Lecture 01-2:
What is Internet anyway

CS 326E Elements of Networking

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The title of the slide is inspired by the following video

So…
What is Internet anyway?

Goal:

After this lecture you will be able to answer!

Outline

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

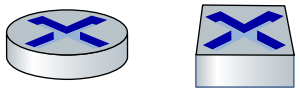
What makes up the Internet?

How you would explain it to 5-year olds…

The Internet: a "nuts and bolts" view

Billions of connected computing devices:

- hosts = end systems
- running network apps at Internet's "edge"



Packet switches: forward packets (chunks of data)

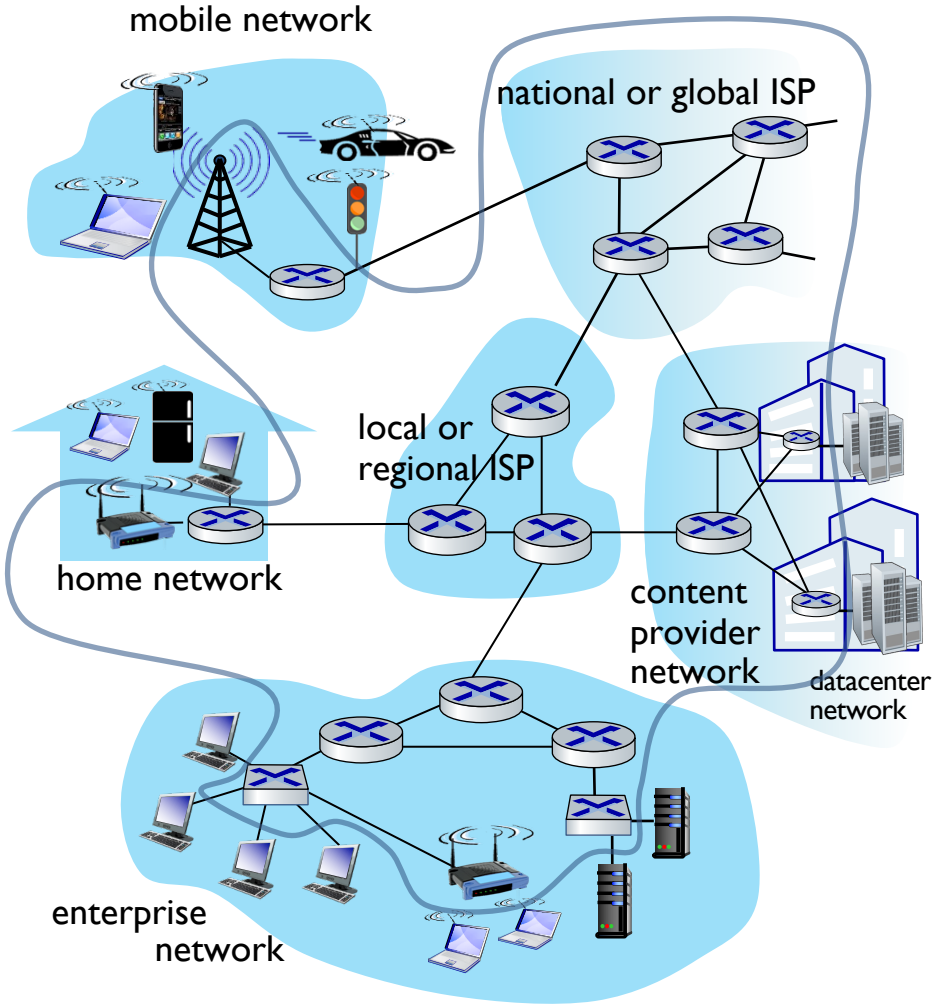
- routers, switches

Communication links

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

Networks

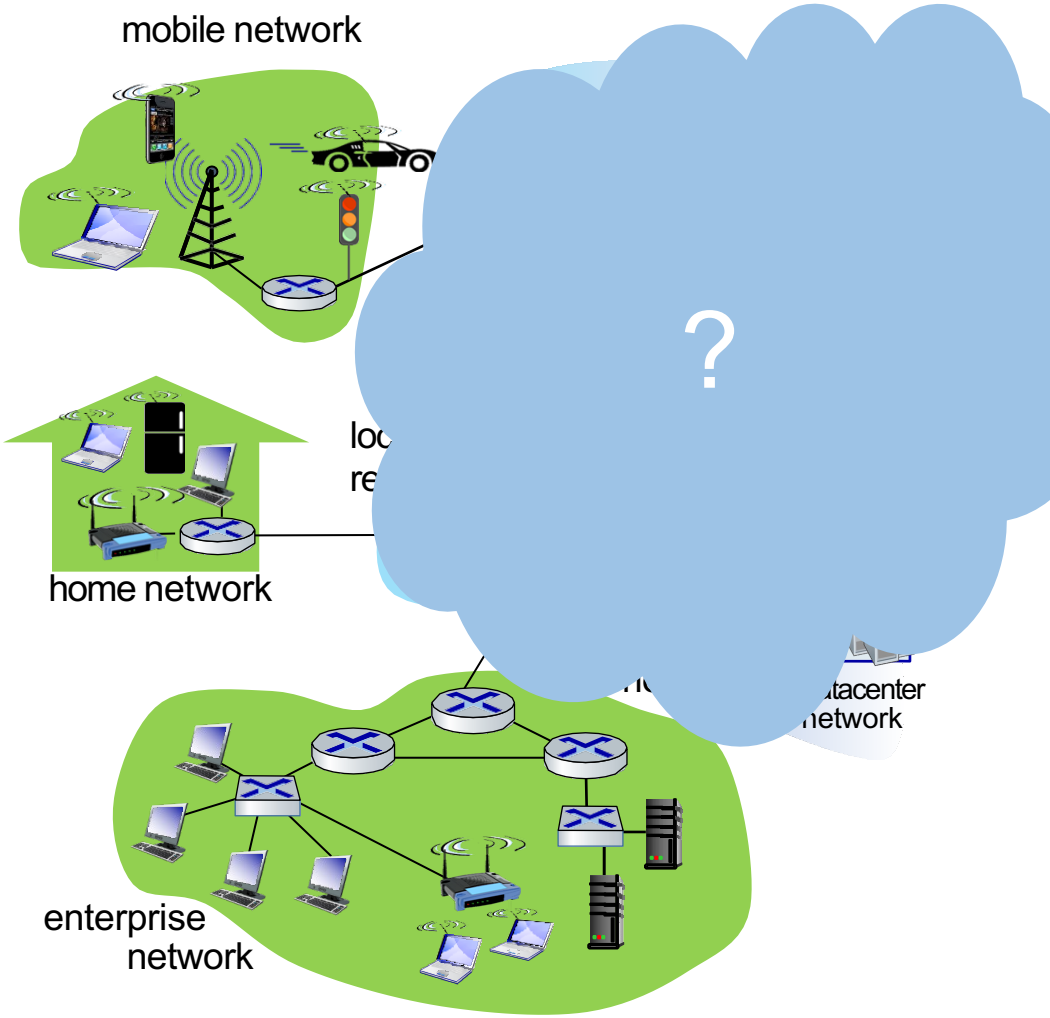
- collection of devices, routers, links: managed by an organization



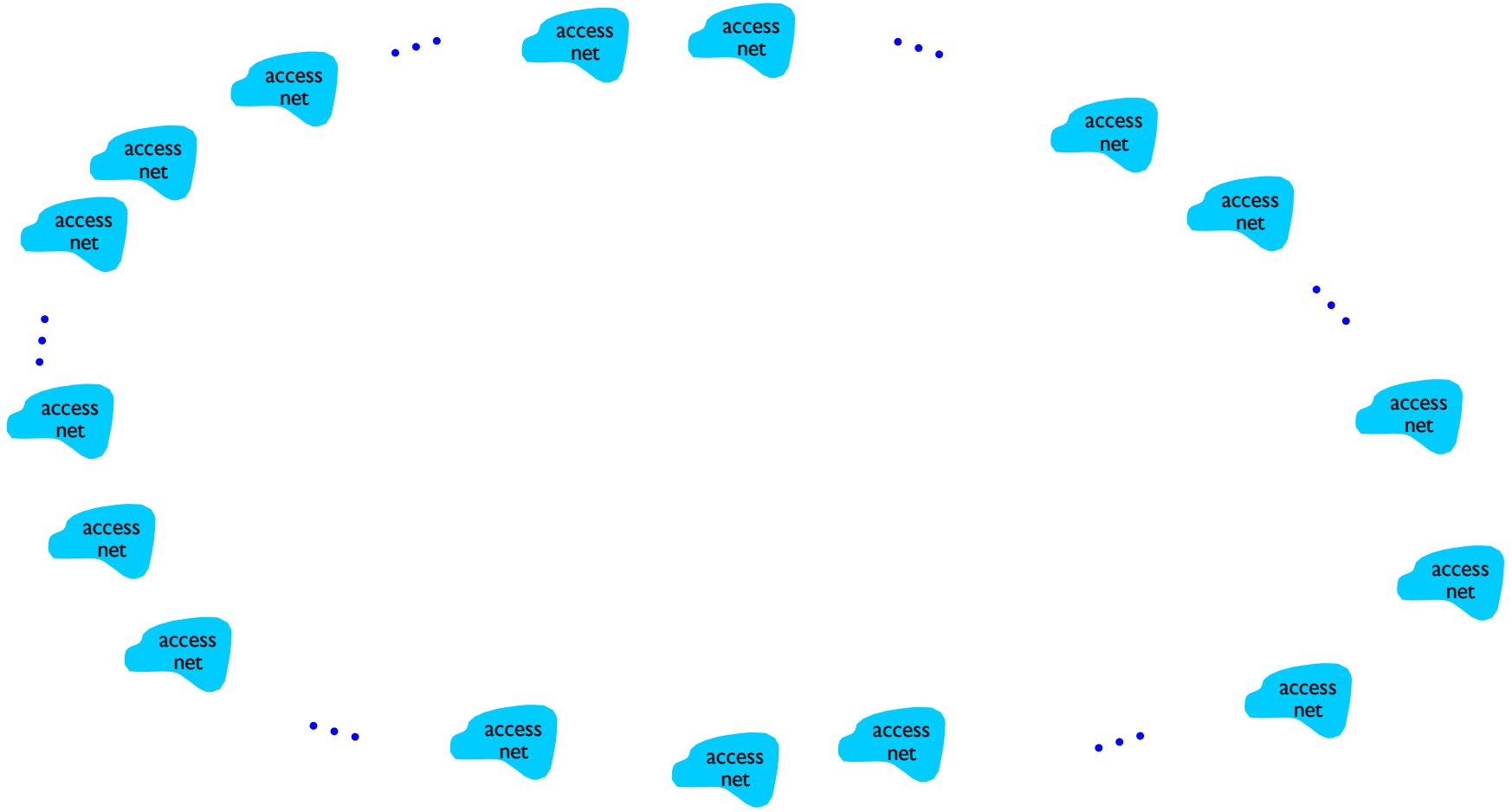
Let's start with an access network

- 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?



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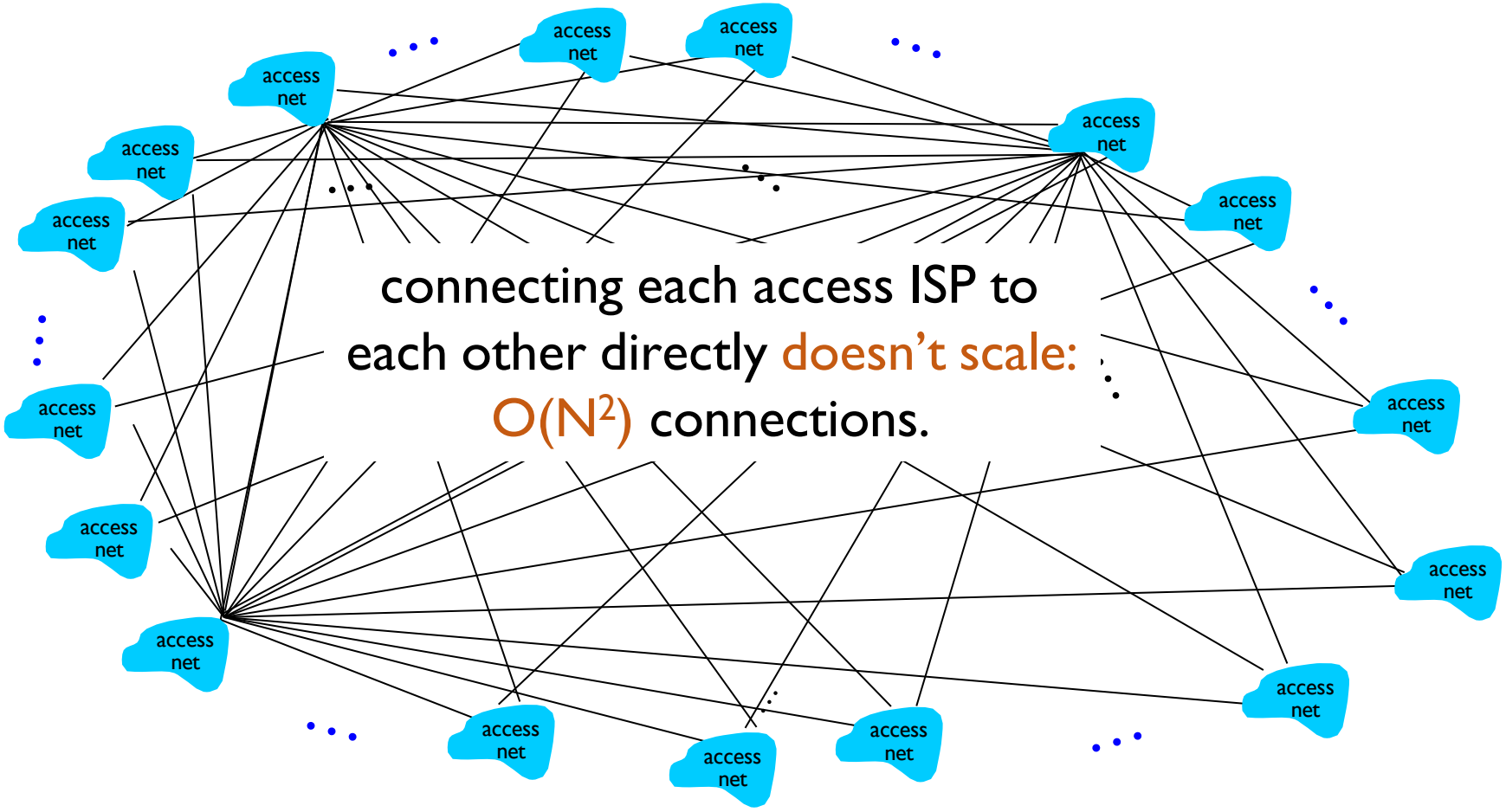
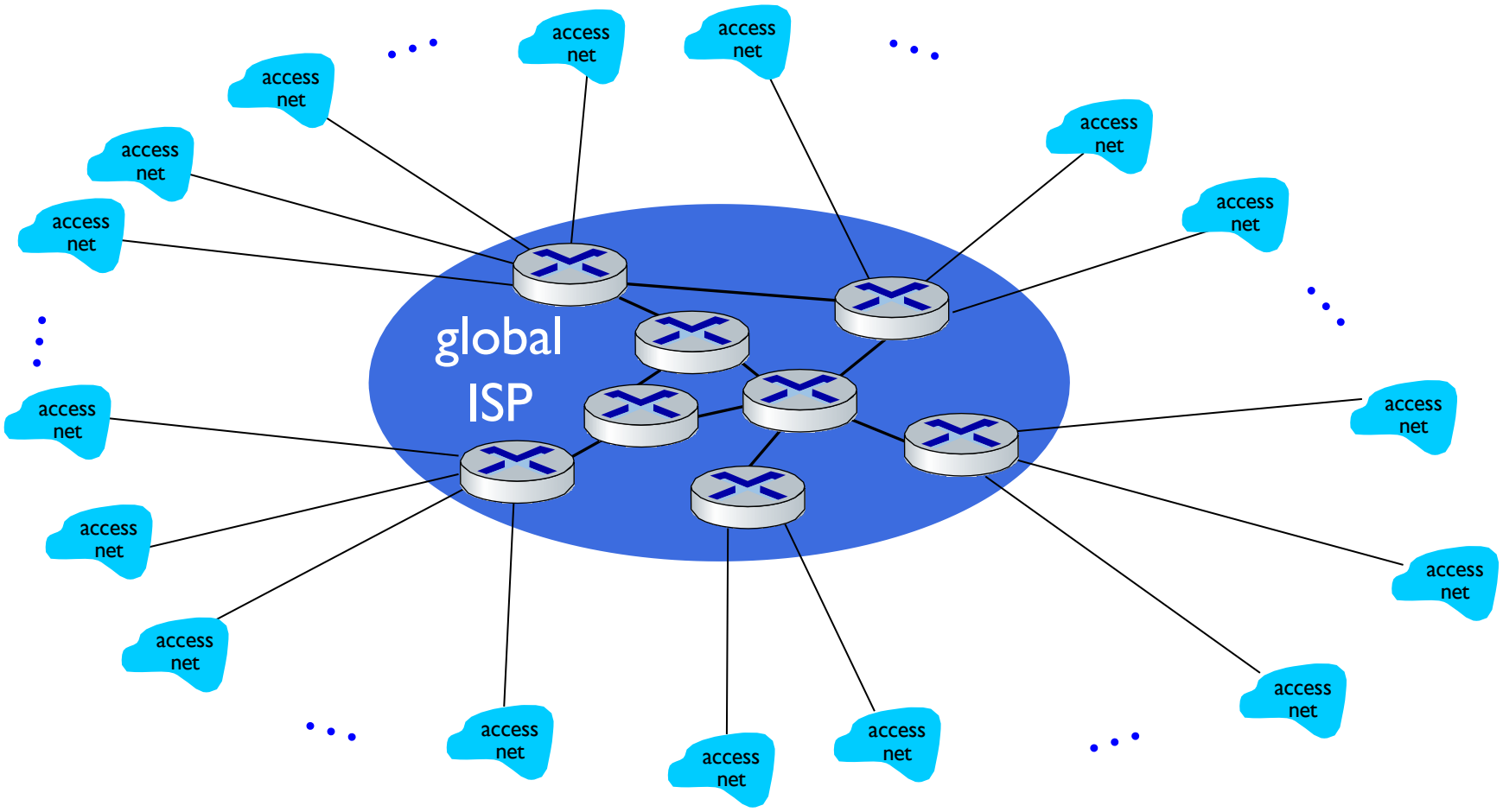
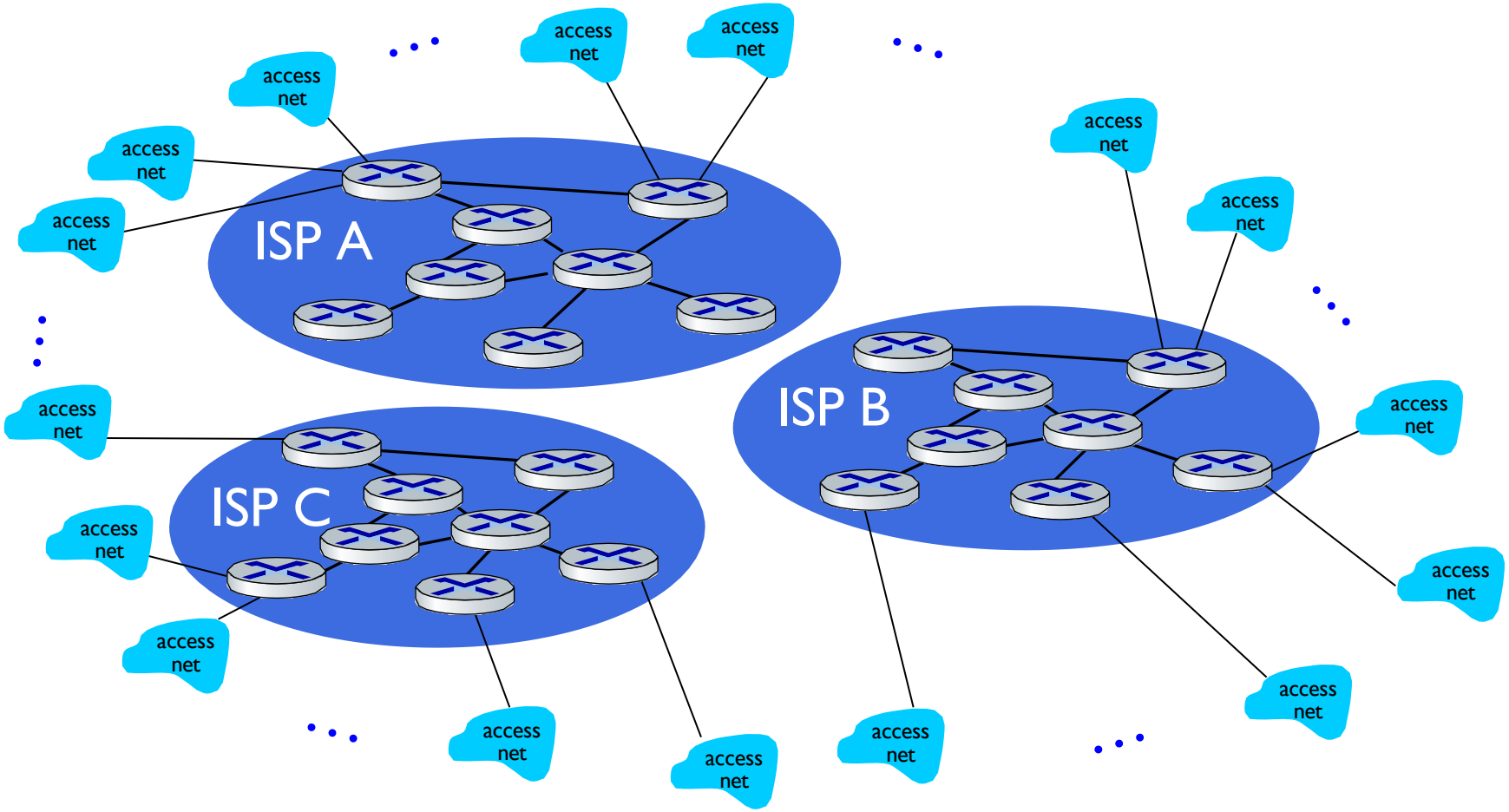


Option: Connect each access ISP to one global transit ISP

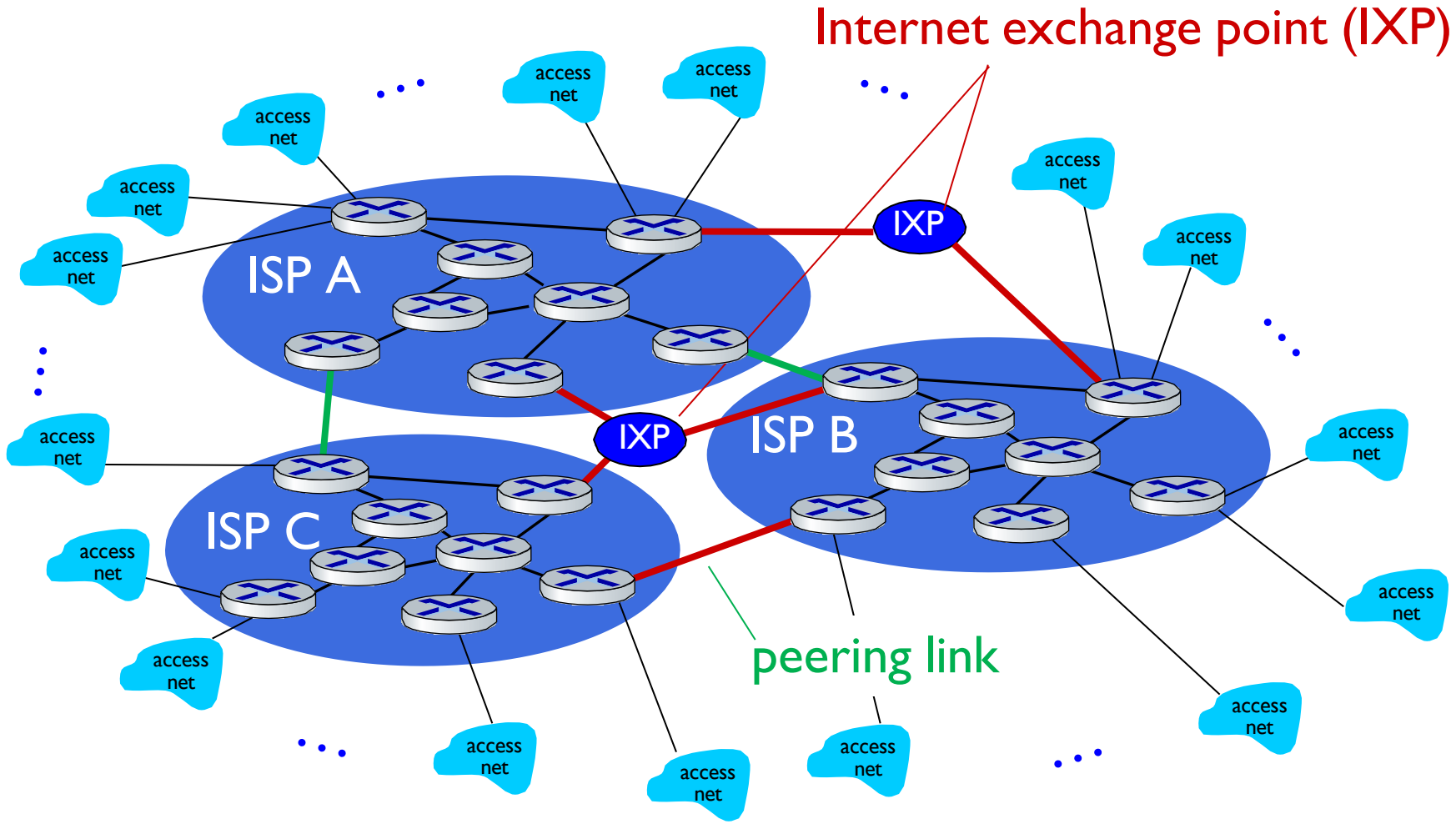
Customer and provider ISPs have economic agreement.



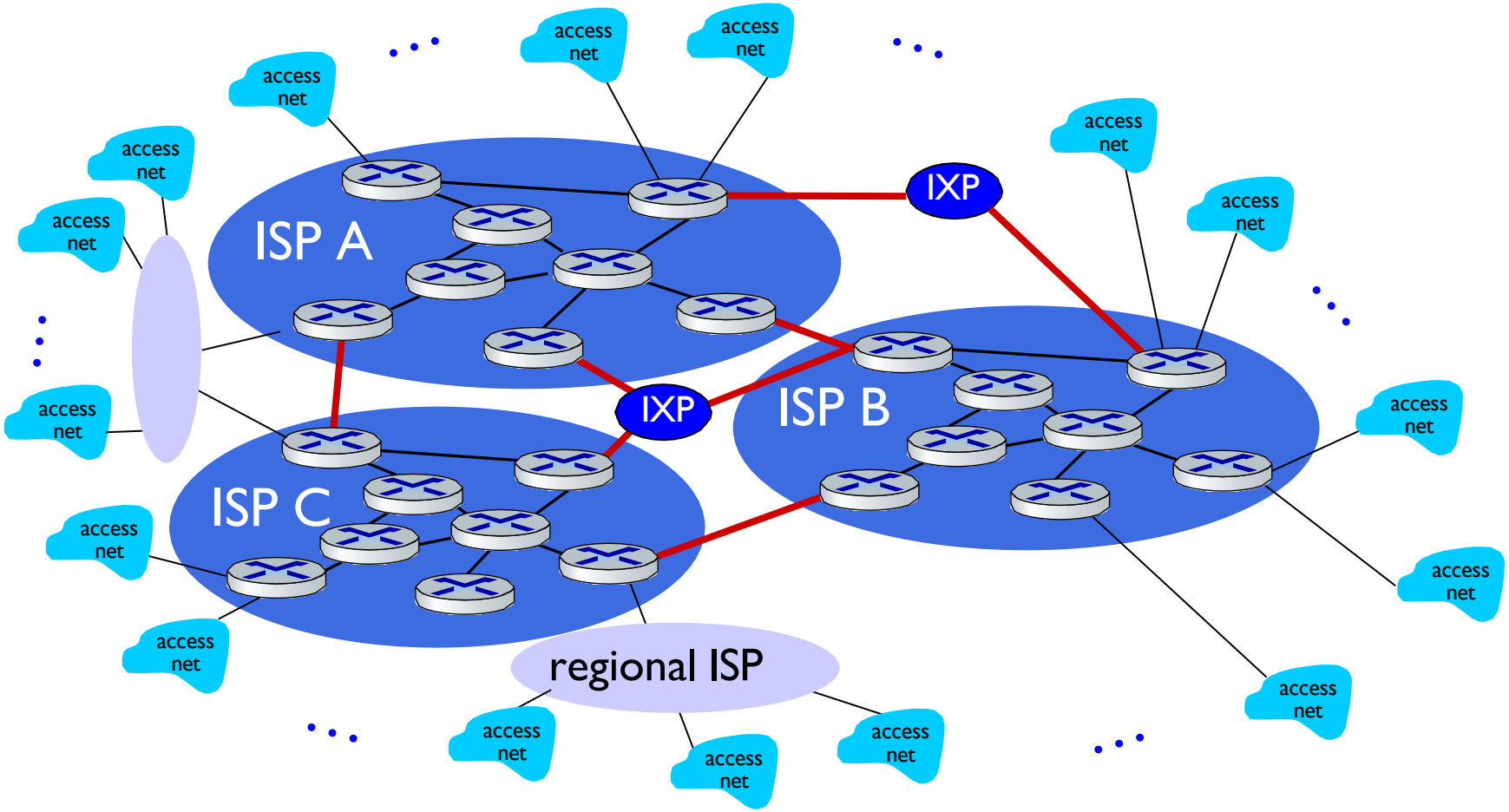
But if one global ISP is viable business, competitors will rise



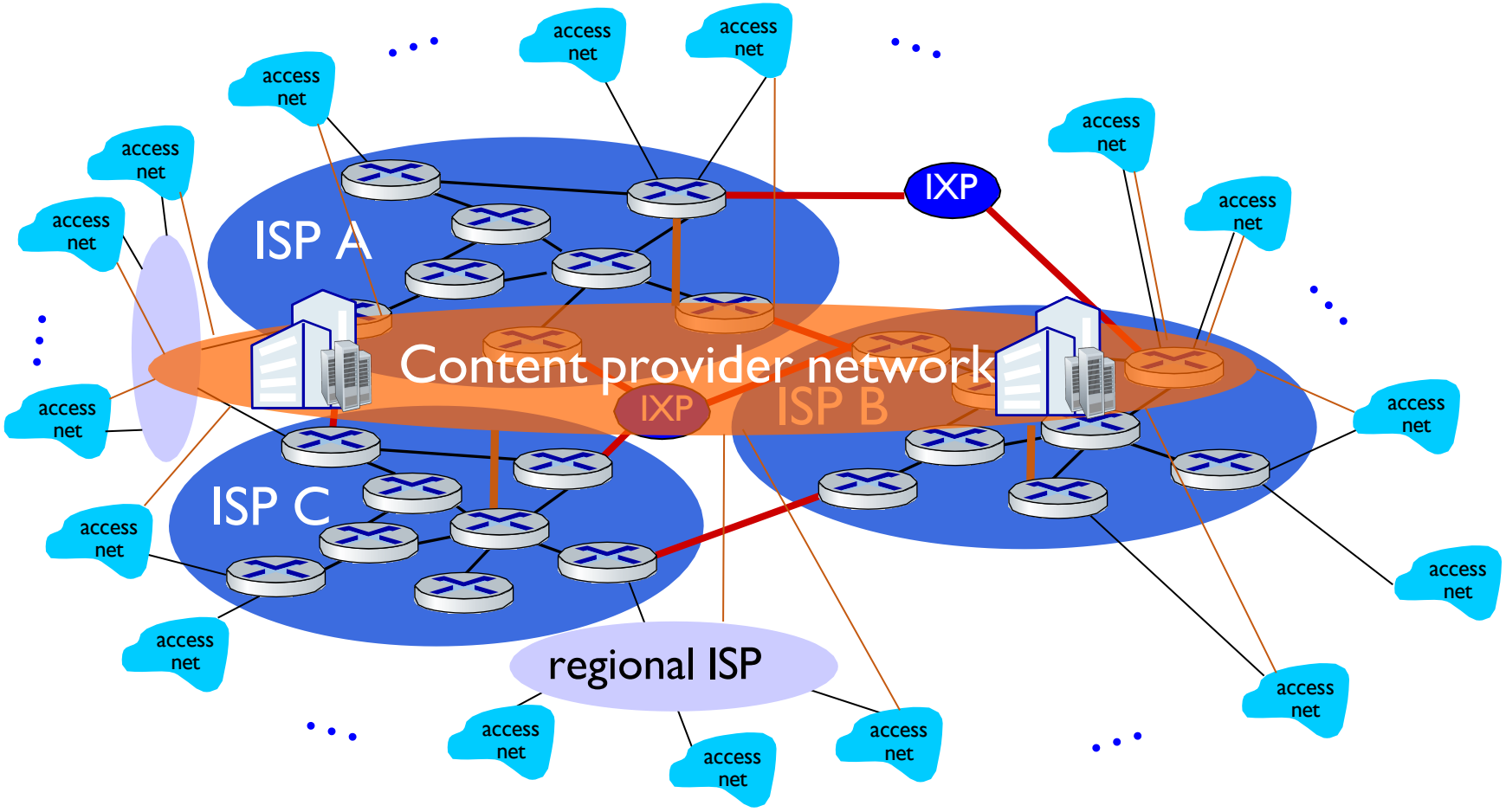
IXP is the physical infrastructure through which ISPs exchange Internet traffic



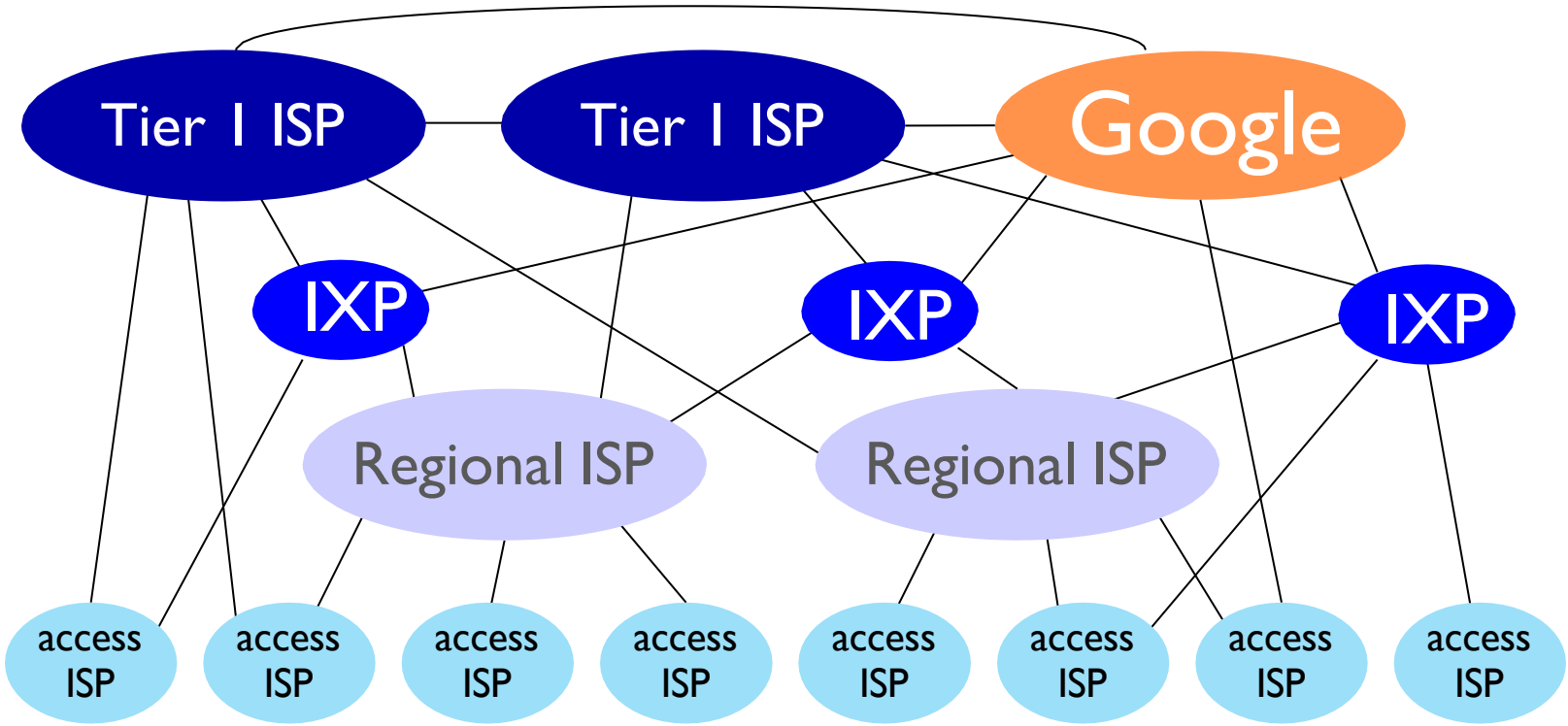
And regional networks may arise to connect access networks to ISPs



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., Netflix, Google,): private network that connects its data centers to Internet, often bypassing tier-1, regional ISPs

Recap: Pick 2 from below and tell your neighbor about it

- What are hosts, and give an example of hosts
- What are the two devices in network core?
- What is an ISP?
- What is an access network?
- What is an IXP?

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?

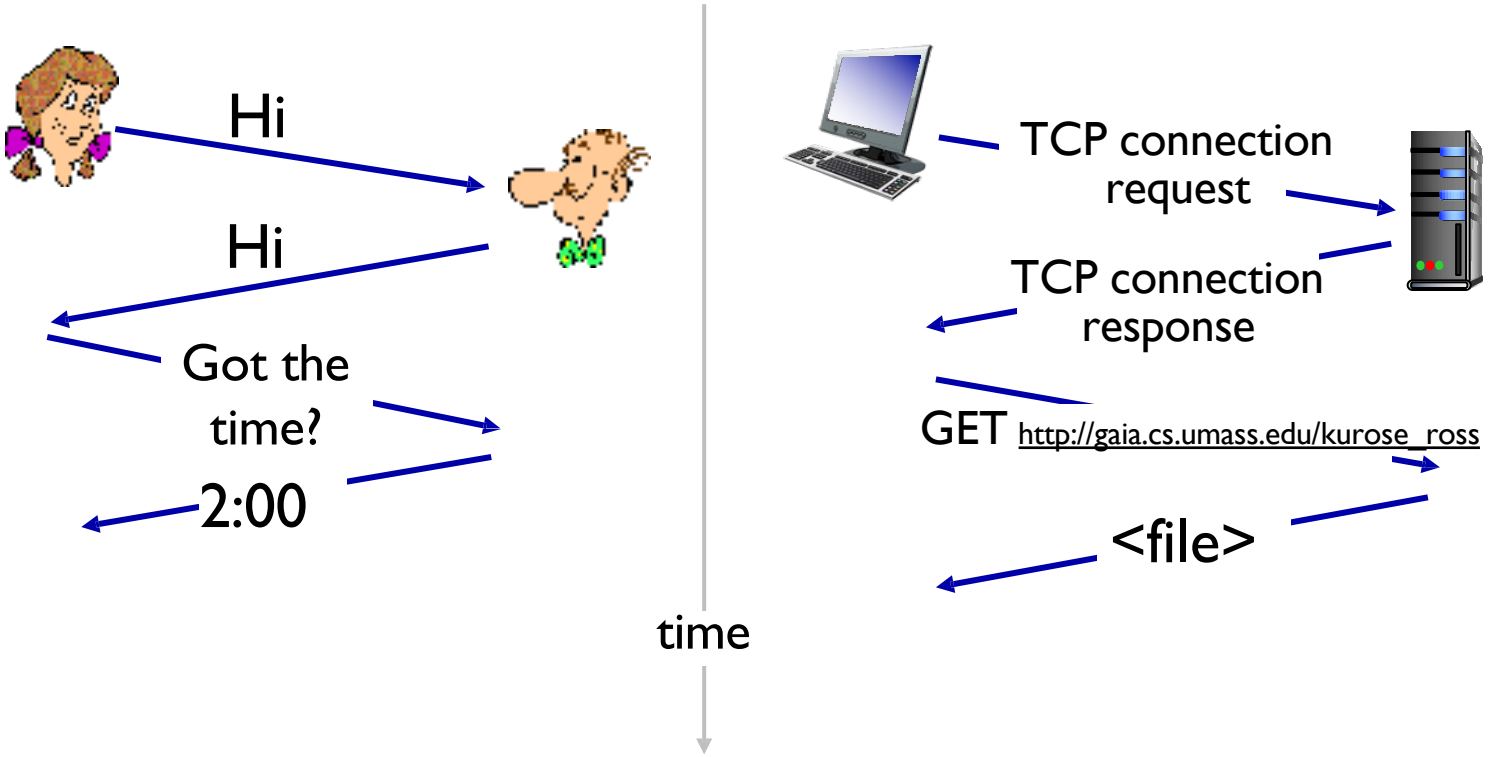
What would be the basic building blocks in network communication?

Protocols and layering are the basic building blocks in network communication

So…
What is protocol anyway?

Why protocol?

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

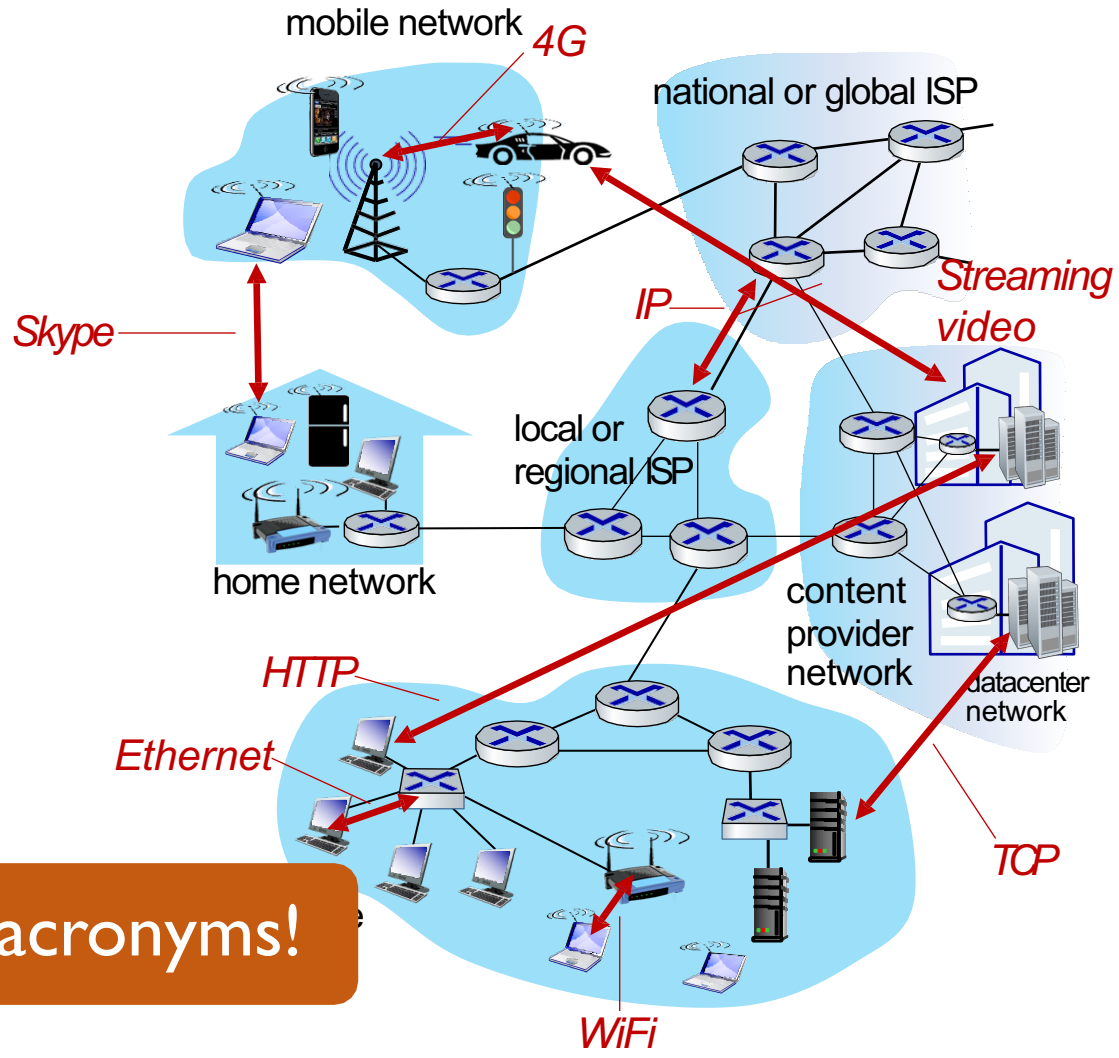


A human protocol vs computer network protocol

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)

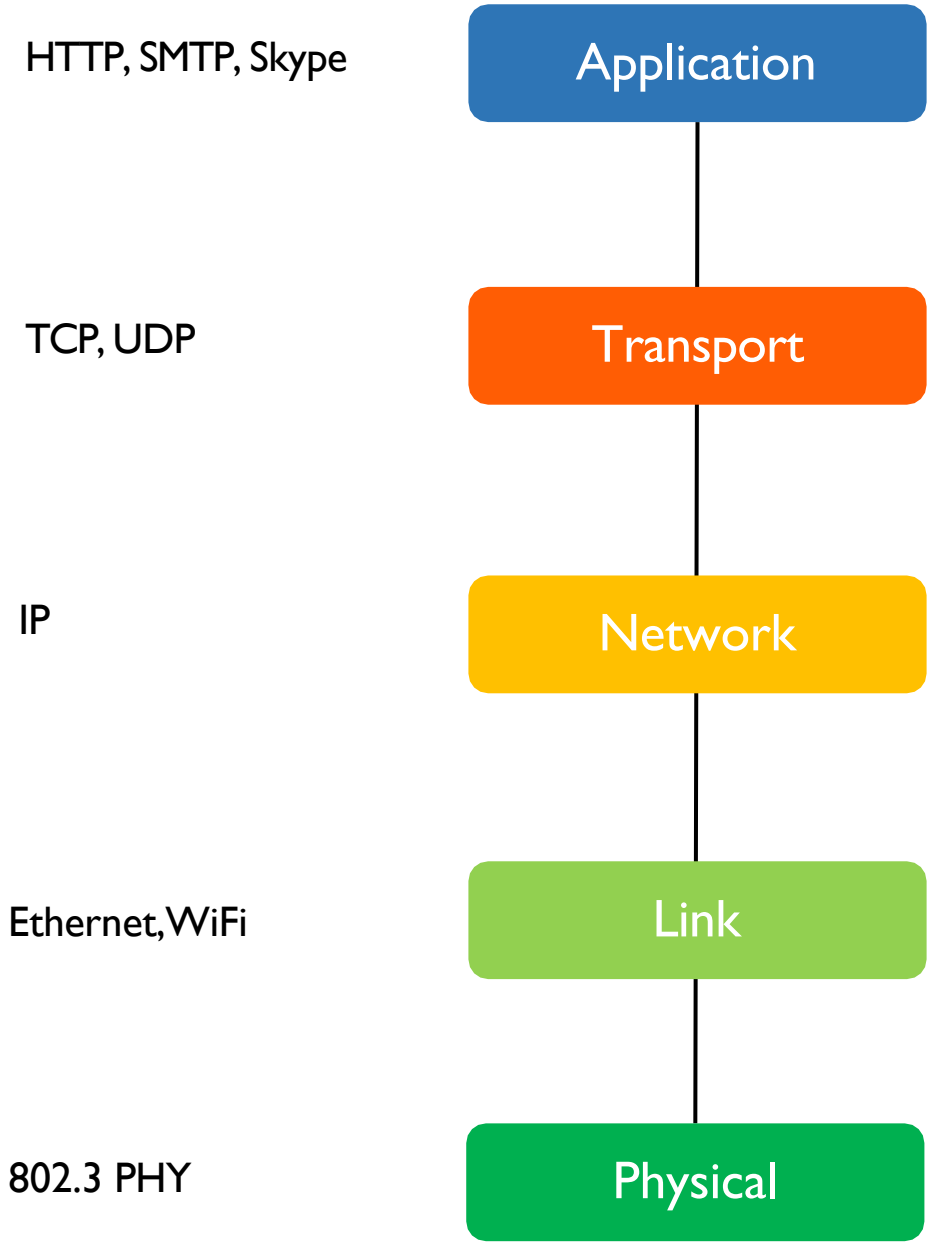


Welcome to the world of excessive acronyms!

Why layering?

What are the layers?

Layers in Internet Protocol Stack

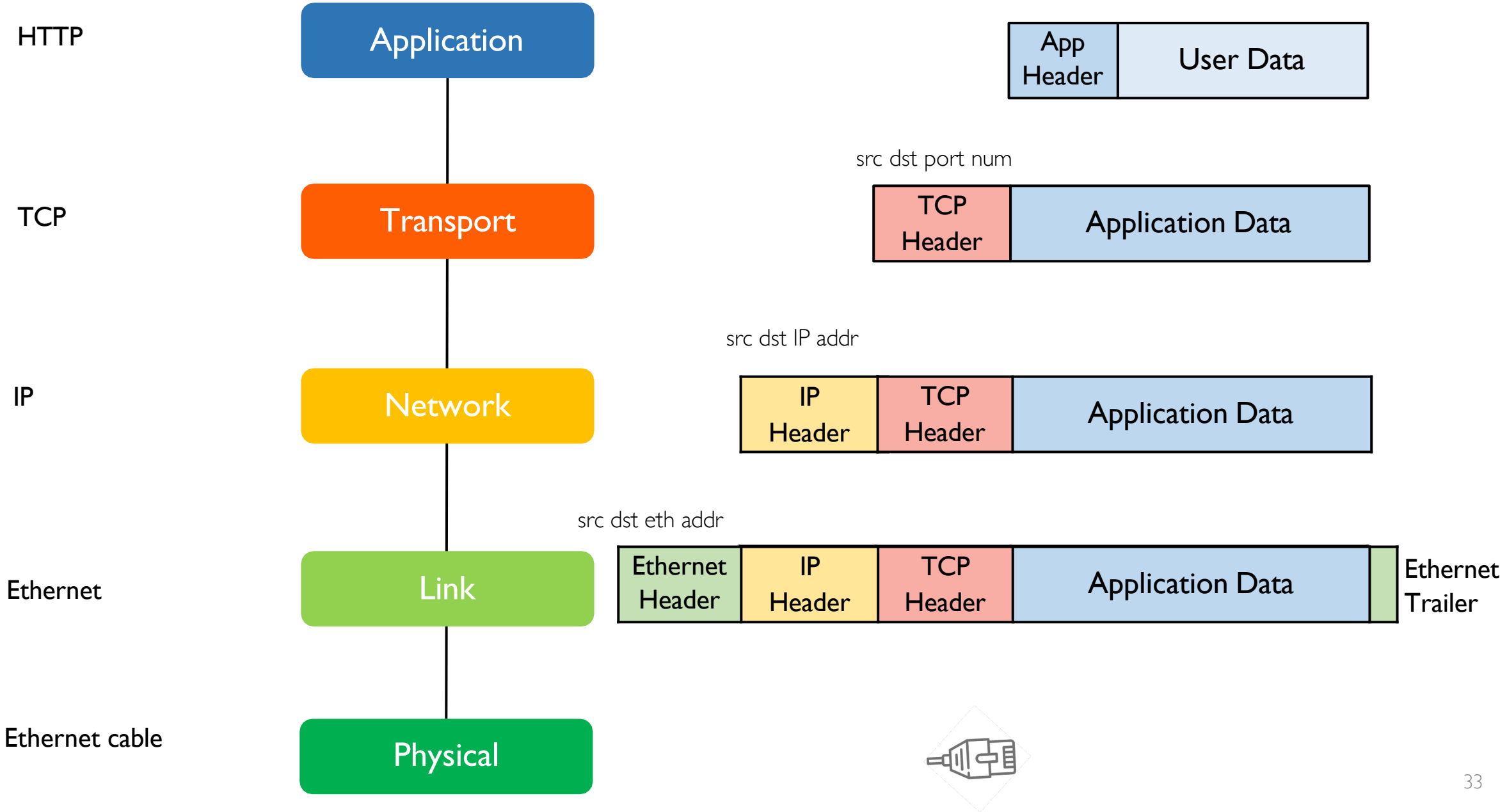



LET'S TACO BOUT IT

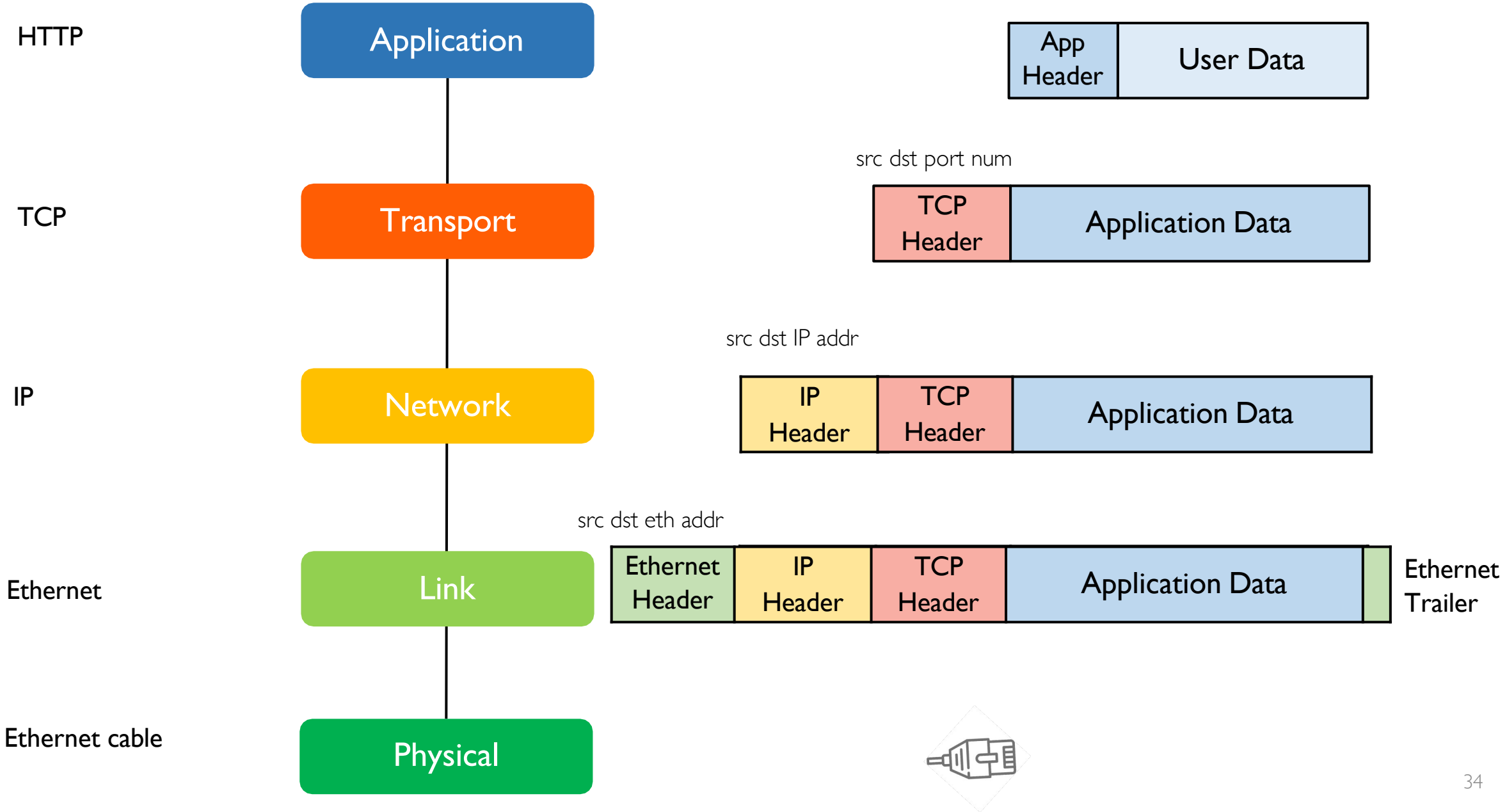
What are some problems to solve to enable communication between two parties?

Example Protocols	Layers	Responsible for
HTTP, SSH, DNS	Application	application specific needs
TCP, UDP	Transport	process to process data transfer
IP	Network	host to host data transfer across different network
WiFi, Ethernet, Bluetooth	Link	data transfer between physically adjacent nodes
802.11, PHY	Physical	bit-by-bit or symbol-by-symbol delivery

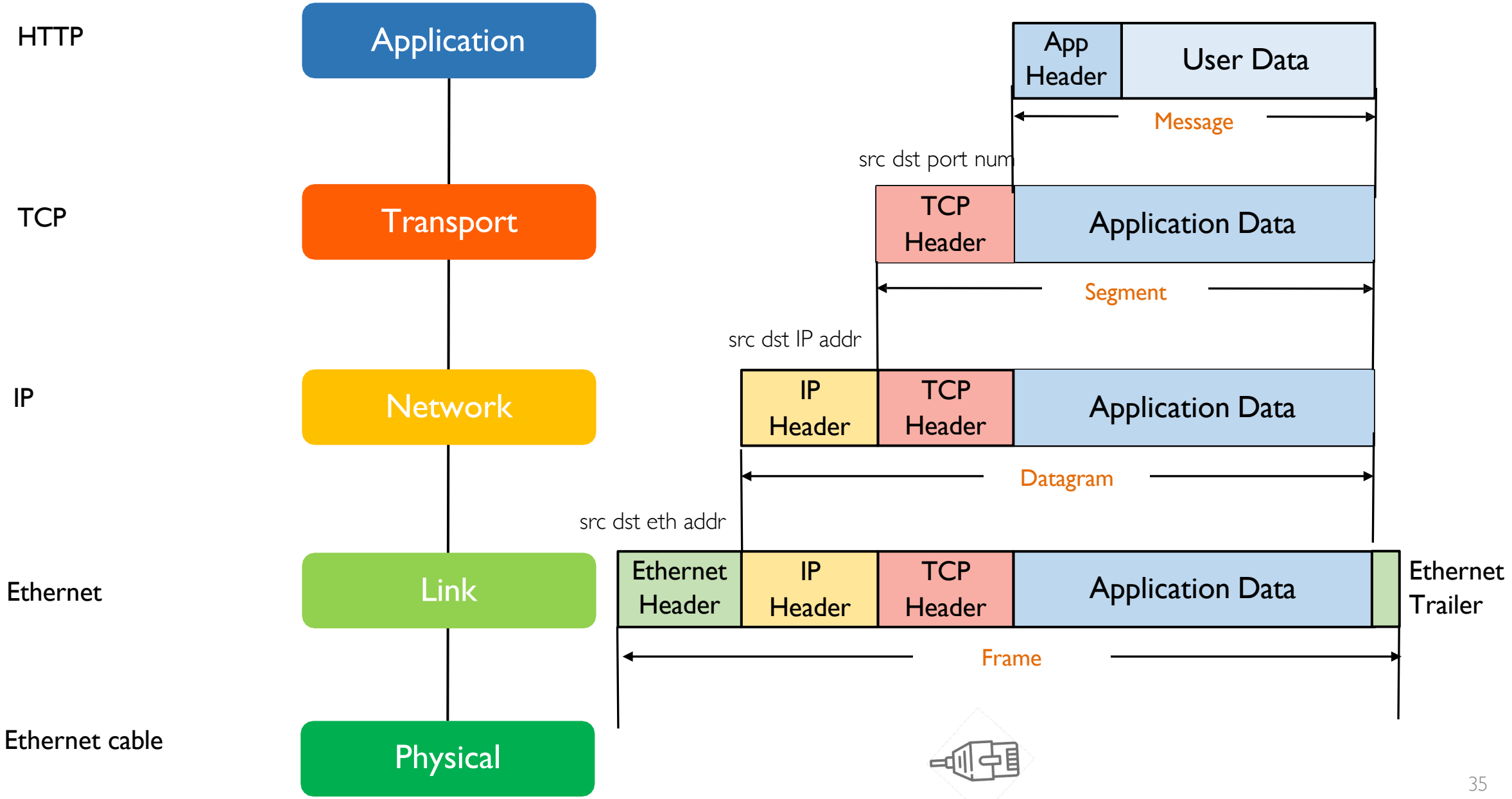
Sender pushes a packet top-down



Receiver pushes a packet bottom-up



Each layer calls a packet differently!

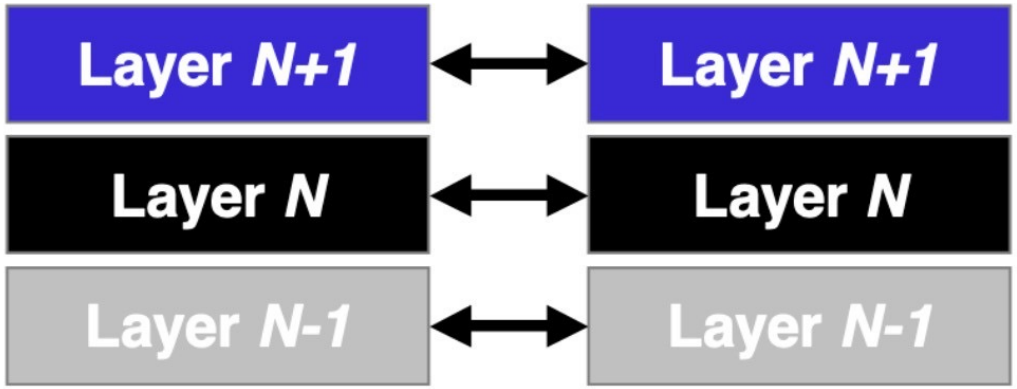


True/False

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

Protocols are horizontal and layers are vertical

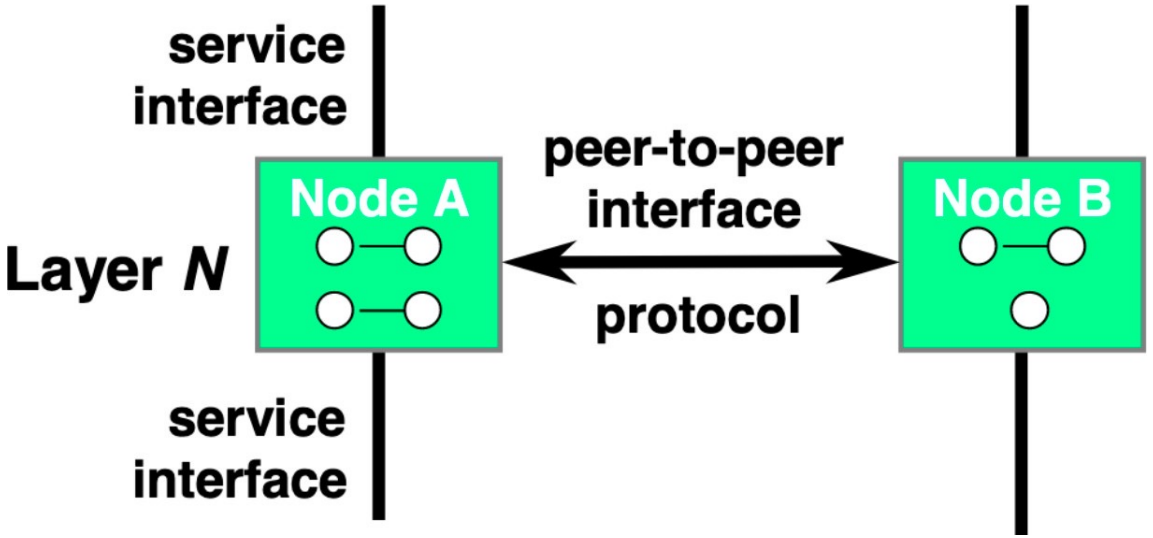
Protocols provides ways for peers to communicate horizontally



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

Each layer provides service to their upper layer

Layer N provides services to layer N+1

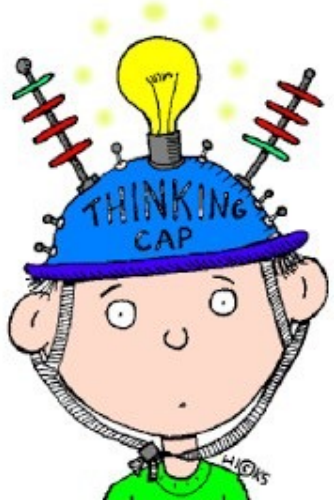


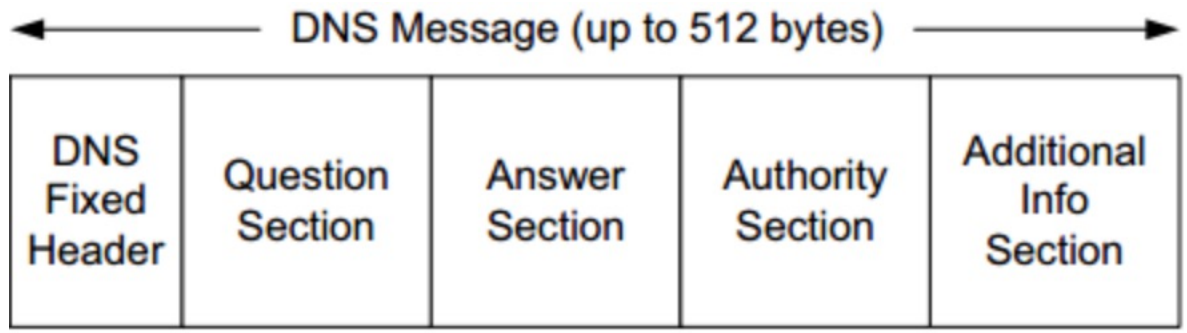
Layer N is serviced by layer N-1

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

Layer N provides service to Layer N+1
is serviced by Layer N-1

Pros and cons of layering

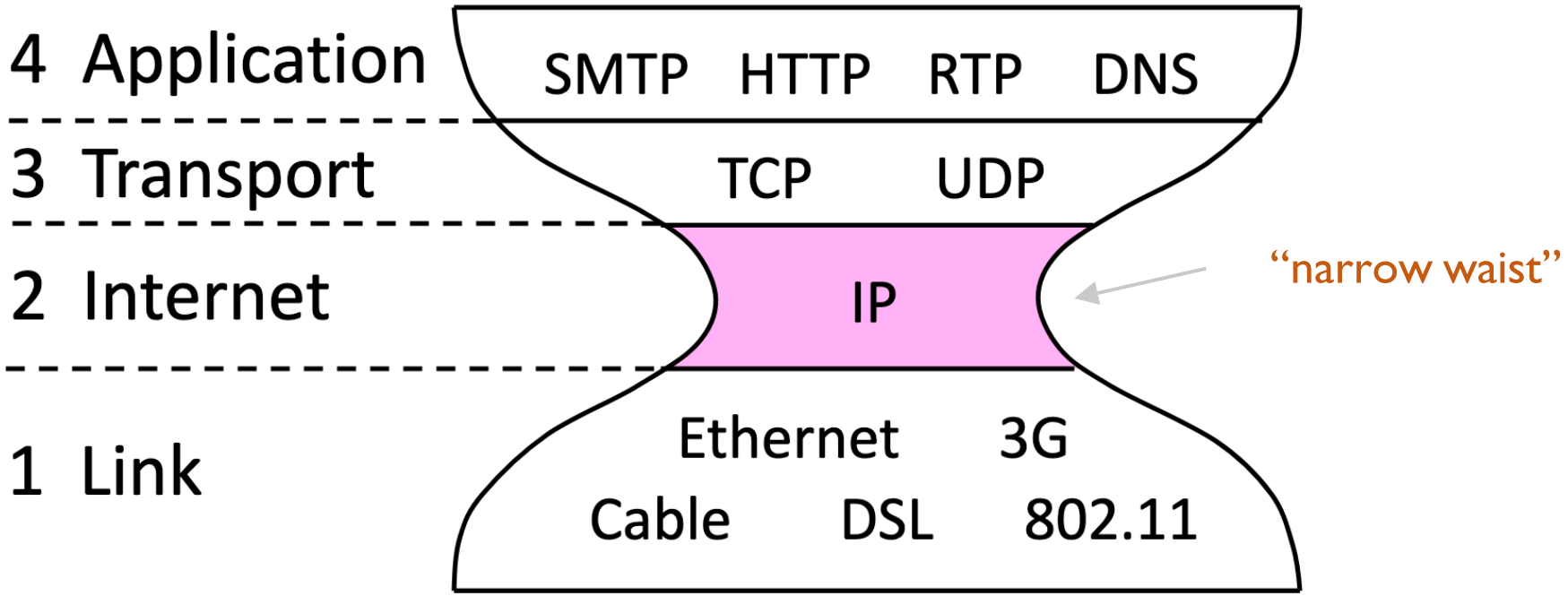



DNS Message (up to 512 bytes)
DNS Fixed Header
Question Section
Answer Section
Authority Section
Additional Info Section

Some more concepts and terms..

Hourglass: IP is the "narrow waist" of the Internet

- Supports many different apps above and links below

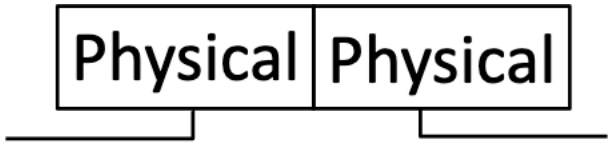


"Protocol stack" refers to a set of protocols in use

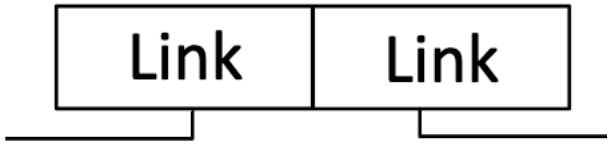
HTTP
TCP
IP
802.11

Repeater vs switch vs router vs proxy

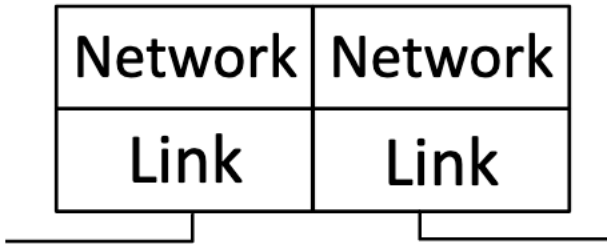
Repeater (hub)



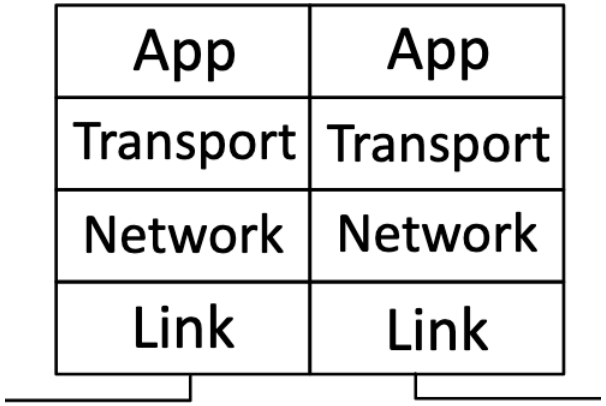
Switch (bridge)



Router



Proxy



But they all look like this! ©

In-class exercise

Acknowledgements

Slides are made based on

- James Kurose's slides