

Lecture 01-2: What is Internet anyway

CS 356R Intro to Wireless Networks

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Goals

Upon completing this lesson, you will be able to

- Answer the question “What is Internet, anyway”
with a bit more details on its components and its architecture
- Understand protocols and layering in network communication
- Describe how the protocol stack operates
- Learn basic concepts and terminologies in networks

Outline

1. Goals

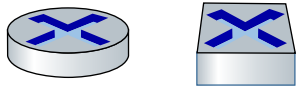
-  2. What is Internet: Components and Architecture
- 3. Internet communication: Protocols and Layers

The Internet: a “nuts and bolts” view



Billions of connected computing *devices*:

- *hosts* = end systems
- runs *network apps* at Internet's “edge”



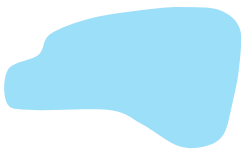
Routers and switches:

- *forwards packets*



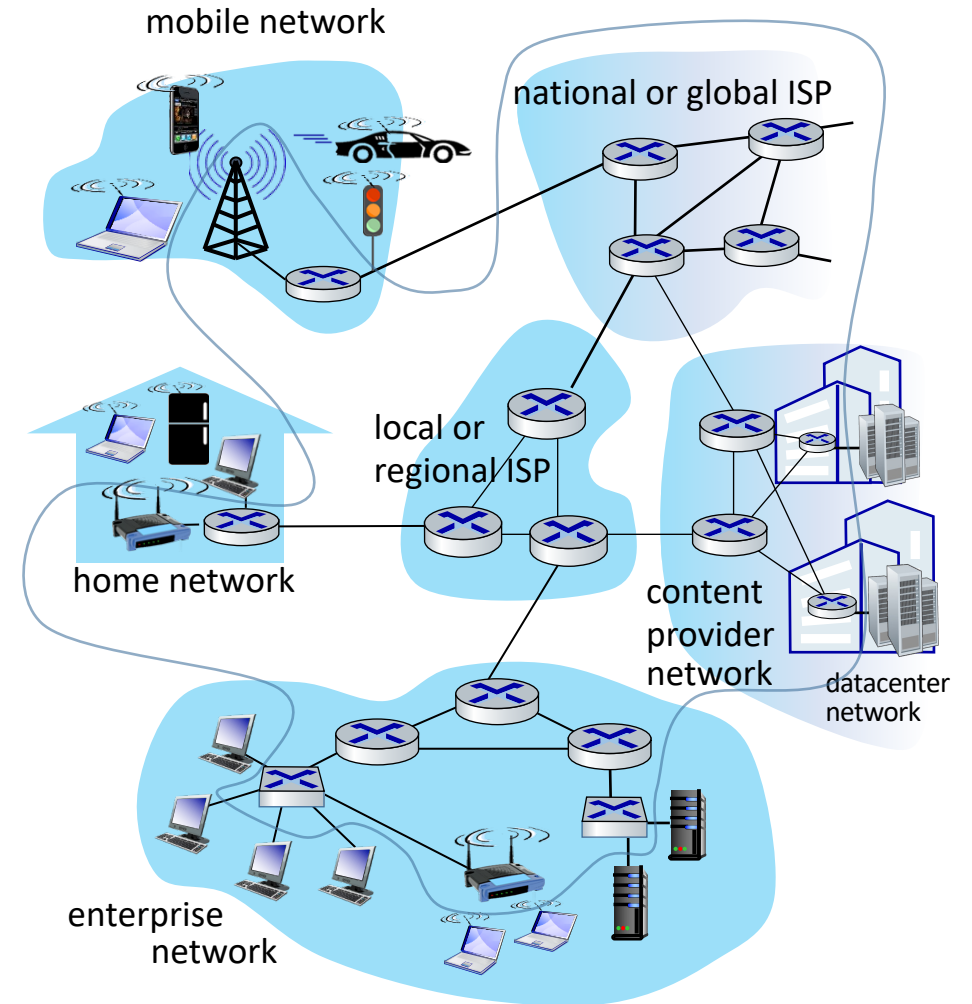
Communication links

- fiber, copper, radio, satellite
- transmission rate: *bandwidth*



Networks

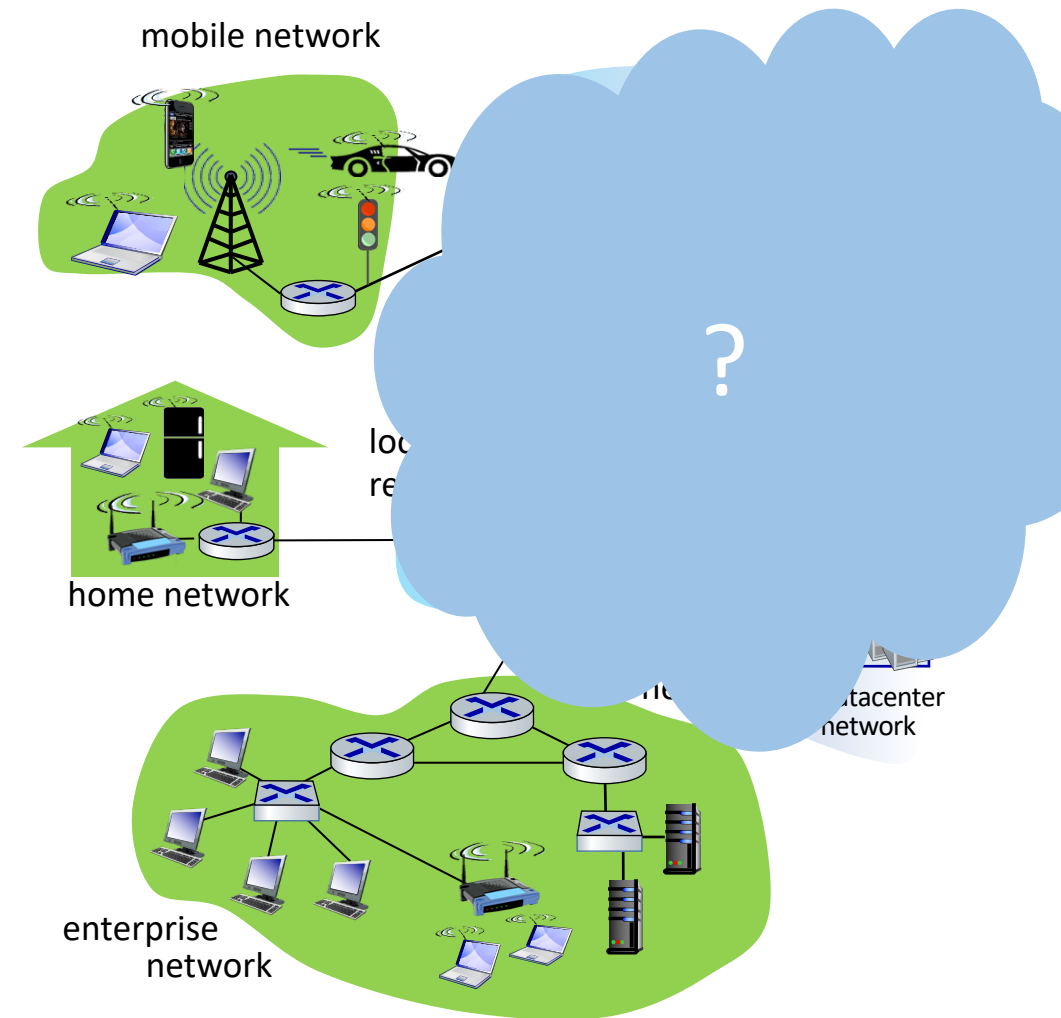
- collection of devices, routers, links: managed by an organization



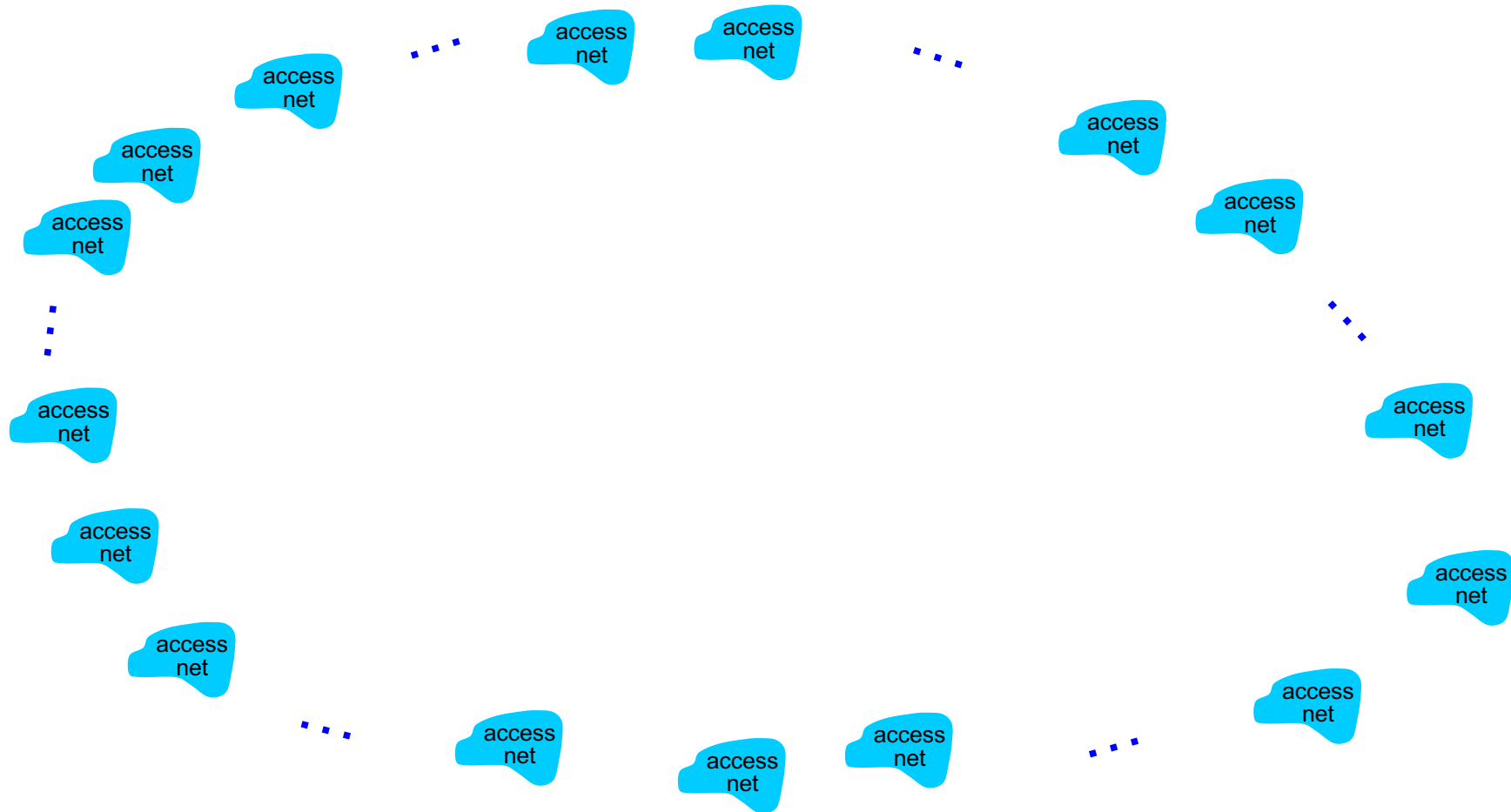
Let's start with an **access network**

- **Access network** – the network that physically connects an end host to its **first router**
 - Types: home, enterprise, mobile network
- Hosts connect to Internet via **access Internet Service Providers (ISPs)**

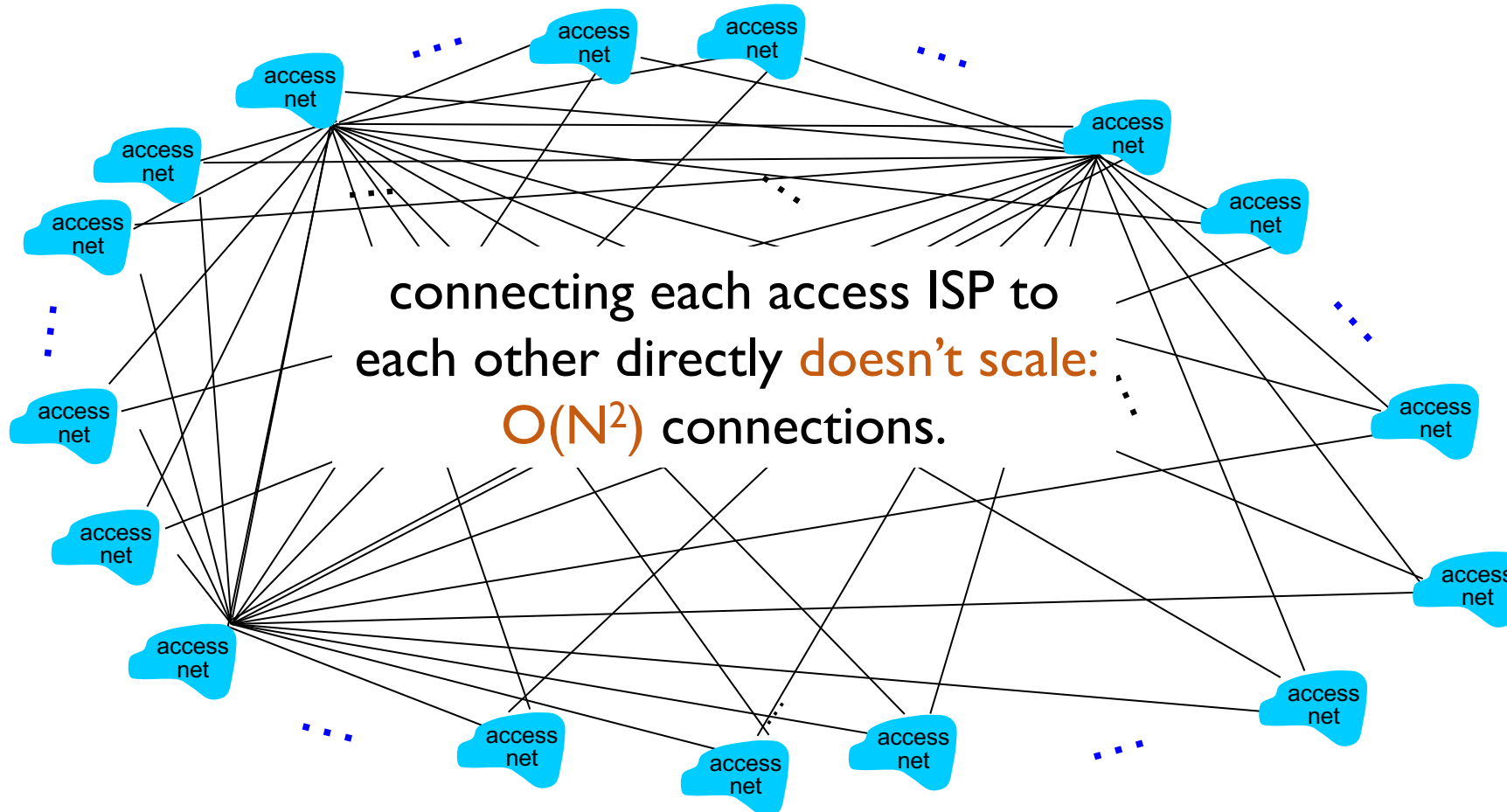
How to connect these access networks?



Given millions of access ISPs how to connect them together?

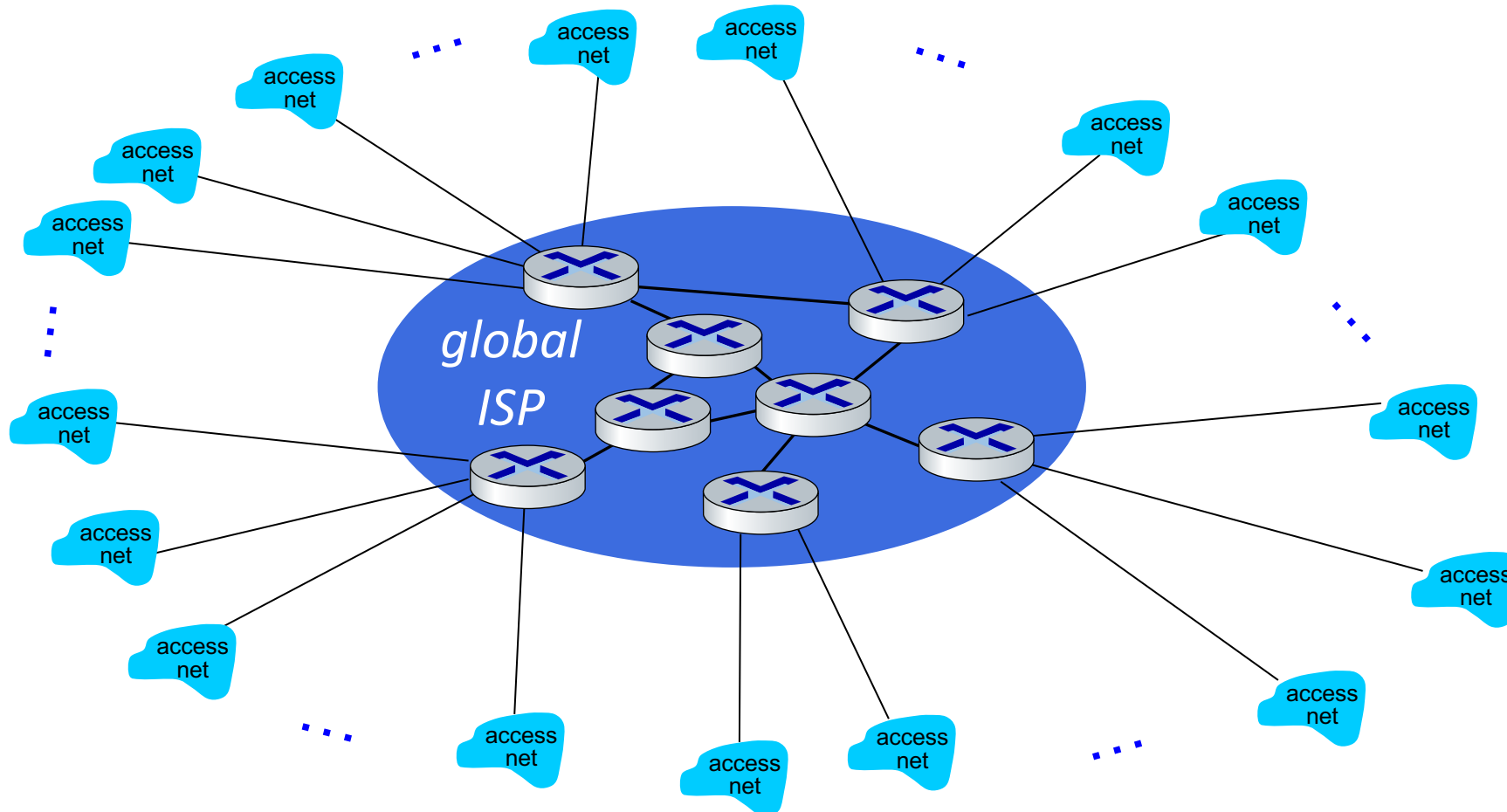


Given millions of access ISPs how to connect them together?

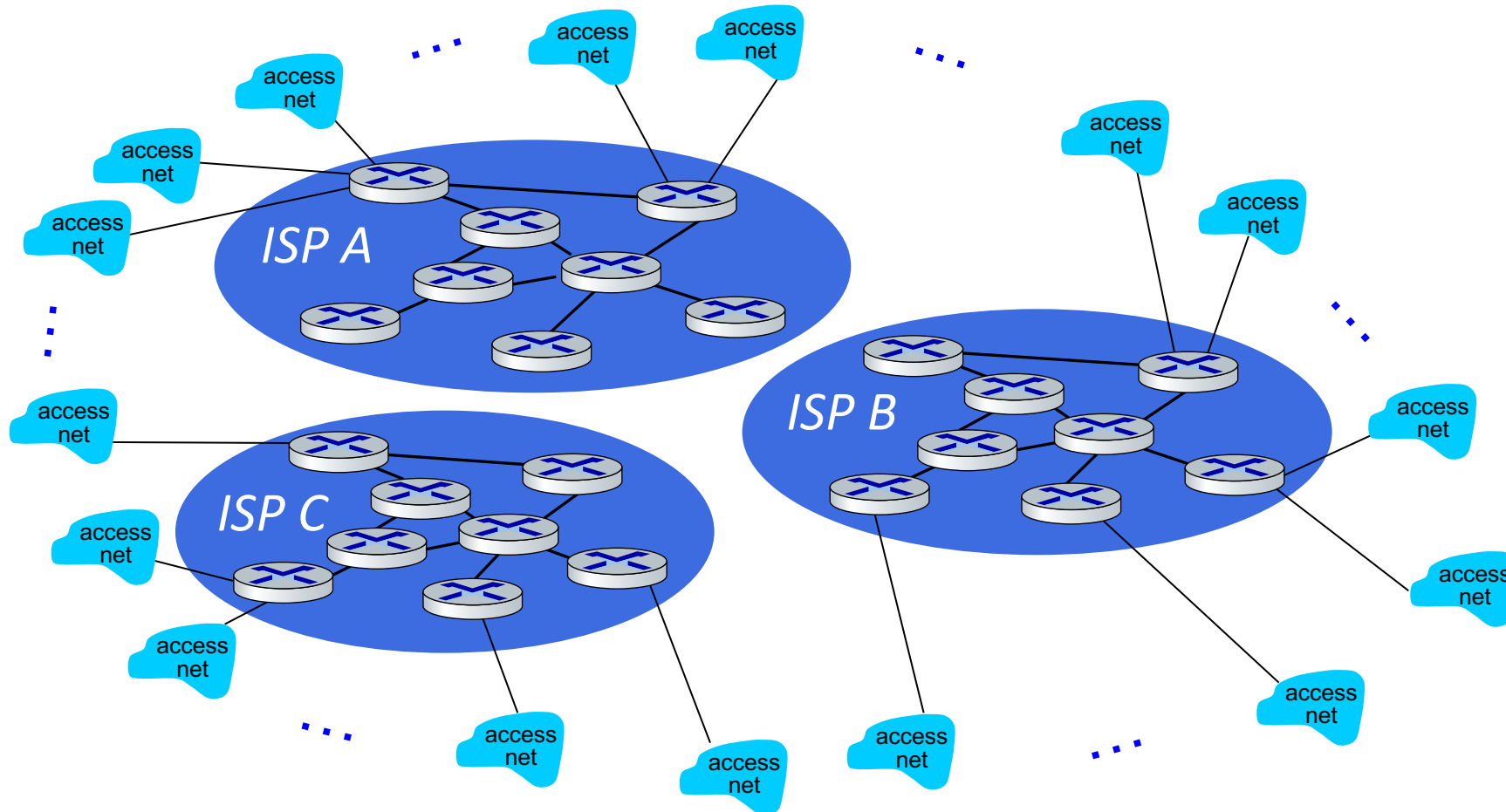


Option: Connect each access ISP to one global transit ISP

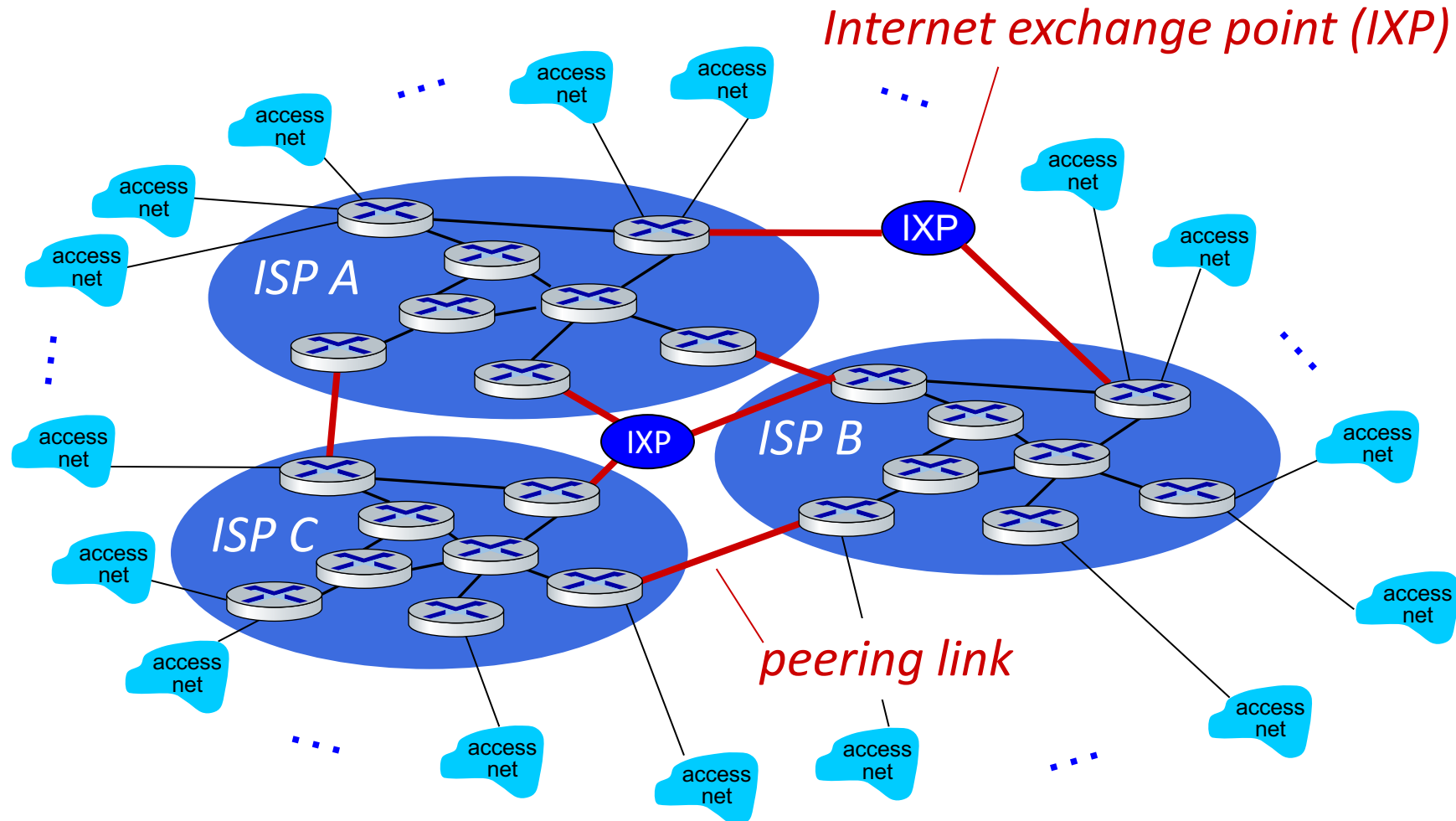
Customer and provider ISPs have economic agreement.



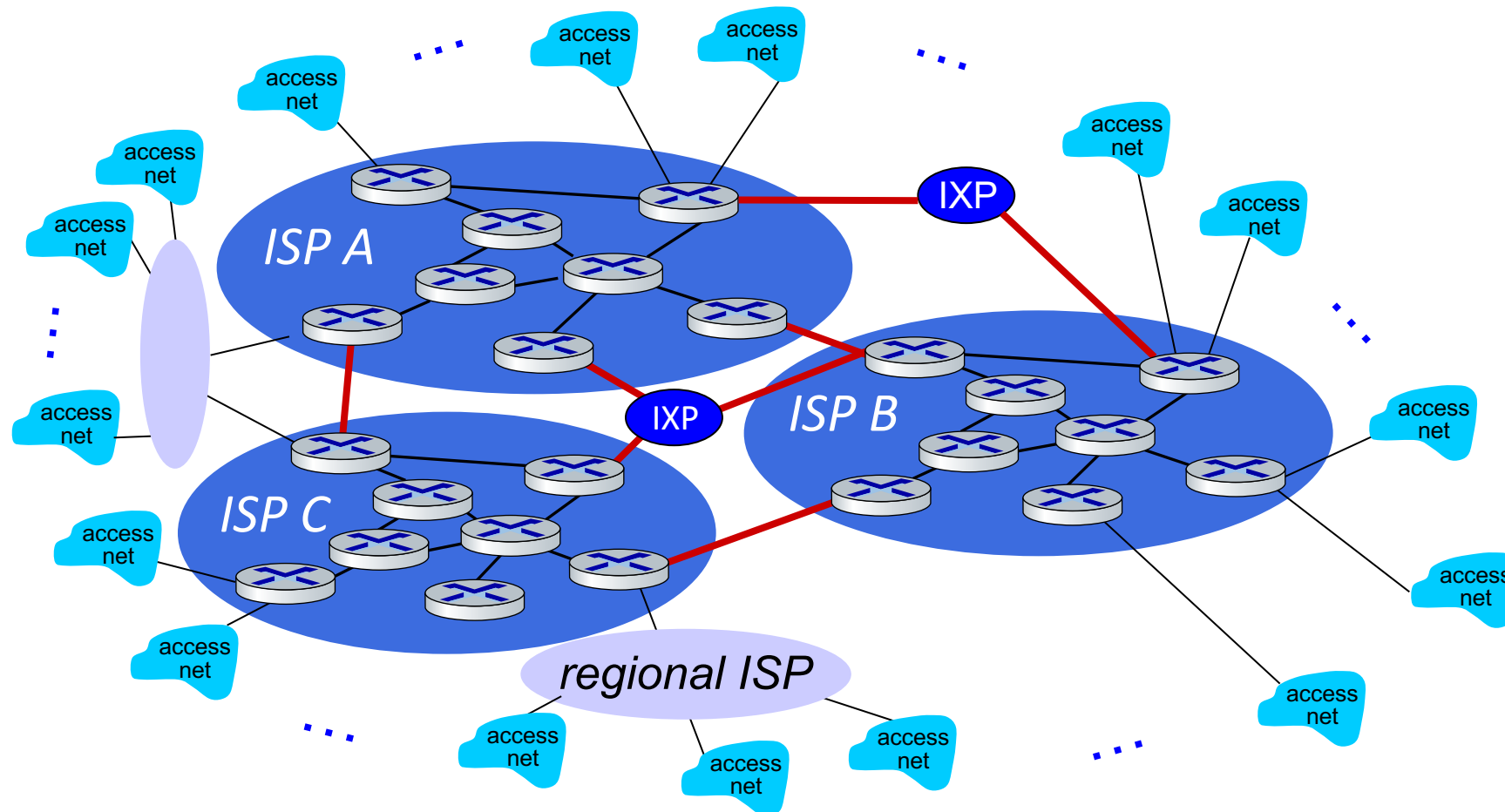
But if one global ISP is viable business, **competitors** will rise



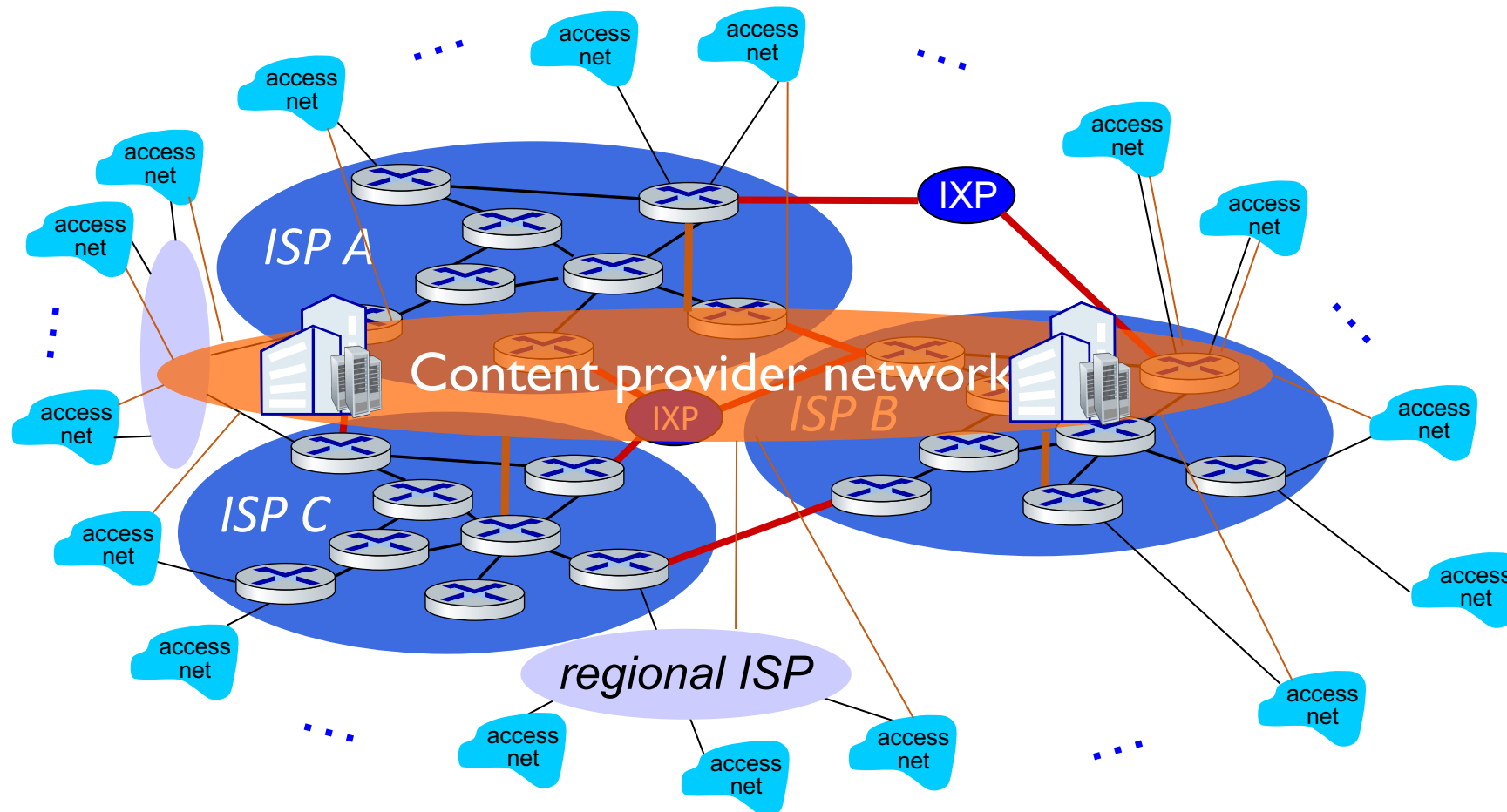
IXP is the physical infrastructure through which ISPs exchange Internet traffic



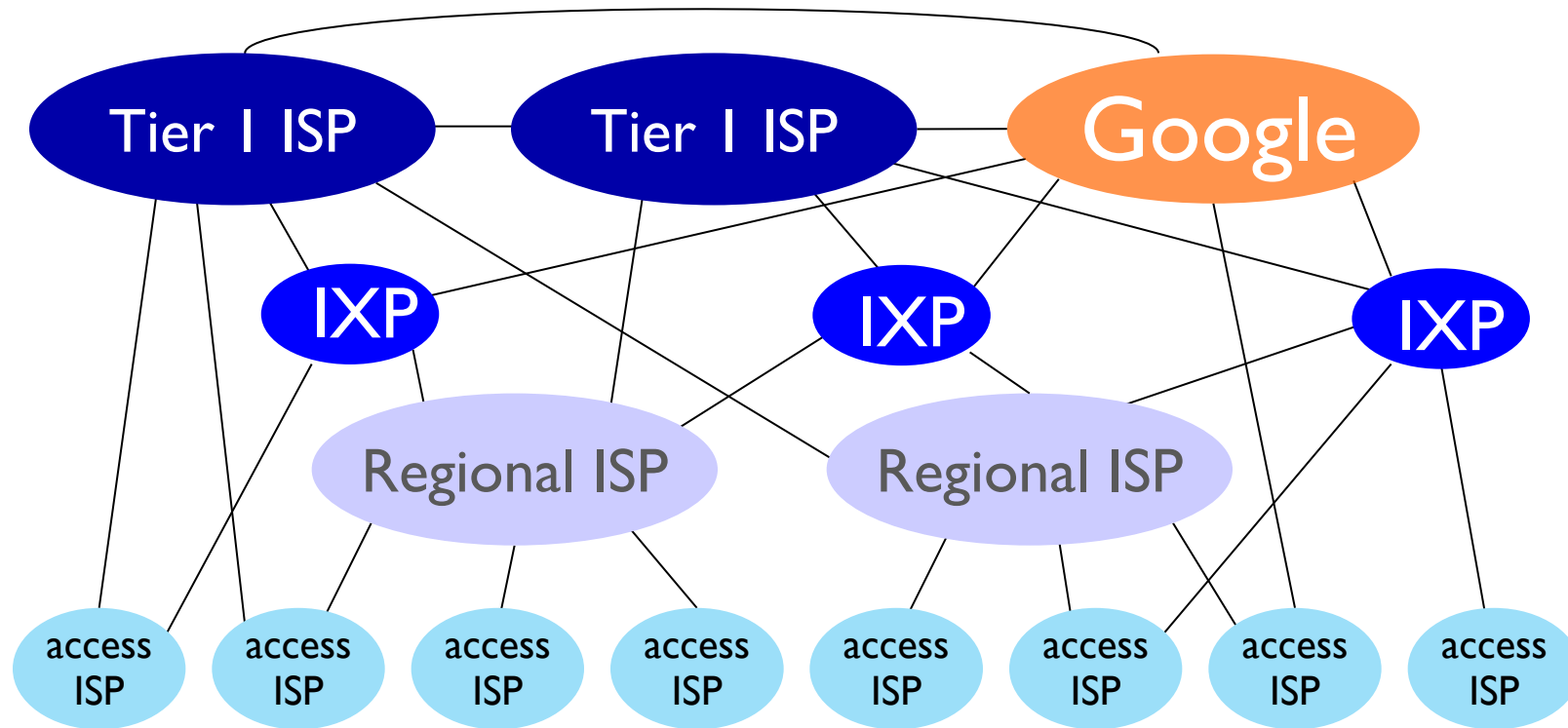
And **regional networks** may arise to connect access networks to ISPs



Also, content providers may run their own network to bring services and content close to end users



Internet structure: a “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 networks** (e.g., Google, Facebook): private network that connects its data centers to Internet, often bypassing tier-1, regional ISPs

Now that we are connected,
how can we communicate over these networks?

Outline

1. Goals
2. What is Internet: the Components and the Architecture
-  3. Two basic building blocks of Internet communication

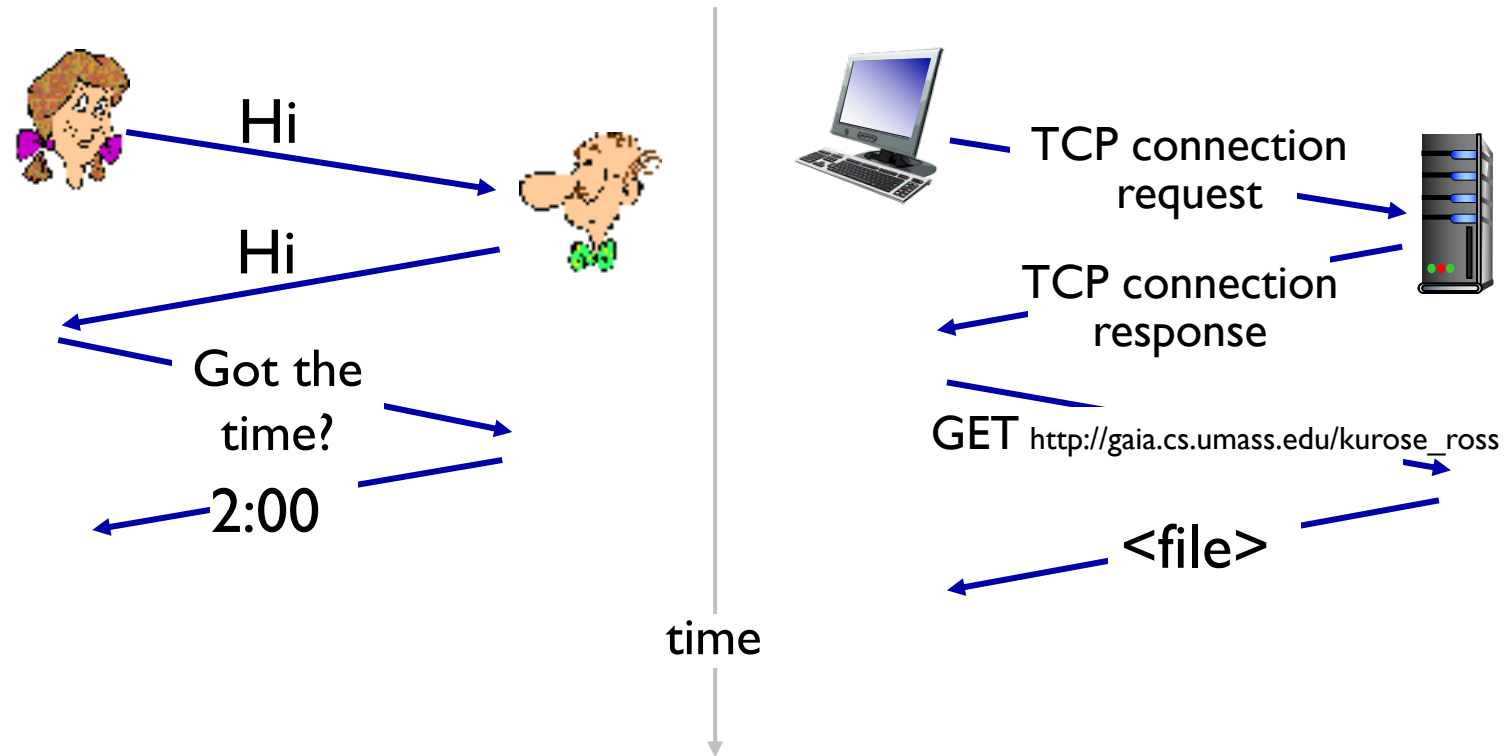
Now two entities are connected via physical medium
What should happen next?

What would be the **basic building blocks** in network communication?

Protocols and **layering** are the basic building blocks in network communication

Why protocol?

Need to agree on who/when/how/what we will communicate

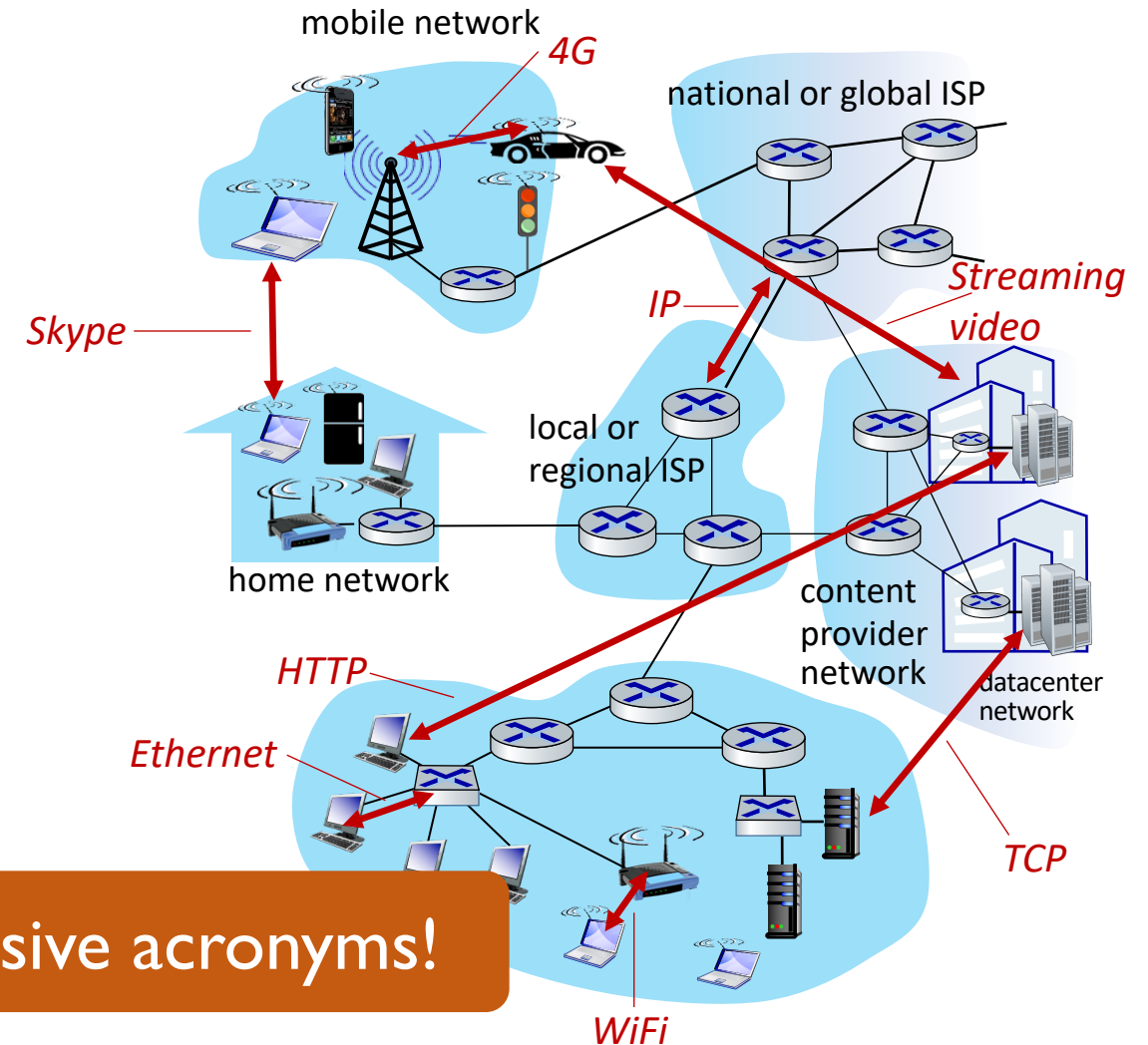


A human protocol vs computer network protocol

Protocols specifies how messages should be sent and received among network entities

HTTP, TCP, IP, ARP, DHCP, DNS, FTP, ICMP, IGMP, IMAP, LDAP, POP3, NTP, MAC, BGP, IRP, PTP, SNMP, SSH, TLS, SIP, RTSP, XMPP, etc..

Protocols follow **Internet standards** maintained by **Internet Engineering Task Force (IETF)**



Welcome to the world of excessive acronyms!

Why layering?

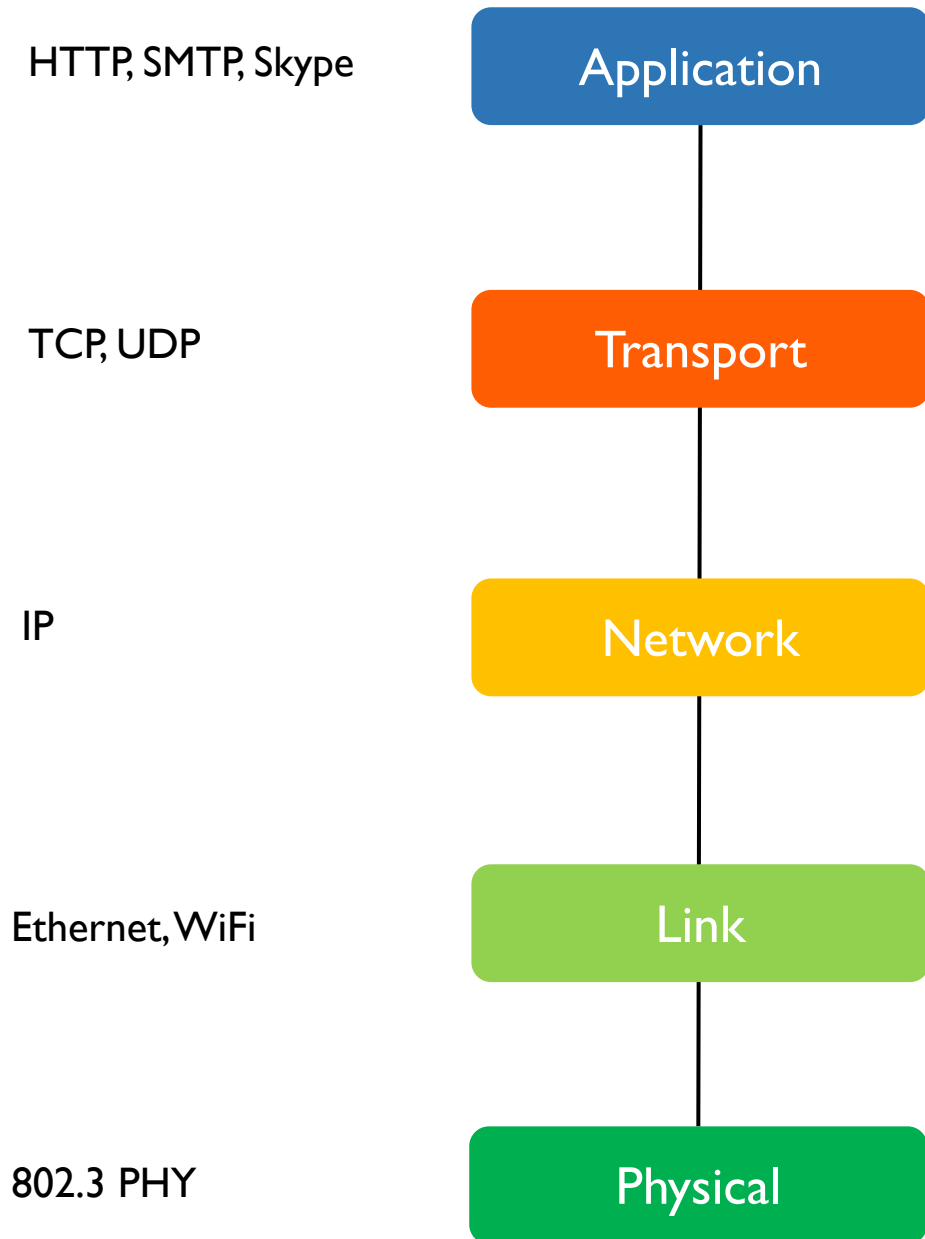
Need to solve various interesting problems

- How to share the same link between multiple users?
- How to do node discovery?
- How to determine the number of hops and routes to take?
- How to ensure the data is indeed received
- How to ensure multiple messages would be delivered in order?
- What if everybody is just sending too much?
- How to ensure the communication is safe?
- How to ensure “Bob” is really “Bob”?
- ...

Assign each problem to an appropriate layer
where the layer only care about the problems assigned

What are the layers?

Layers in Internet Protocol Stack



Example Protocols

Layers

Responsible for

FTP, HTTP, SMTP

Application

application specific needs

TCP, UDP

Transport

process to process data transfer

IP

Network

host to host data transfer across different network

Ethernet, WiFi

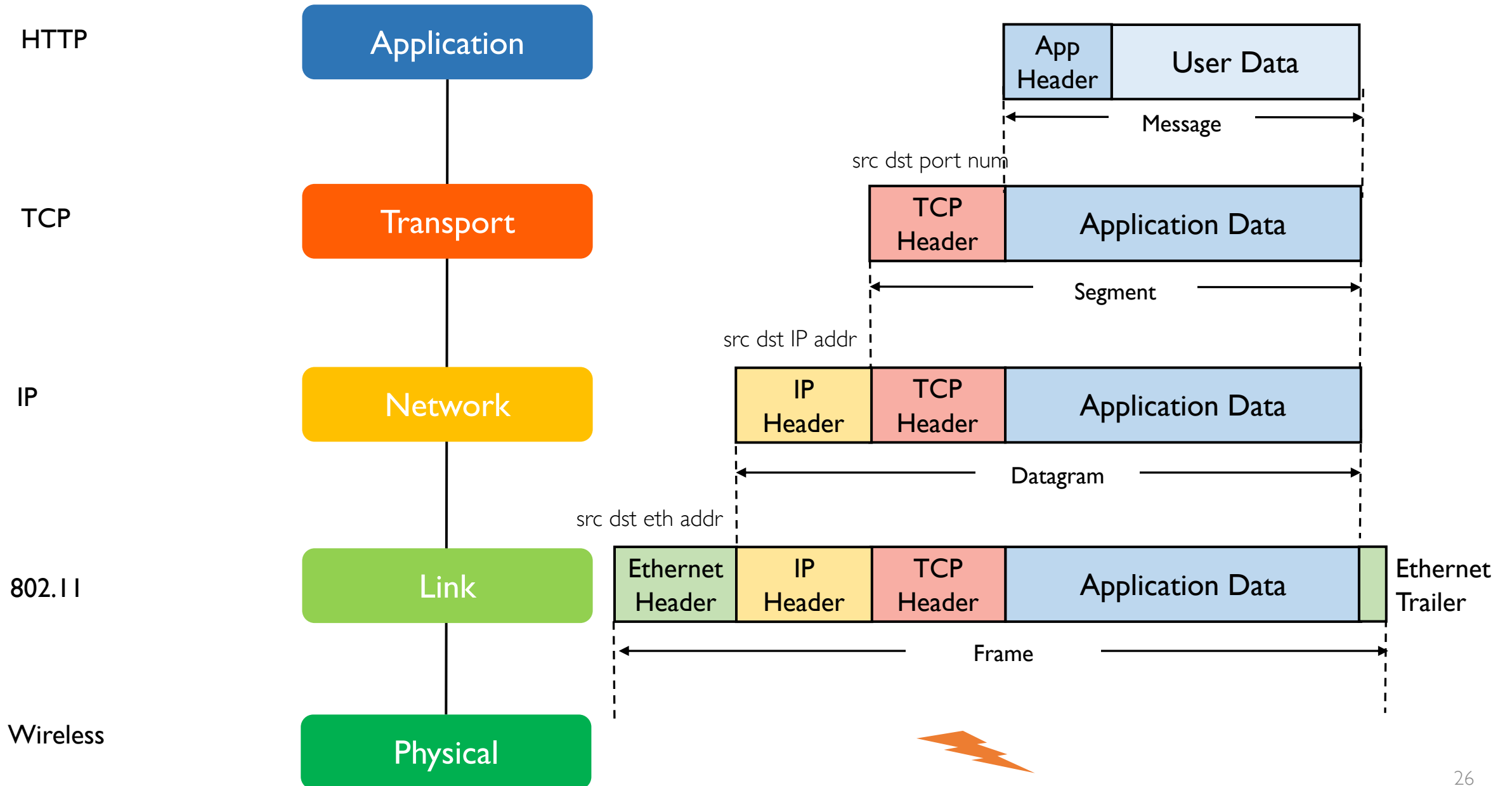
Link

data transfer between physically adjacent nodes

802.3 PHY

Physical

bit-by-bit or symbol-by-symbol delivery



Pros and cons of layering

- + Provides abstraction and encapsulation
- + Changes are one layer do not affect other layers
- + Flexible: Supports heterogenous links and hosts (mix-n-match!)
- Overhead: every layer adds info to the payload
- Limited visibility
 - When having poor performance: hard to know what was the real cause
 - Layer2 is doing hard work to ensure next hop delivery but the packet was a UDP packet (waste of effort)
- Redundancy in error handling

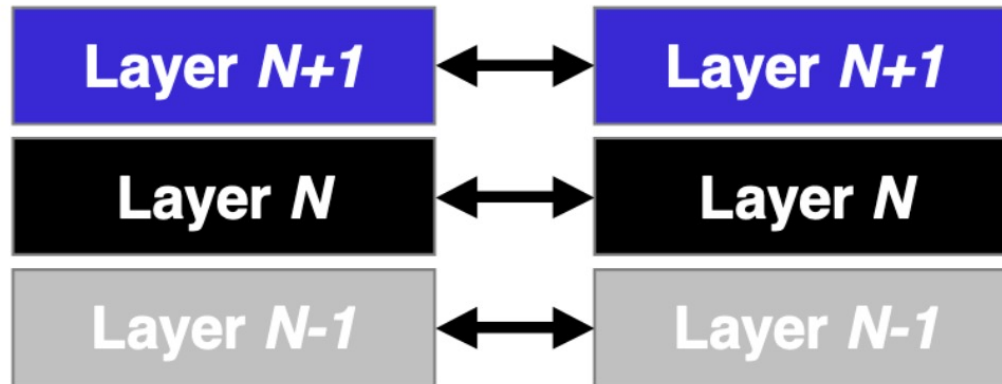
True/False

- A protocol always consider two communicating parties
- The two communicating parties can be from different layers

Note:

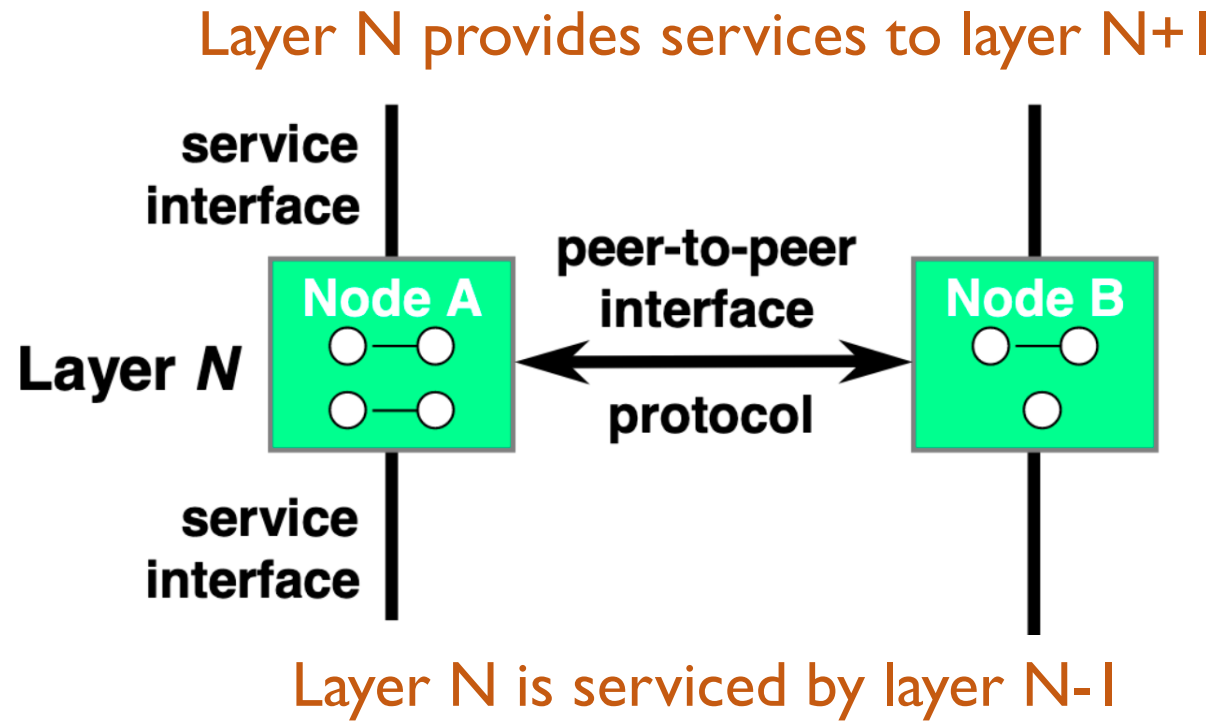
Protocols are horizontal and layers are vertical

Protocols provides ways
for peers to communicate **horizontally**



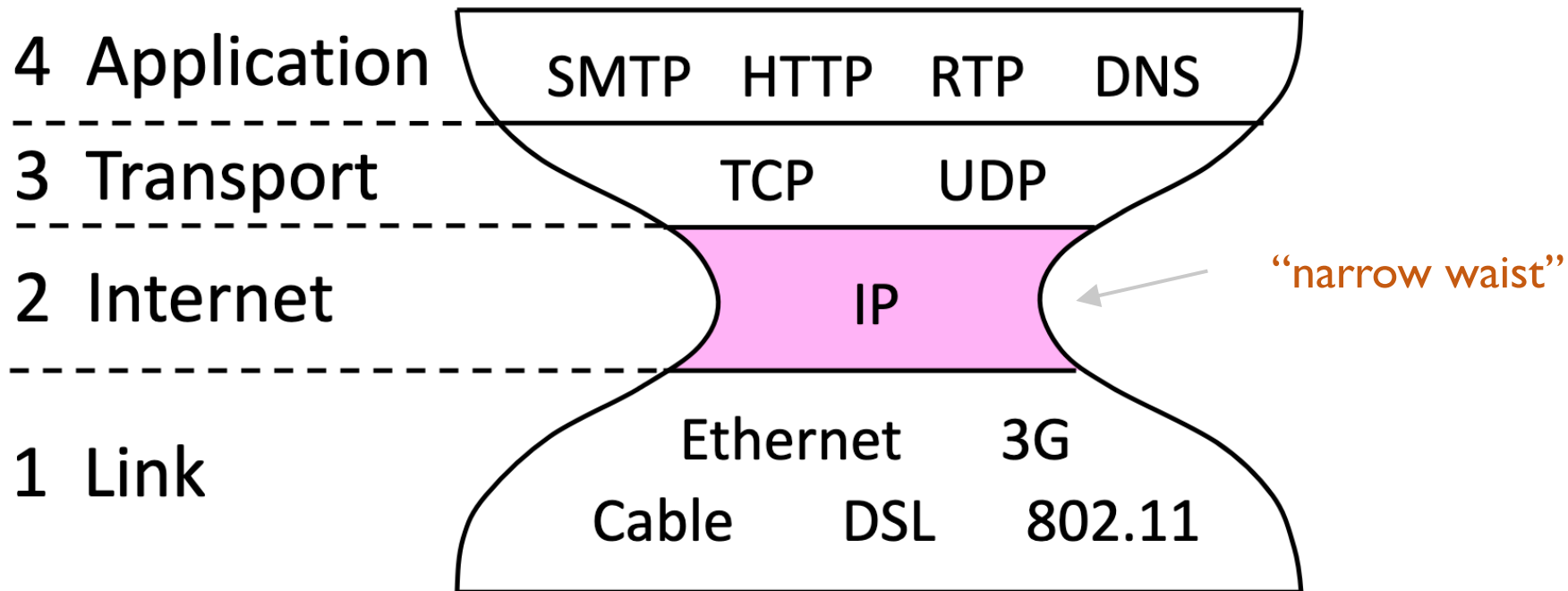
Layer N ONLY interact with peers
in the same layer N via protocol

Each **layer** provides service to their upper layer

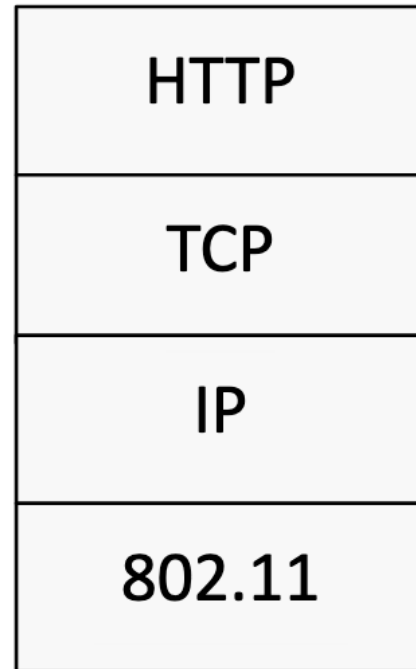


Hourglass: IP is the “narrow waist” of the Internet

- Supports many different apps above and links below




“Protocol stack” refers to a set of protocols in use

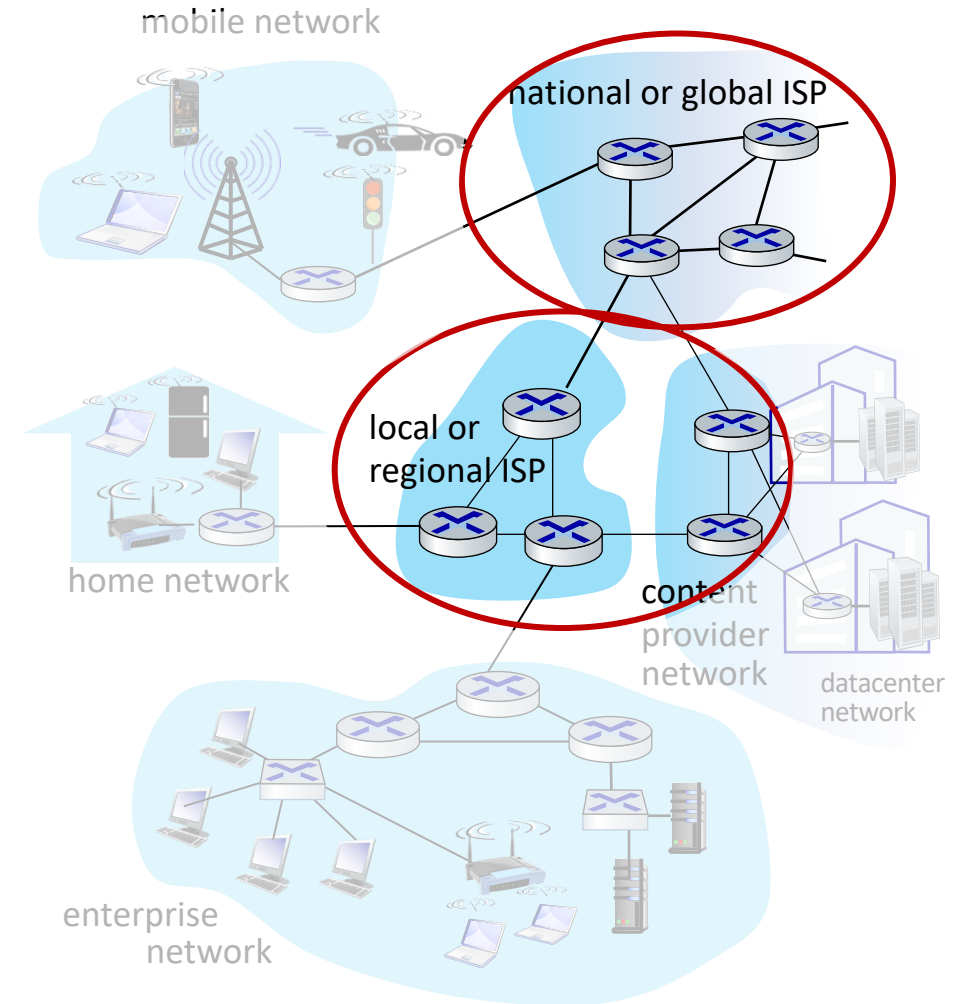


Some more concepts and terms..

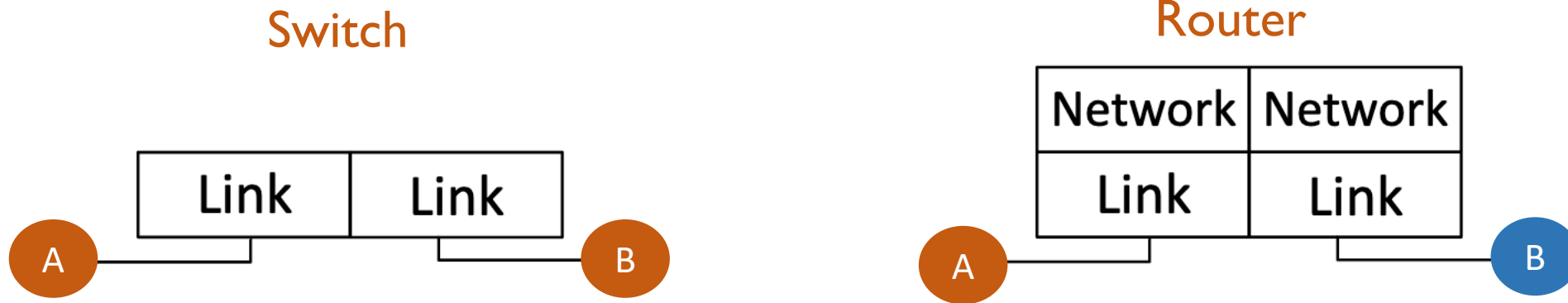
Outline

1. Goals
2. What is Internet: Components and Architecture
3. Internet communication: Protocols and Layers
-  4. More terms: routing vs forwarding

The network core consists of **switches** and **routers** which **forwards** packets from src to dst



Switches vs routers: Both do packet forwarding!

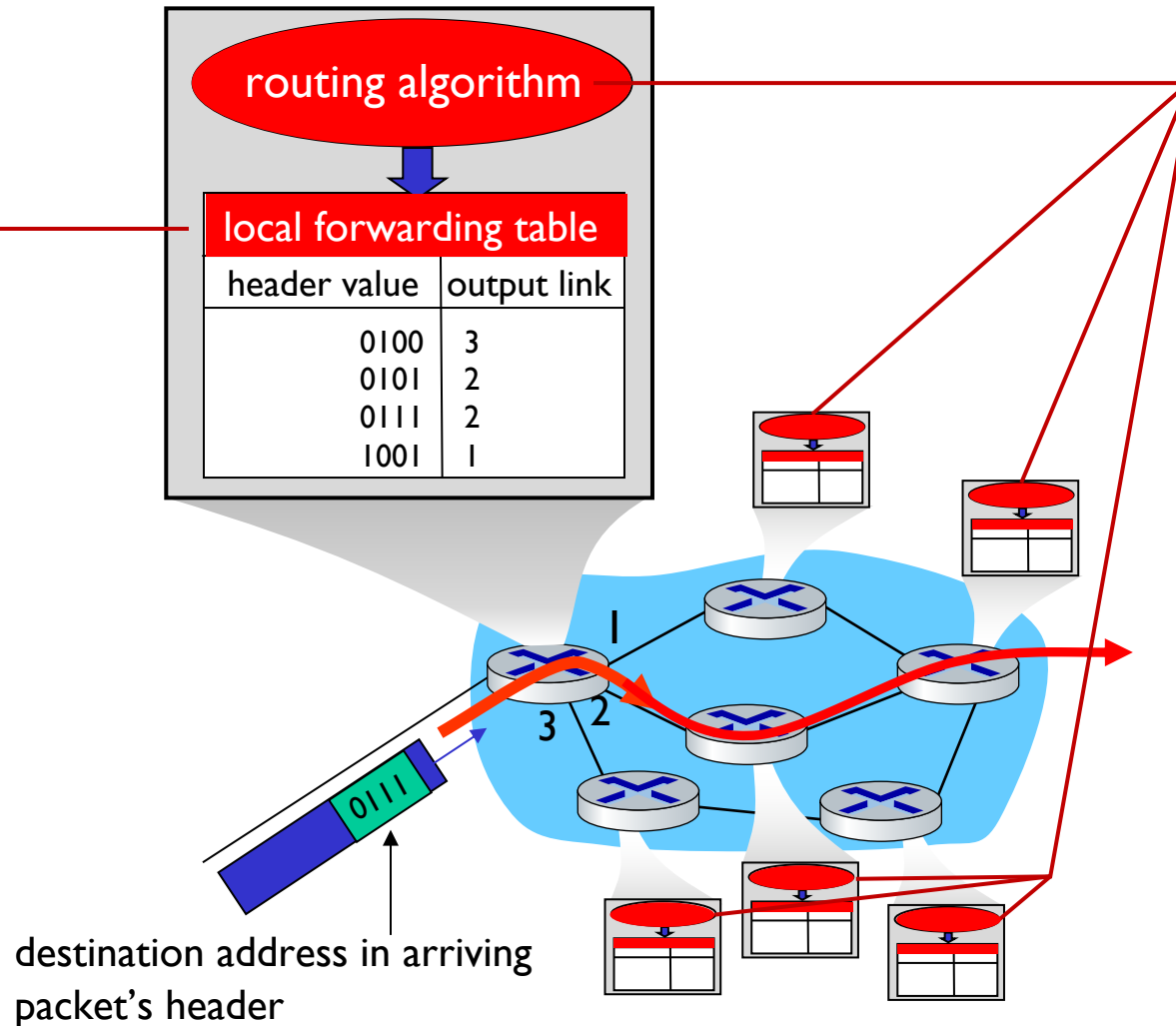


Switch forwards within the same network,
whereas routers forwards across different network

Forwarding vs routing

Forwarding:

- **local** action:
move arriving
packets to
appropriate
output link



Routing:

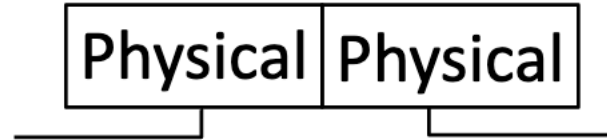
- **global** action:
determine src-dst
paths taken by packets



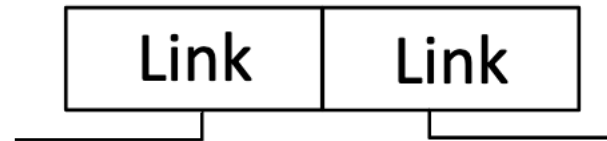


Repeater vs switch vs router vs proxy

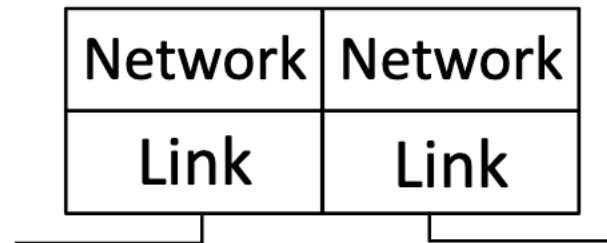
Repeater (hub)



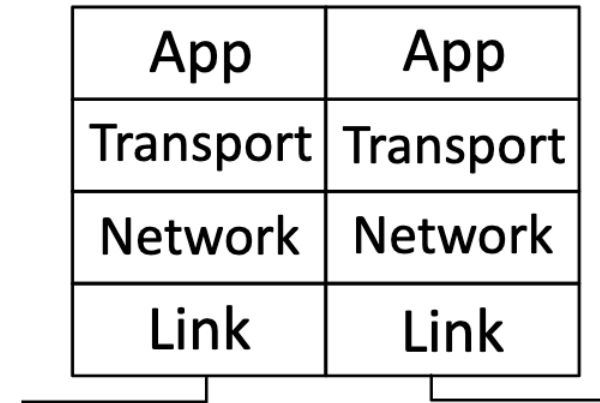
Switch (bridge)



Router



Proxy



But they all look like this! 😊



Acknowledgements

Slides are made based on

- James Kurose's slides