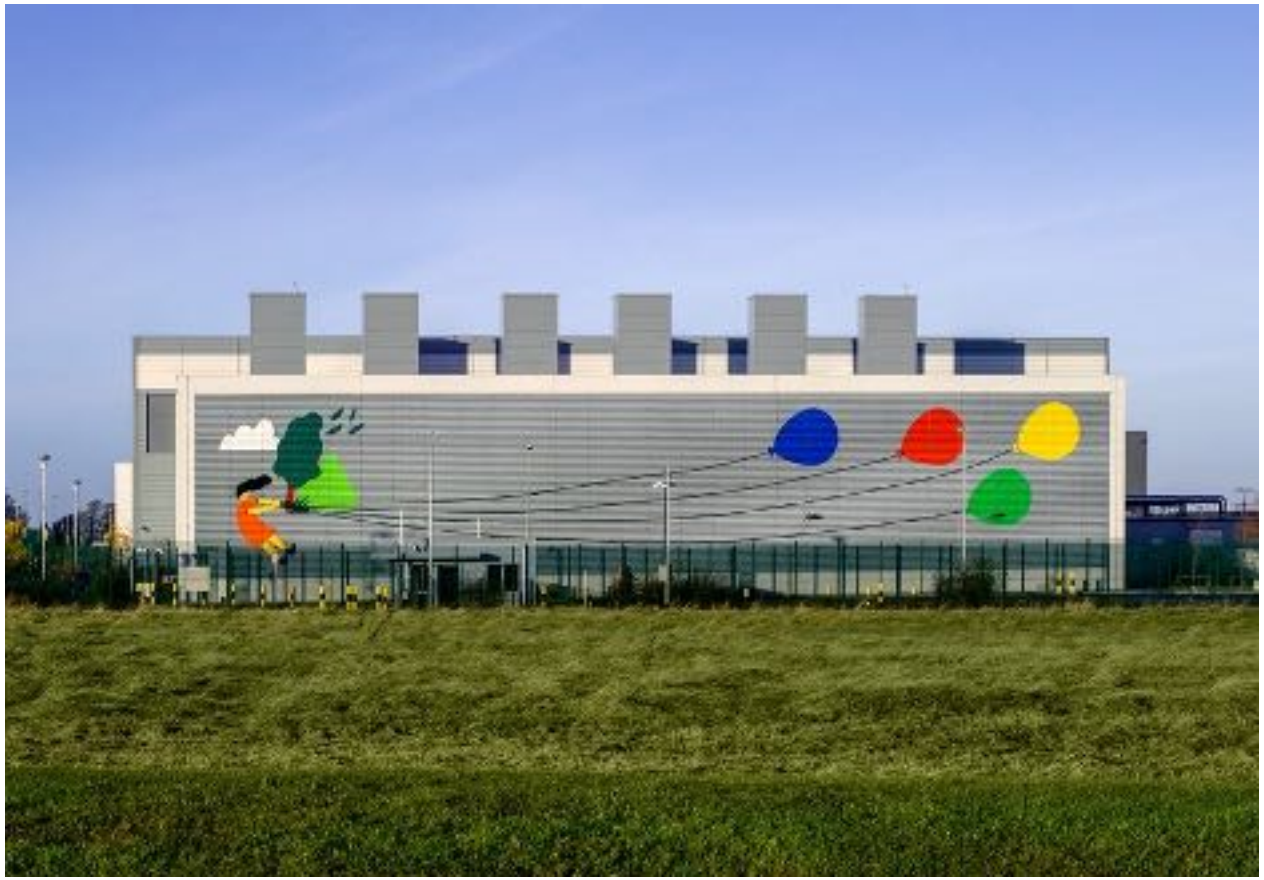
Internet structure: network of networks

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



Google Data Centers

- March 2017, Google spent nearly $30 billion on data centers over the preceding three years.

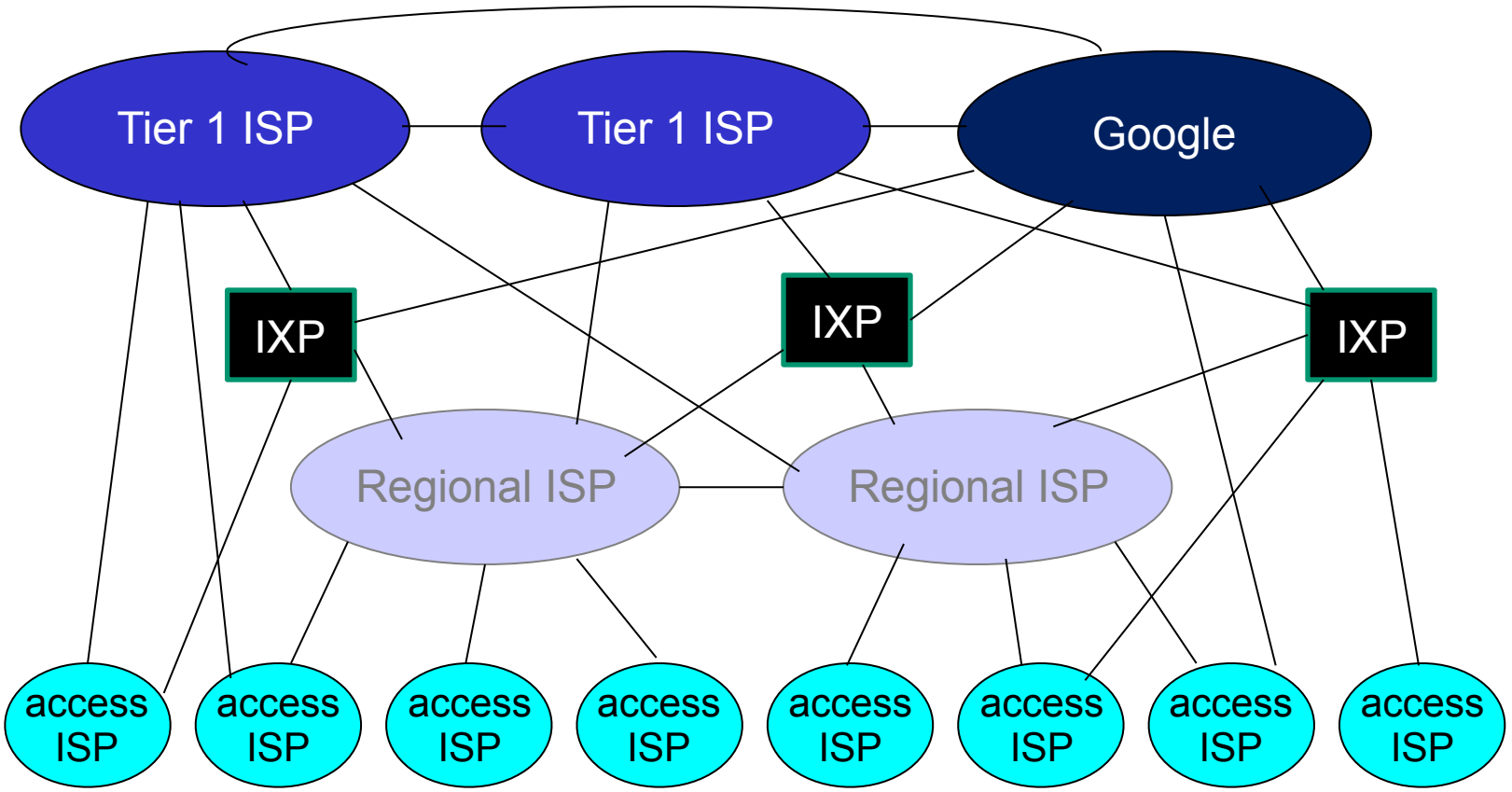


Google Data Centers

- 8 in U.S., 1 in South America, 4 in Europe and 2 in Asia.
- Data center uses around 260 megawatts of power

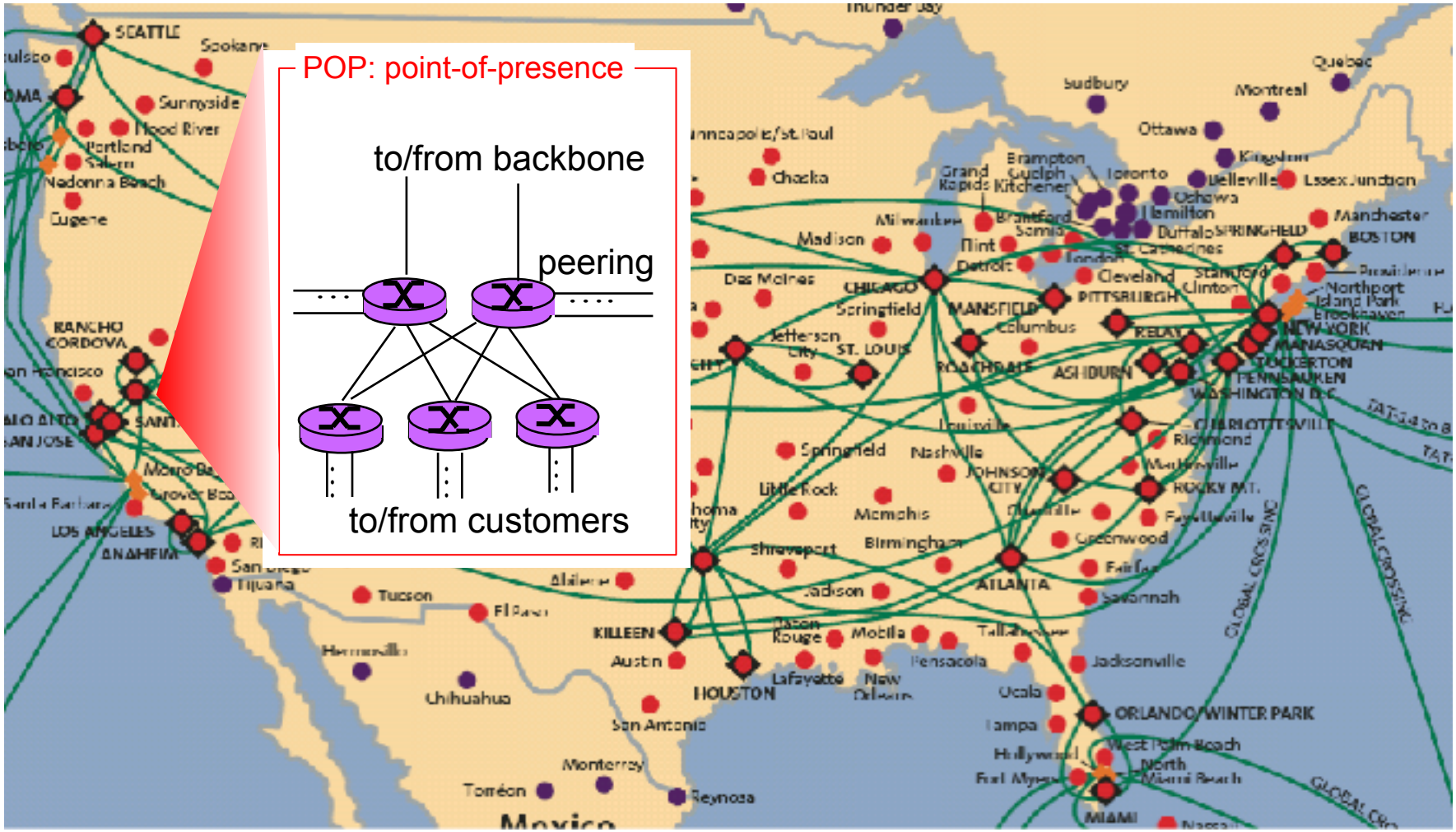
Oregon (2006)

Internet structure: network of networks



- at center: small # of well-connected large networks
  - "tier-1" commercial ISPs (e.g., Level 3, Sprint, AT&T, NTT), national & international coverage
  - content provider network (e.g, Google): private network that connects it data centers to Internet, often bypassing tier-1, regional ISPs

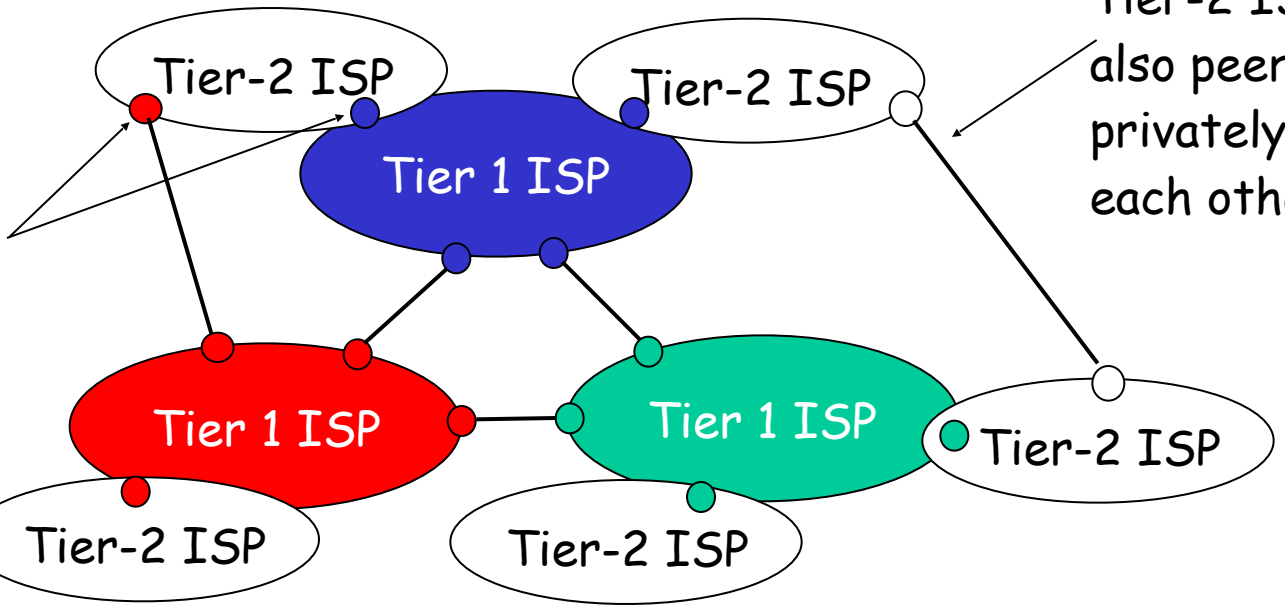
Tier-1 ISP: e.g., Sprint



Internet structure: network of networks

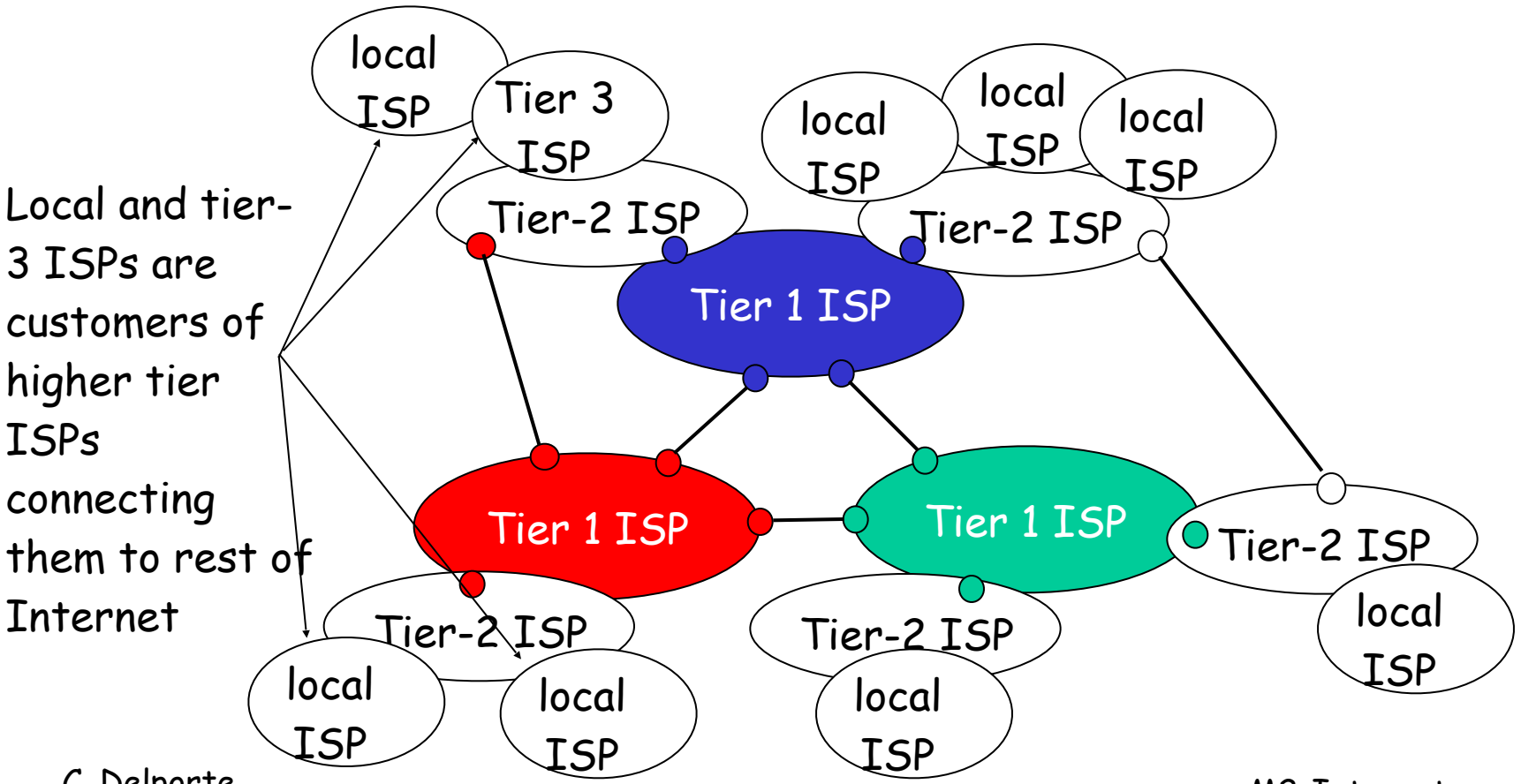
- "Tier-2" ISPs: smaller (often regional) ISPs
  - Connect to one or more tier-1 ISPs, possibly other tier-2 ISPs

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



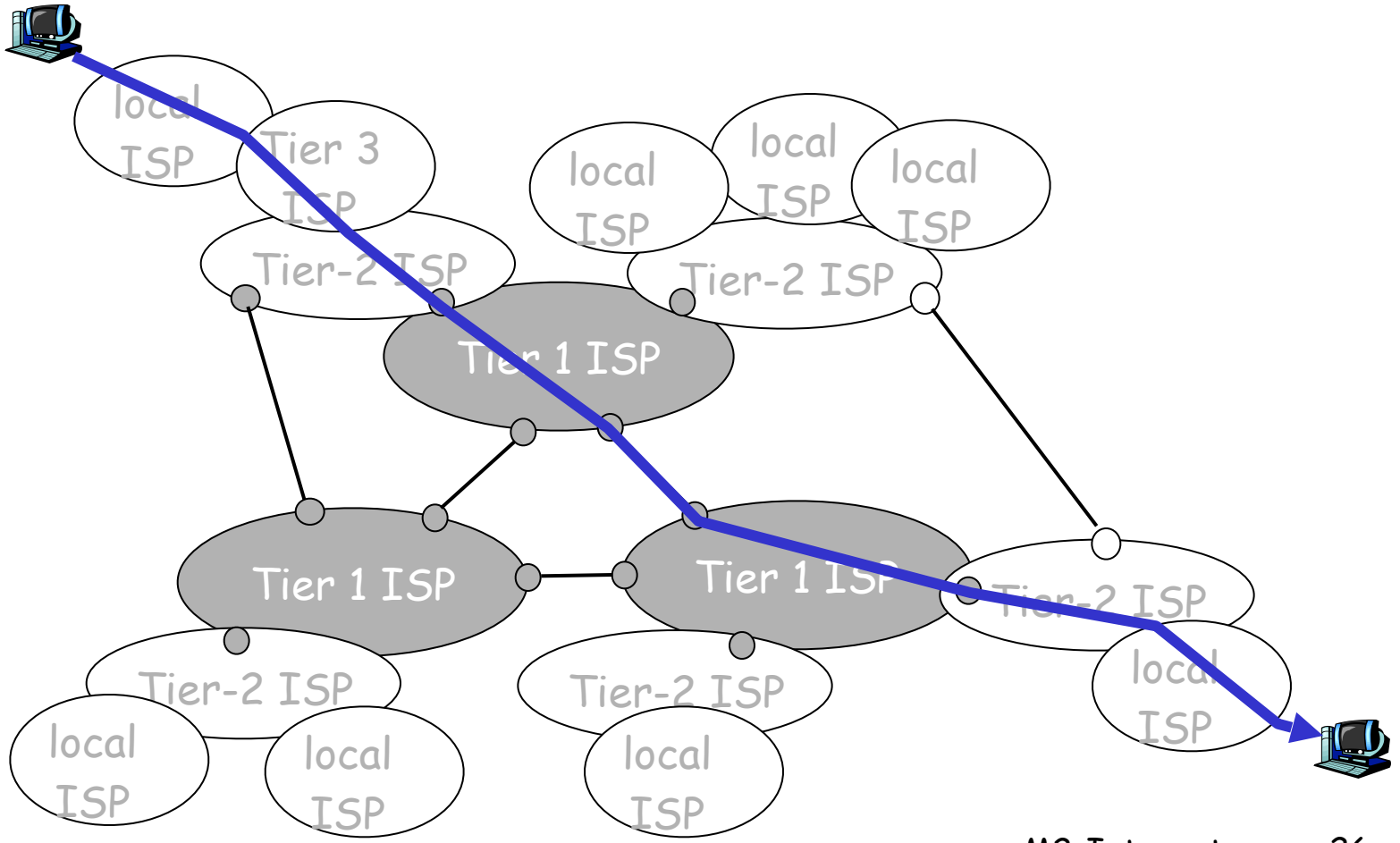
Internet structure: network of networks

- "Tier-3" ISPs and local ISPs
  - last hop ("access") network (closest to end systems)



Internet structure: network of networks

- a packet passes through many networks!



Protocols, layers

Networks are complex!

- many "pieces":
  - hosts
  - routers
  - links of various media
  - applications
  - protocols
  - hardware, software

Question:

Is there any hope of organizing structure of network?

Or at least our discussion of networks?

What's a protocol?

human protocols:

- "what's the time?"
- "I have a question"
- introductions

… specific msgs sent

… specific actions taken when msgs received, or other events

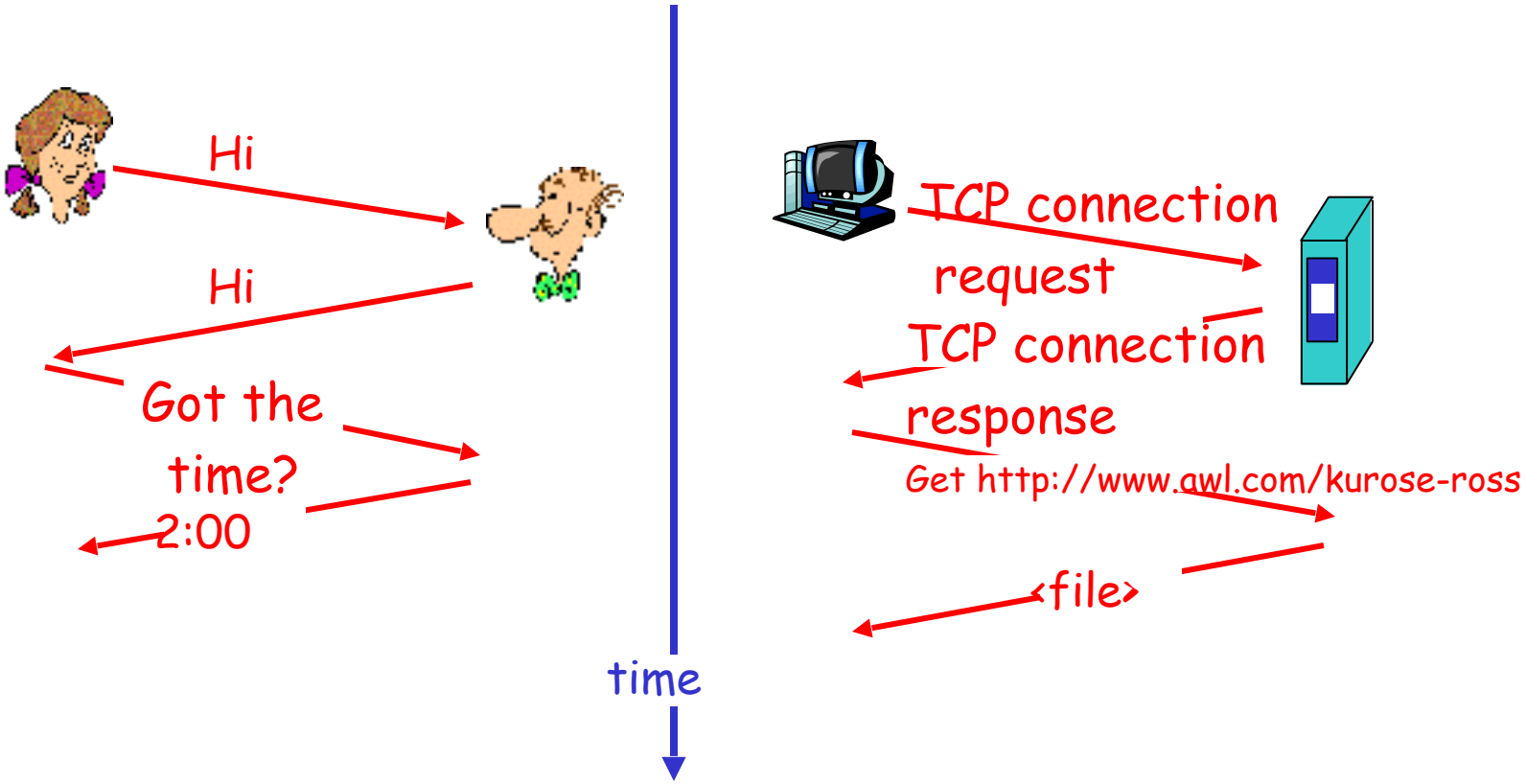
network protocols:

- machines rather than humans
- all communication activity in Internet governed by protocols

protocols define format, order of msgs sent and received among network entities, and actions taken on msg transmission, receipt

What's a protocol?

a human protocol and a computer network protocol:



Q: Other human protocols?

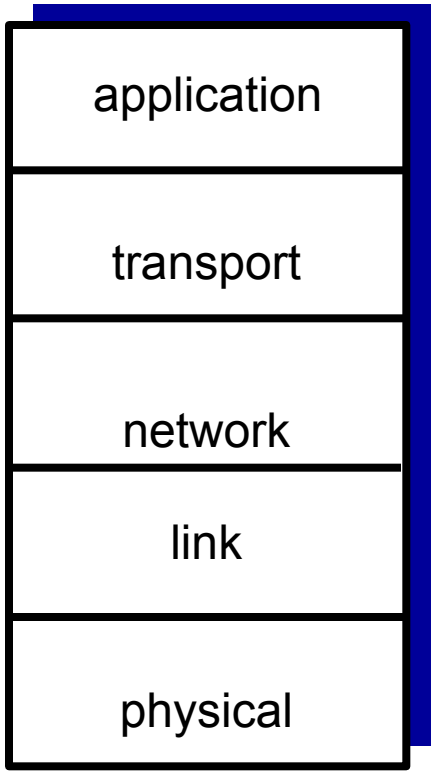
Why layering?

dealing with complex systems:

- explicit structure allows identification, relationship of complex system's pieces
  - layered *reference model* for discussion
- modularization eases maintenance, updating of system
  - change of implementation of layer's service transparent to rest of system
  - e.g., change in gate procedure doesn't affect rest of system
- layering considered harmful?

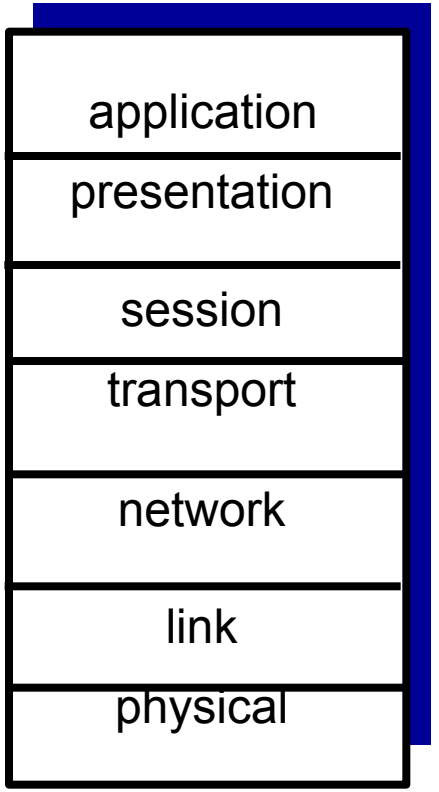
Internet protocol stack

- *application:* supporting network applications
  - FTP, SMTP, HTTP
- *transport:* process-process data transfer
  - TCP, UDP
- *network:* routing of datagrams from source to destination
  - IP, routing protocols
- *link:* data transfer between neighboring network elements
  - Ethernet, 802.111 (WiFi), PPP
- *physical:* bits “on the wire”

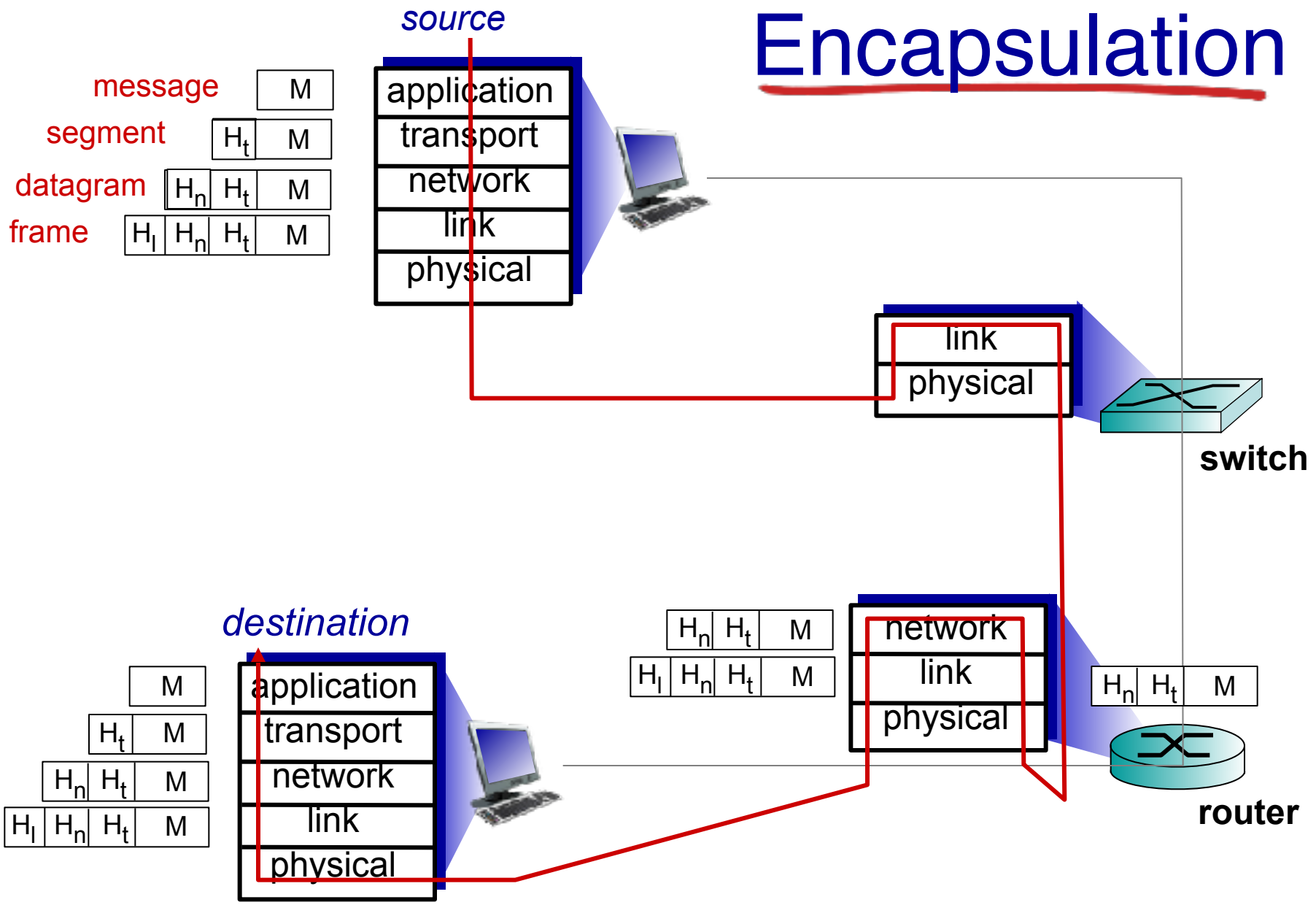


ISO/OSI reference model

- *presentation:* allow applications to interpret meaning of data, e.g., encryption, compression, machine-specific conventions
- *session:* synchronization, checkpointing, recovery of data exchange
- Internet stack "missing" these layers!
  - these services, *if needed,* must be implemented in application
  - needed?



Encapsulation



Network Security

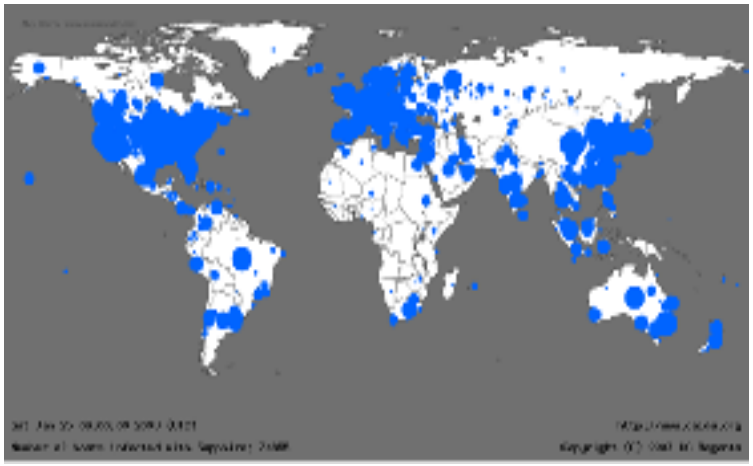
- The field of network security is about:
  - how bad guys can attack computer networks
  - how we can defend networks against attacks
  - how to design architectures that are immune to attacks
- Internet not originally designed with (much) security in mind
  - original vision: "a group of mutually trusting users attached to a transparent network" ☺
  - Security considerations in all layers!

Bad guys can put malware into hosts via Internet

- Malware can get in host from a virus, worm, or trojan horse.
- Spyware malware can record keystrokes, web sites visited, upload info to collection site.
- Infected host can be enrolled in a botnet, used for spam and DDoS attacks.
- Malware is often self-replicating: from an infected host, seeks entry into other hosts

Bad guys can put malware into hosts via Internet

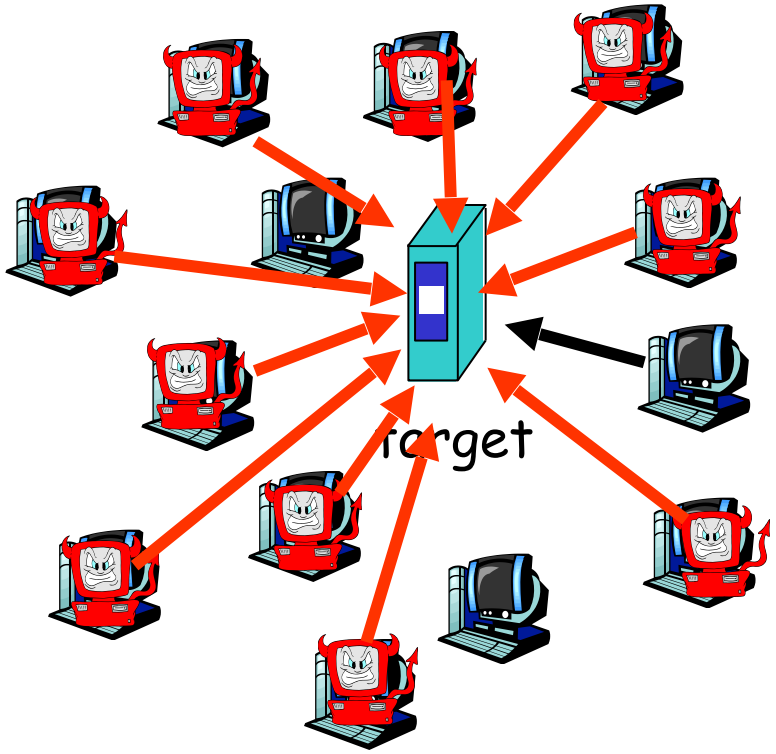
- Trojan horse
  - Hidden part of some otherwise useful software
  - Today often on a Web page (Active-X, plugin)
- Virus
  - infection by receiving object (e.g., e-mail attachment), actively executing
  - self-replicating: propagate itself to other hosts, users
- Worm:
  - infection by passively receiving object that gets itself executed
  - self- replicating: propagates to other hosts, users



Bad guys can attack servers and network infrastructure

- Denial of service (DoS): attackers make resources (server, bandwidth) unavailable to legitimate traffic by overwhelming resource with bogus traffic

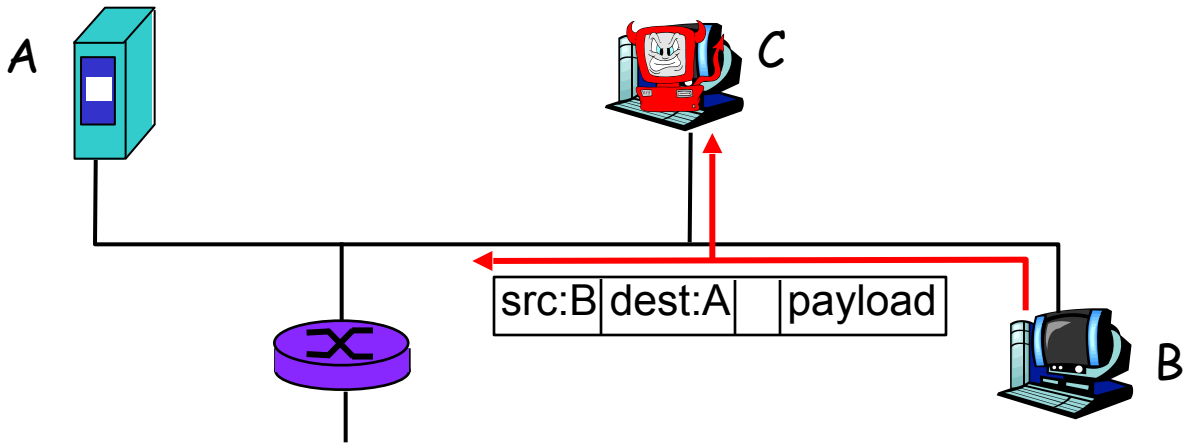
1. select target
2. break into hosts around the network (see botnet)
3. send packets toward target from compromised hosts



The bad guys can sniff packets

Packet sniffing:

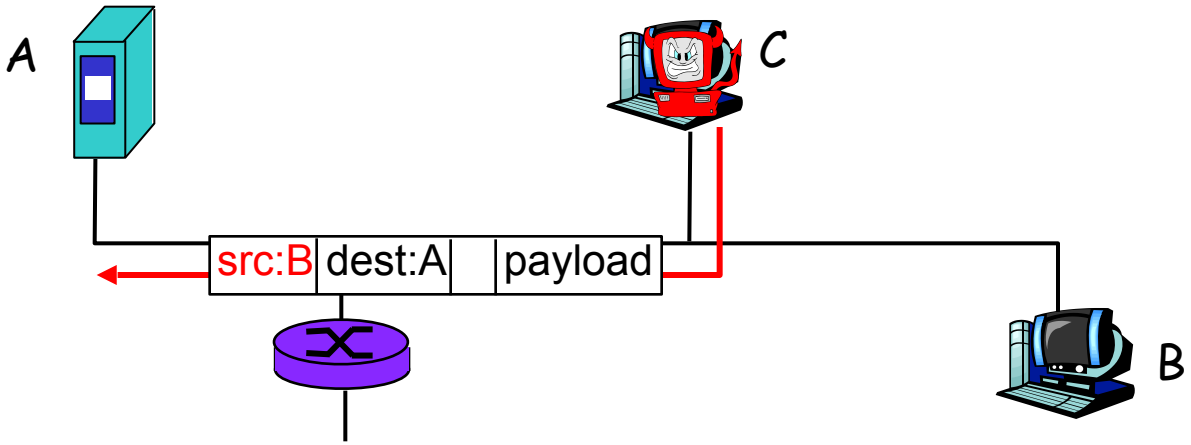
- broadcast media (shared Ethernet, wireless)
- promiscuous network interface reads/records all packets (e.g., including passwords!) passing by



- Wireshark software used for end-of-chapter labs is a (free) packet-sniffer

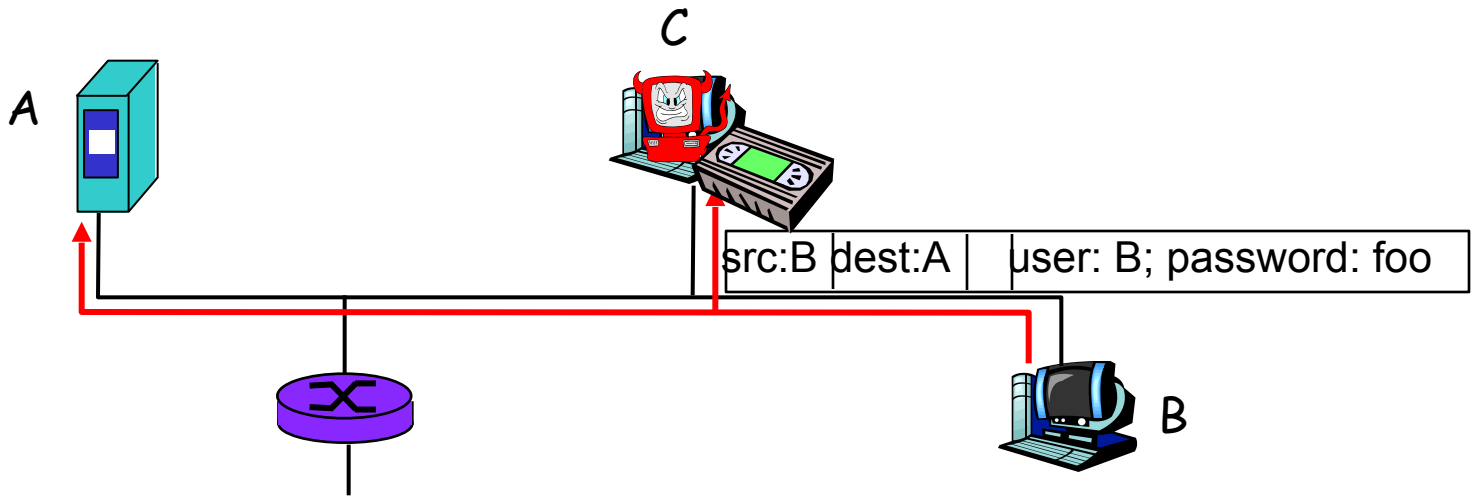
The bad guys can use false source addresses

- IP spoofing: send packet with false source address



The bad guys can record and playback

- record-and-playback: sniff sensitive info (e.g., password), and use later
  - password holder is that user from system point of view



Internet History

1961-1972: Early packet-switching principles

- 1961: Kleinrock - queueing theory shows effectiveness of packet-switching
- 1964: Baran - packet-switching in military nets
- 1967: ARPAnet conceived by Advanced Research Projects Agency
- 1969: first ARPAnet node operational

- 1972:
  - ARPAnet public demonstration
  - 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

- 1970: ALOHAnet satellite network in Hawaii
  - réseau français Cyclades
- 1974: Cerf and Kahn - architecture for interconnecting networks
- 1976: Ethernet at Xerox PARC
- ate70's: proprietary architectures: DECnet, SNA, XNA
- late 70's: switching fixed length packets (ATM precursor)
- 1979: ARPAnet has 200 nodes

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

Internet History

1990, 2000's: commercialization, the Web, new apps

- Early 1990's: ARPAnet decommissioned
- 1991: NSF lifts restrictions on commercial use of NSFnet (decommissioned, 1995)
- early 1990s: Web
  - hypertext [Bush 1945, Nelson 1960's]
  - HTML, HTTP: Berners-Lee
  - 1994: Mosaic, later Netscape
  - late 1990's: commercialization of the Web

Late 1990's – 2000's:

- killer apps: email, web, instant messaging, P2P file sharing
- network security to forefront
- est. 50 million host, 100 million+ users
- backbone links running at Gbps

Internet history

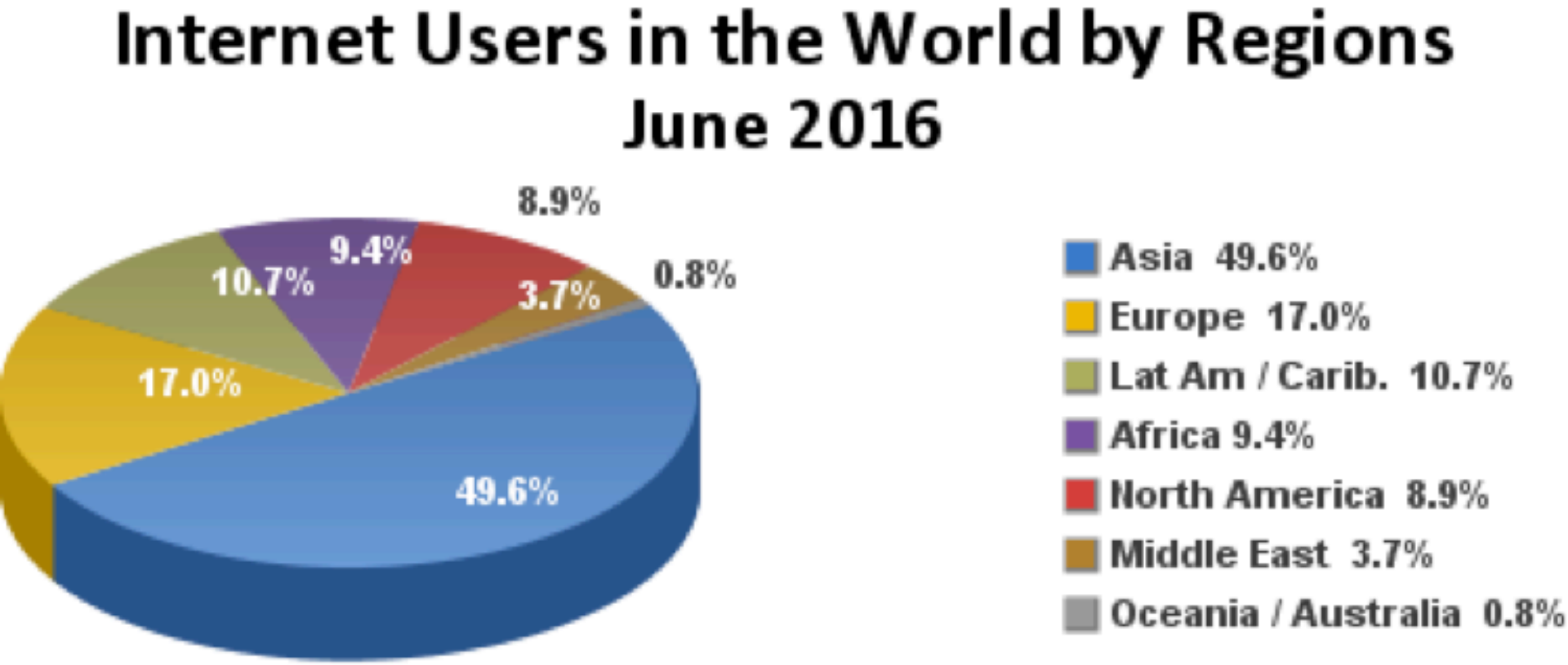
2005-present

- ~750 million hosts
  - Smartphones and tablets
- Aggressive deployment of broadband access
- Increasing ubiquity of high-speed wireless access
- Emergence of online social networks:
  - Facebook: soon one billion users
- Service providers (Google, Microsoft) create their own networks
  - Bypass Internet, providing “instantaneous” access to search, email, etc.
- E-commerce, universities, enterprises running their services in “cloud” (eg, Amazon EC2)

Les standard internet

- Internet Engineering Task Force (IETF) (ouvert)
- W3C (industriels fermé)
- RFC IETF:
  - Experimental
  - Proposed standard
  - Draft standard
  - Standard Informational
  - Historic
- Niveau de recommandation
  - Not recommended
  - Limited use
  - Elective
  - Recommended
  - required

Internet 2016 http://www.internetworldstats.com

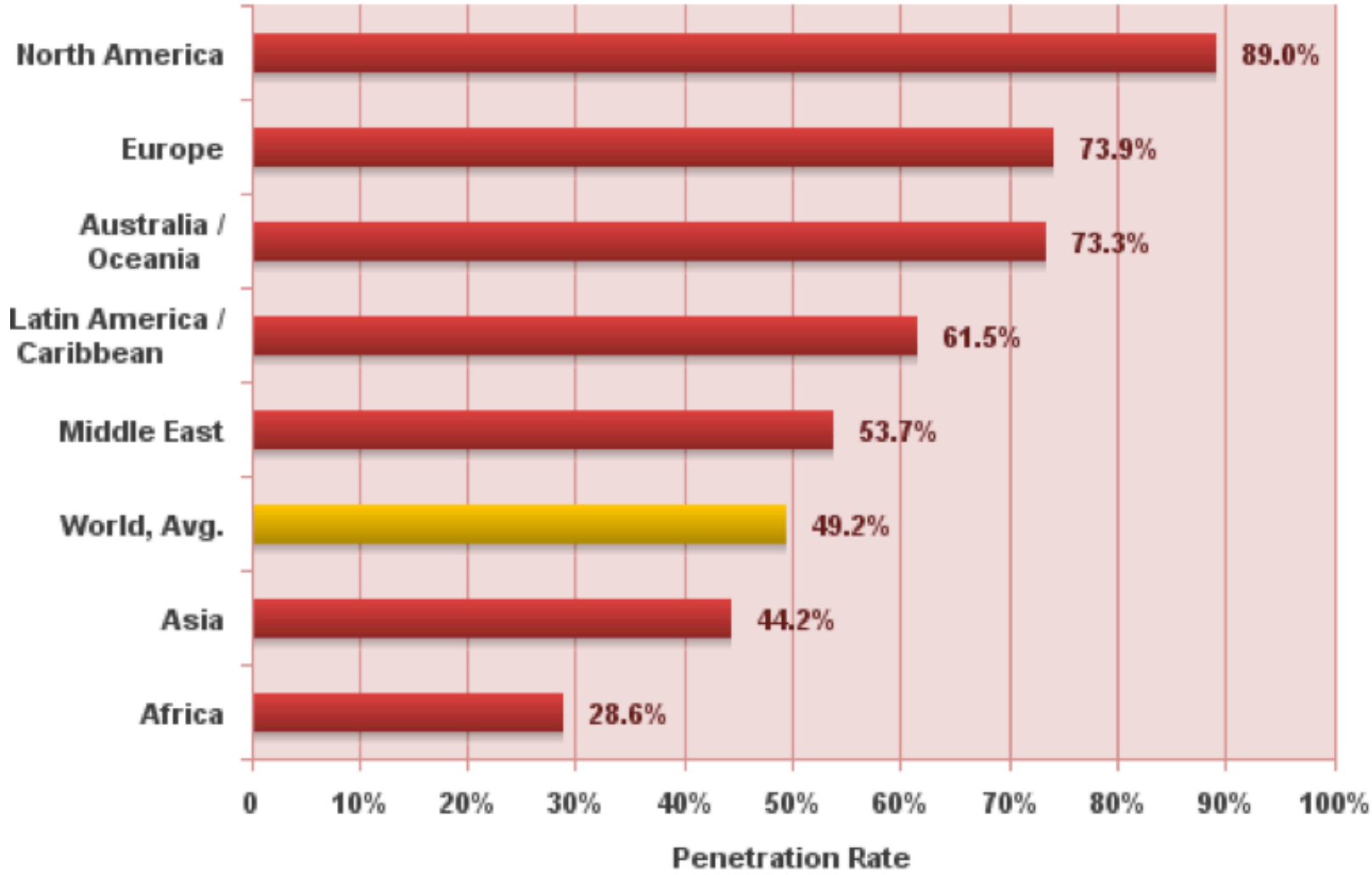


Source: Internet World Stats - www.internetworldstats.com/stats.htm
Basis: 3,611,375,813 Internet users on June 30, 2016

statistiques

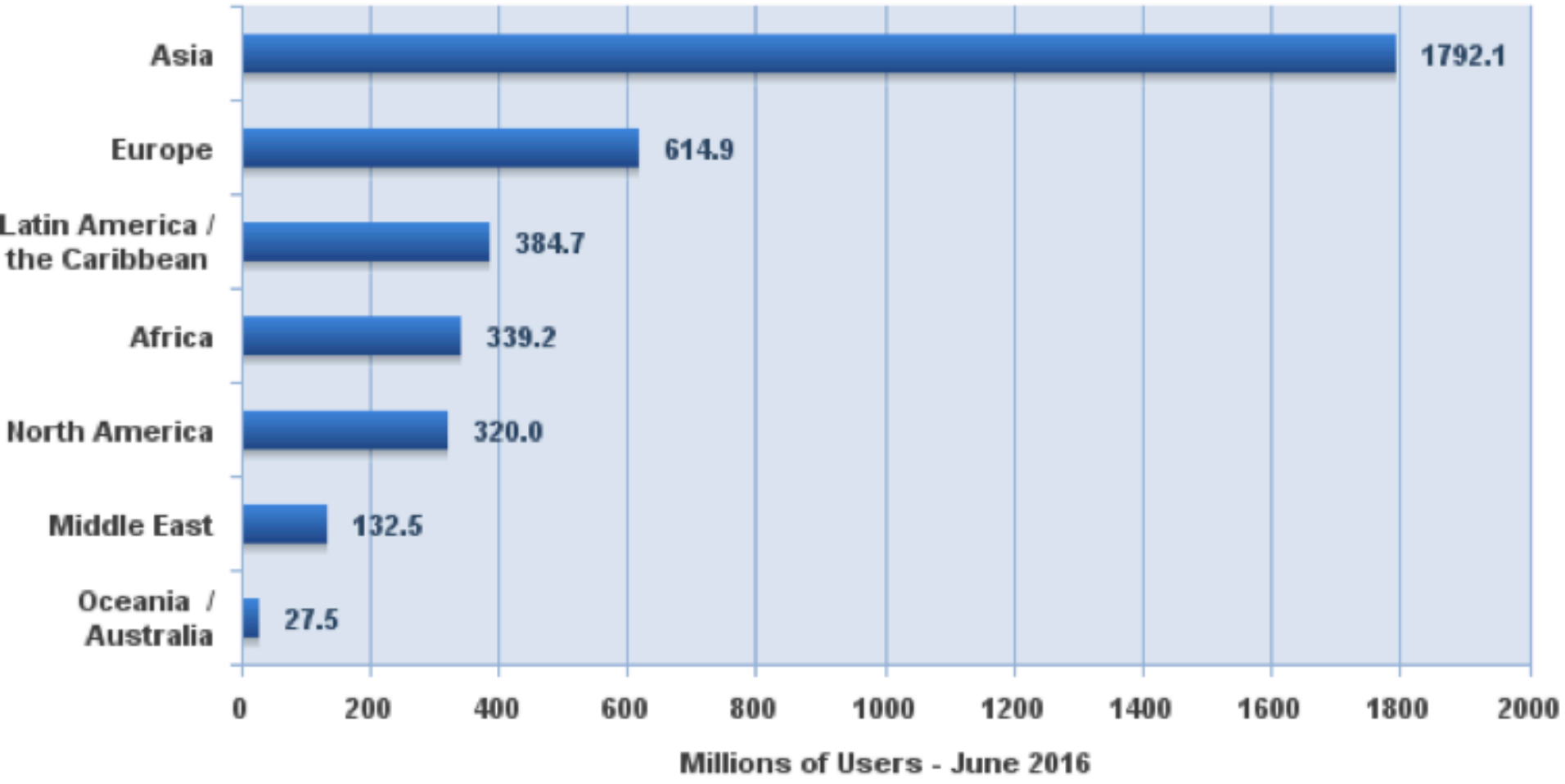
World Regions	Population (2016 Est.)	Population % of World	Internet Users 30 June 2016	Penetration (% Population)	Growth 2000-2016
Africa	1,185,529,578	16 %	**339,283,342**	29 %	7415,600 %
Asia	4,052,652,889	55 %	**1,792,163,654**	44 %	1467,900 %
Europe	832,073,224	11 %	**614,979,903**	74 %	485 %
Latin America / Caribbean	626,054,392	9 %	**384,751,302**	62 %	2029,400 %
Middle East	246,700,900	3 %	**132,589,765**	54 %	3936,500 %
North America	359,492,293	5 %	**320,067,193**	89 %	196 %
Oceania / Australia	37,590,704	1 %	**27,540,654**	73 %	261 %
WORLD TOTAL	**7,340,093,980**	**100 %**	**3,611,375,813**	**49 %**	**900 %**

Internet World Penetration Rates by Geographic Regions - June 2016



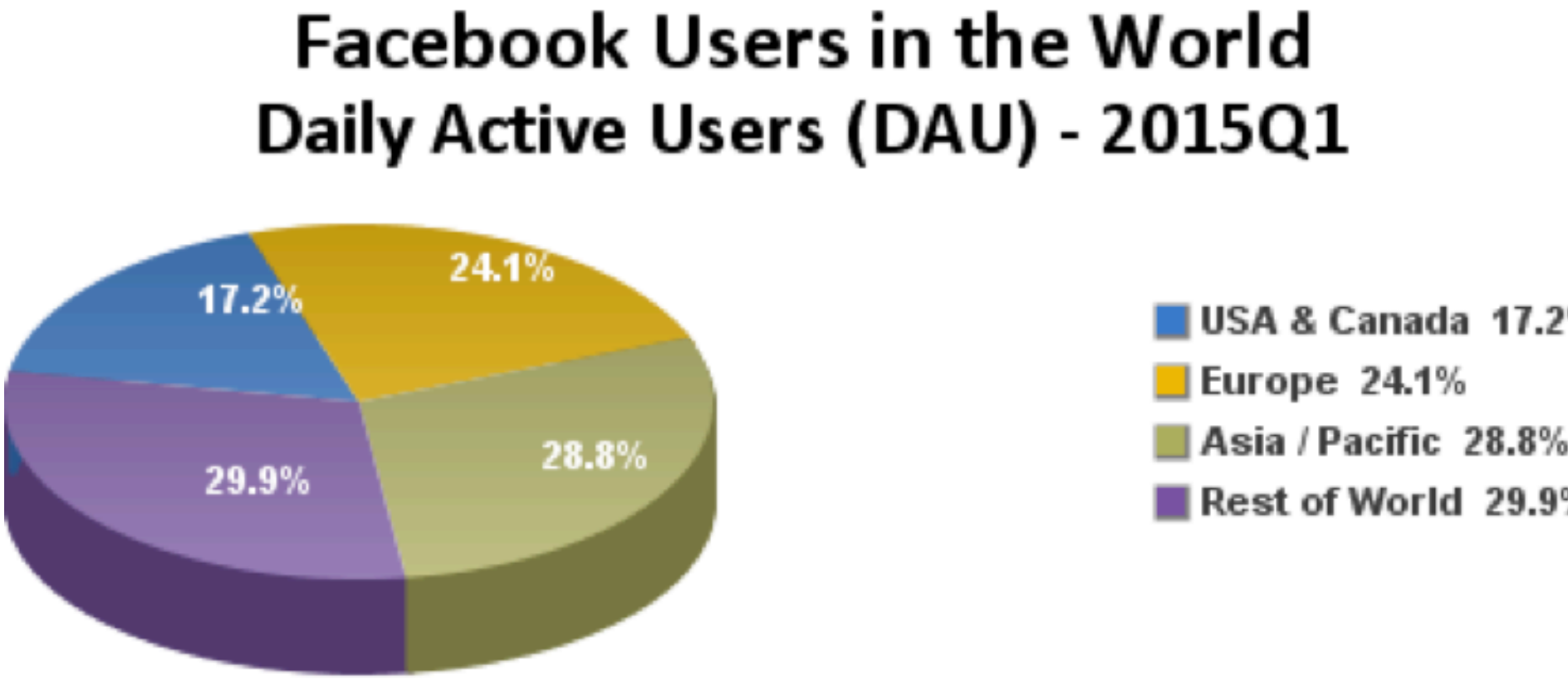
Source: Internet World Stats - www.internetworldstats.com/stats.htm
Penetration Rates are based on a world population of 7,340,093,980 and 3,611,375,813 estimated Internet users on June 30, 2016.

Internet Users in the World by Geographic Regions - June 2016

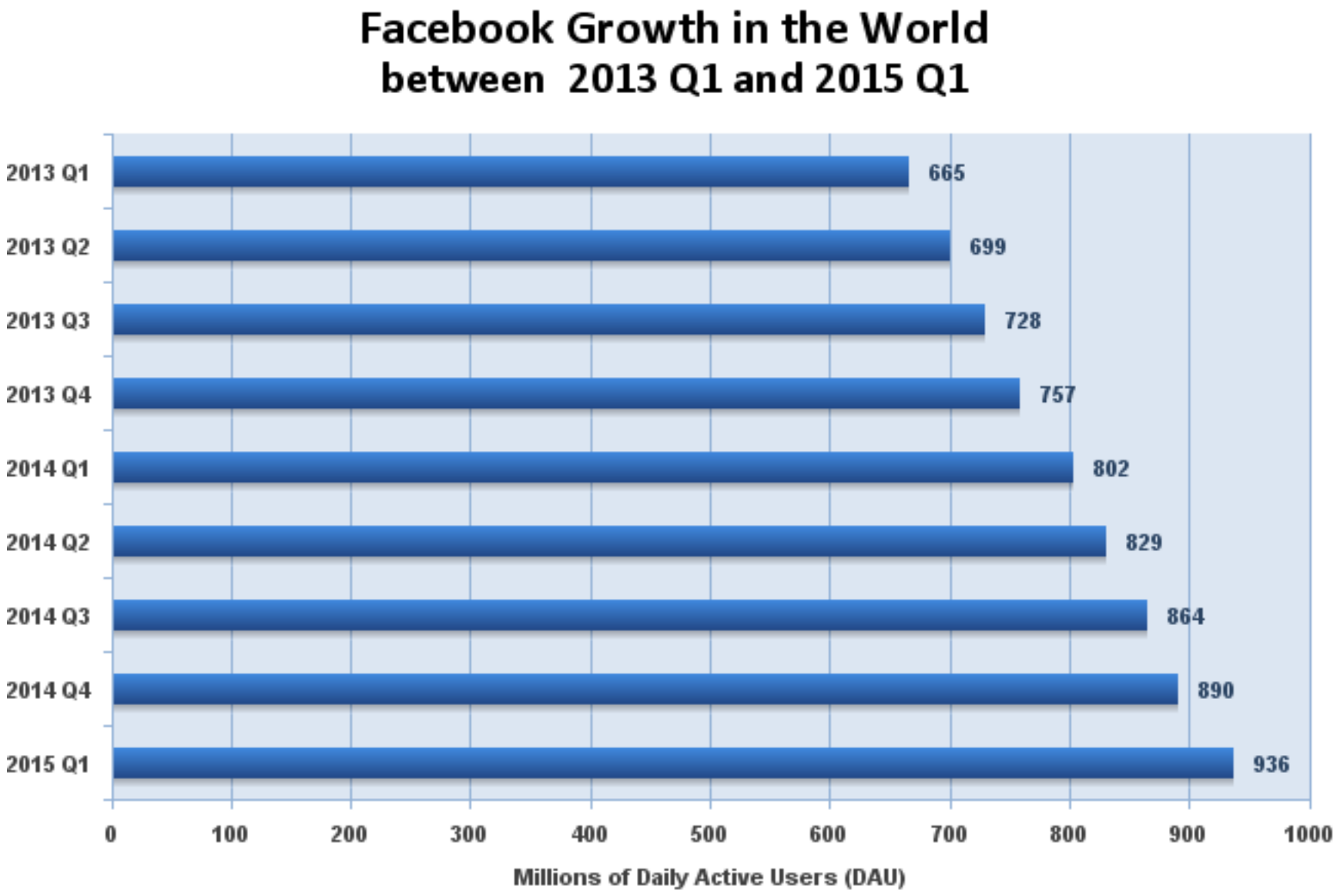


Source: Internet World Stats - www.internetworldstats.com/stats.htm
Basis: 3,611,375,813 Internet users estimated for June 30, 2016

Facebook 2015

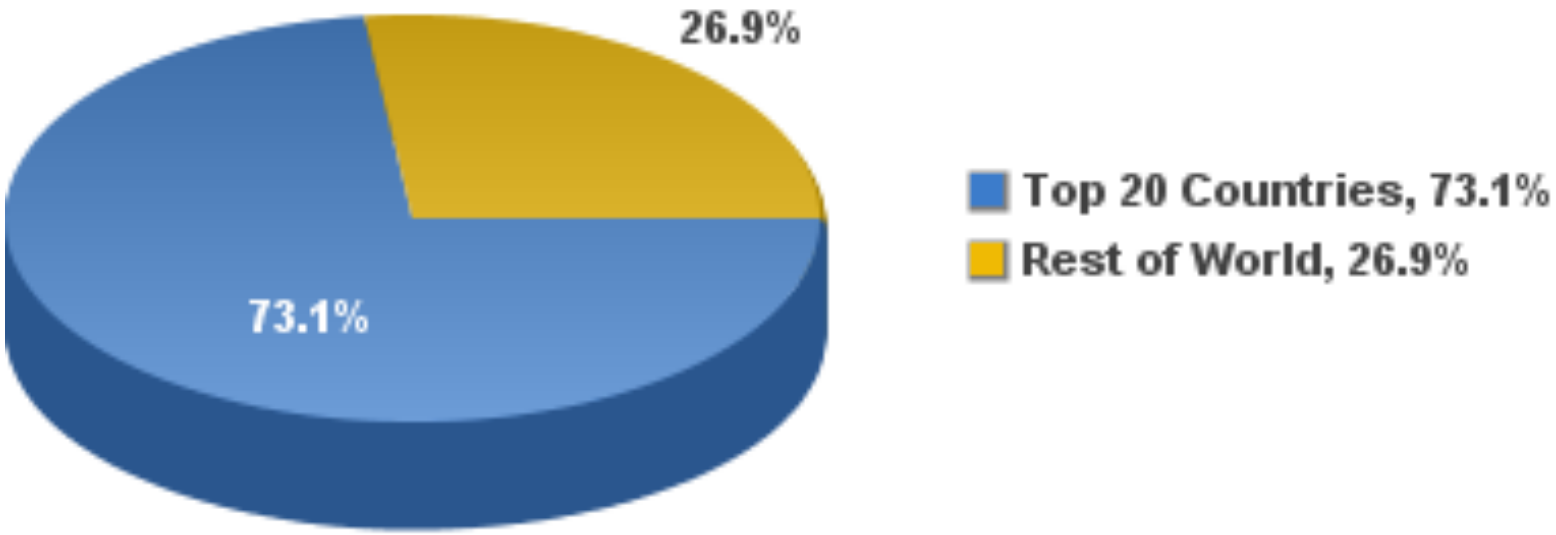


Source: Internet World Stats - www.internetworldstats.com/facebook.htm
Basis: Facebook Published Data, retrieved on April 26, 2015



Source: Internet World Stats - www.internetworldstats.com/facebook.htm
Facebook daily active users worldwide, retrieved on April 26, 2015

Internet Users in Top 20 Countries vs. World - June 30, 2016



Source: Internet World Stats - www.internetworldstats.com/top20.htm
3,611,375,813 estimated Internet users for June 30, 2016

Les 19 pays avec le plus grand nombre d'utilisateurs internet

#	Country or Region	Population, 2016 Est.	Internet Users 30 June 2016	Internet Penetration	Growth (*) 2000 - 2016	Facebook 30 June 2016
1	China	1,378,561,591	721,434,547	52 %	3106,400 %	1,800,000
2	India	1,266,883,598	462,124,989	37 %	9142,500 %	157,000,000
3	United States	323,995,528	286,942,362	89 %	201 %	201,000,000
4	Brazil	206,050,242	139,111,185	68 %	2682,200 %	111,000,000
5	Japan	126,464,583	115,111,595	91 %	145 %	26,000,000
6	Russia	146,358,055	103,147,691	71 %	3227,300 %	12,000,000
7	Nigeria	186,879,760	97,210,000	52 %	48505,000 %	16,000,000
8	Indonesia	258,316,051	88,000,000	34 %	4300,000 %	88,000,000
9	Germany	80,722,792	71,727,551	89 %	199 %	31,000,000
10	Mexico	123,166,749	69,000,000	56 %	2443,900 %	69,000,000
11	United Kingdom	64,430,428	60,273,385	94 %	291 %	39,000,000
12	France	66,836,154	55,860,330	84 %	557 %	33,000,000
13	Philippines	102,624,209	54,000,000	53 %	2600,000 %	54,000,000
14	Bangladesh	162,855,651	53,941,000	33 %	53841,000 %	21,000,000
15	Vietnam	95,261,021	49,063,762	52 %	24431,900 %	40,000,000
16	Iran	82,801,633	47,800,000	58 %	19020,000 %	n/a
17	Turkey	80,274,604	46,196,720	58 %	2209,800 %	46,000,000
18	Korea, South	49,180,776	45,314,248	92 %	138 %	17,000,000
19	Thailand	68,200,824	41,000,000	60 %	1682,600 %	41,000,000