

COS 461/561: Computer Networks

Lecture 1: Introduction to Networks

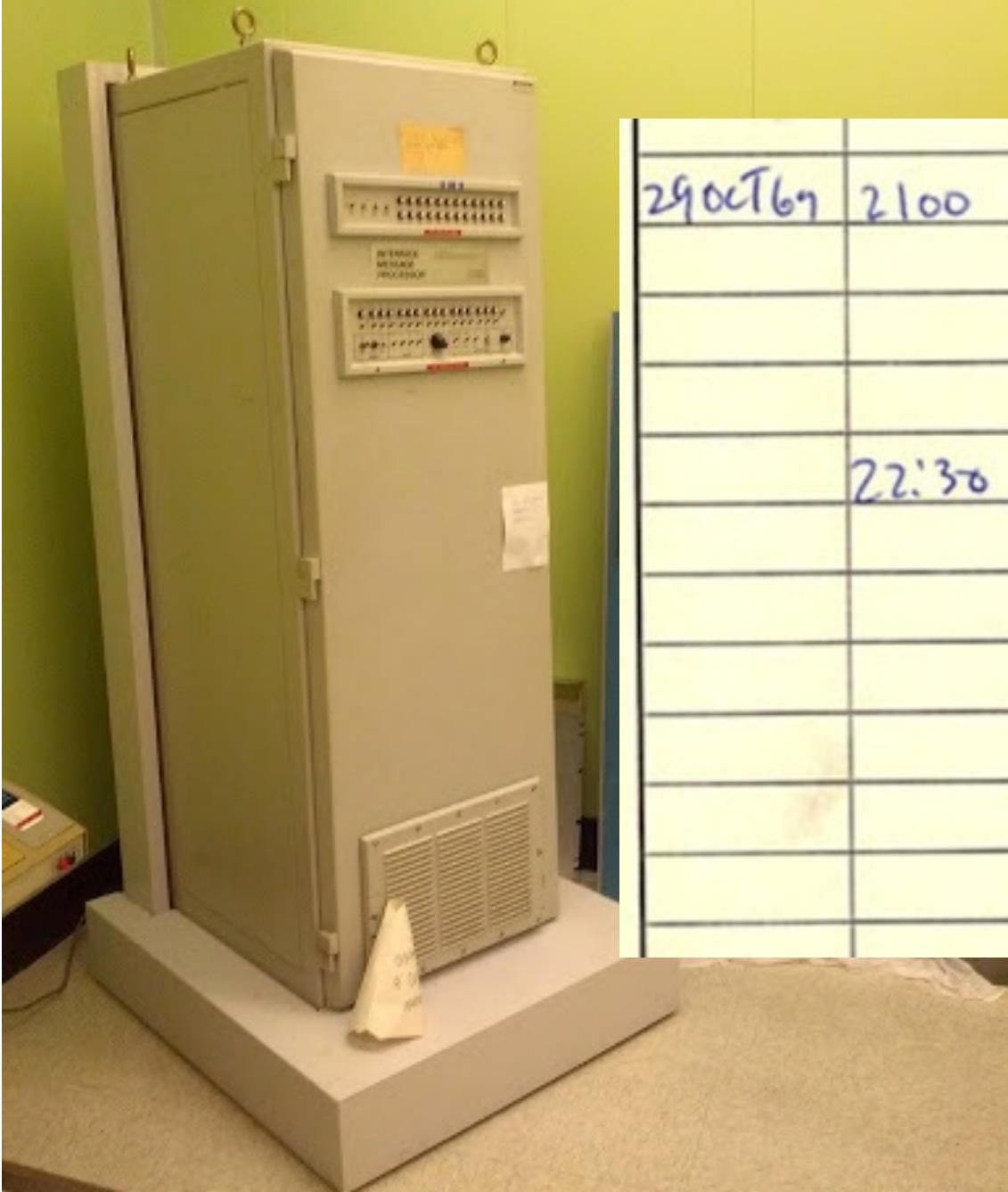
Kyle Jamieson

Today

1. Origins of the Internet
2. Central Concepts in Networking
3. Course Introduction and Policies (461 & 561)

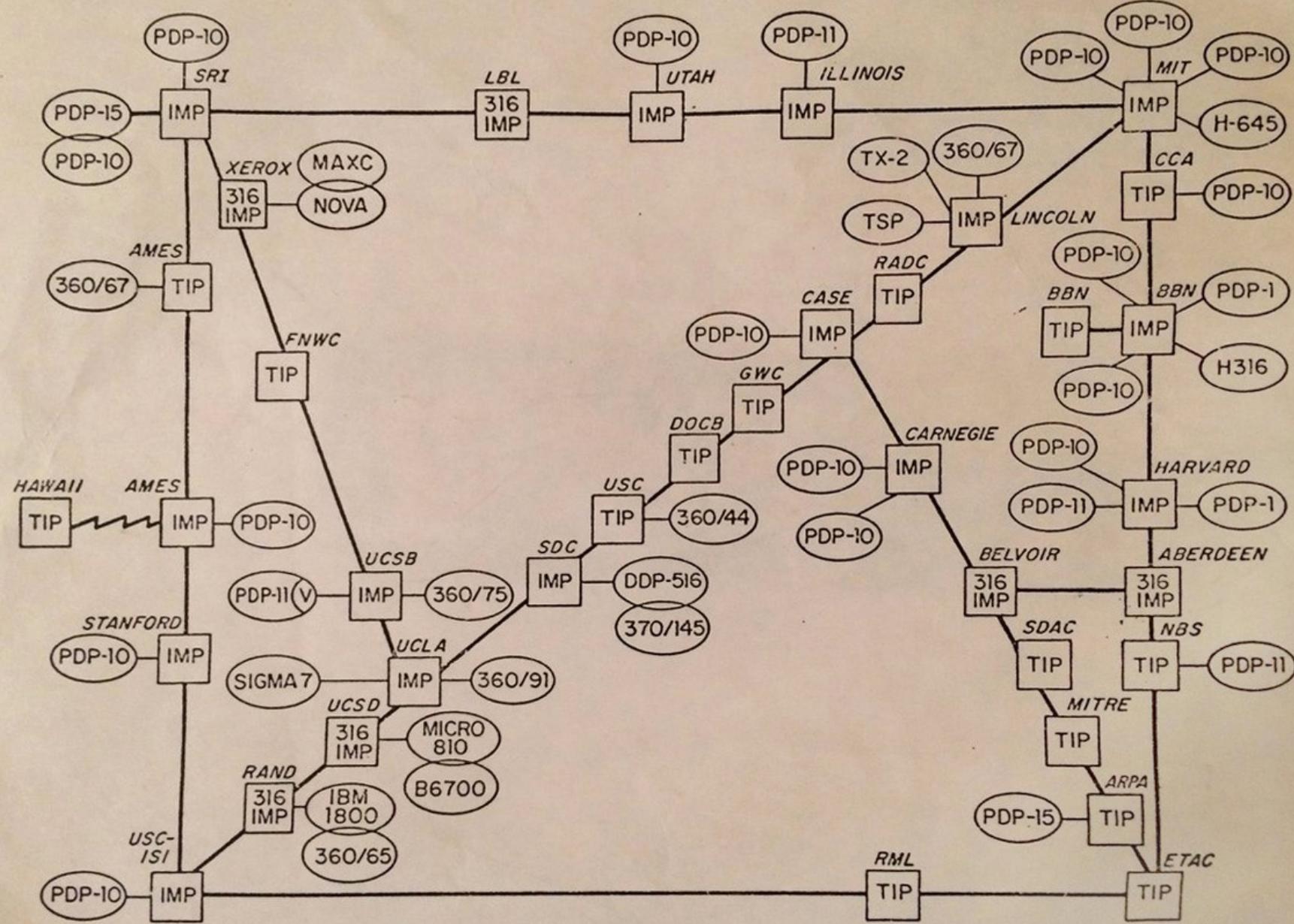
What are the Origins of Today's Internet?

Interface Message Processor

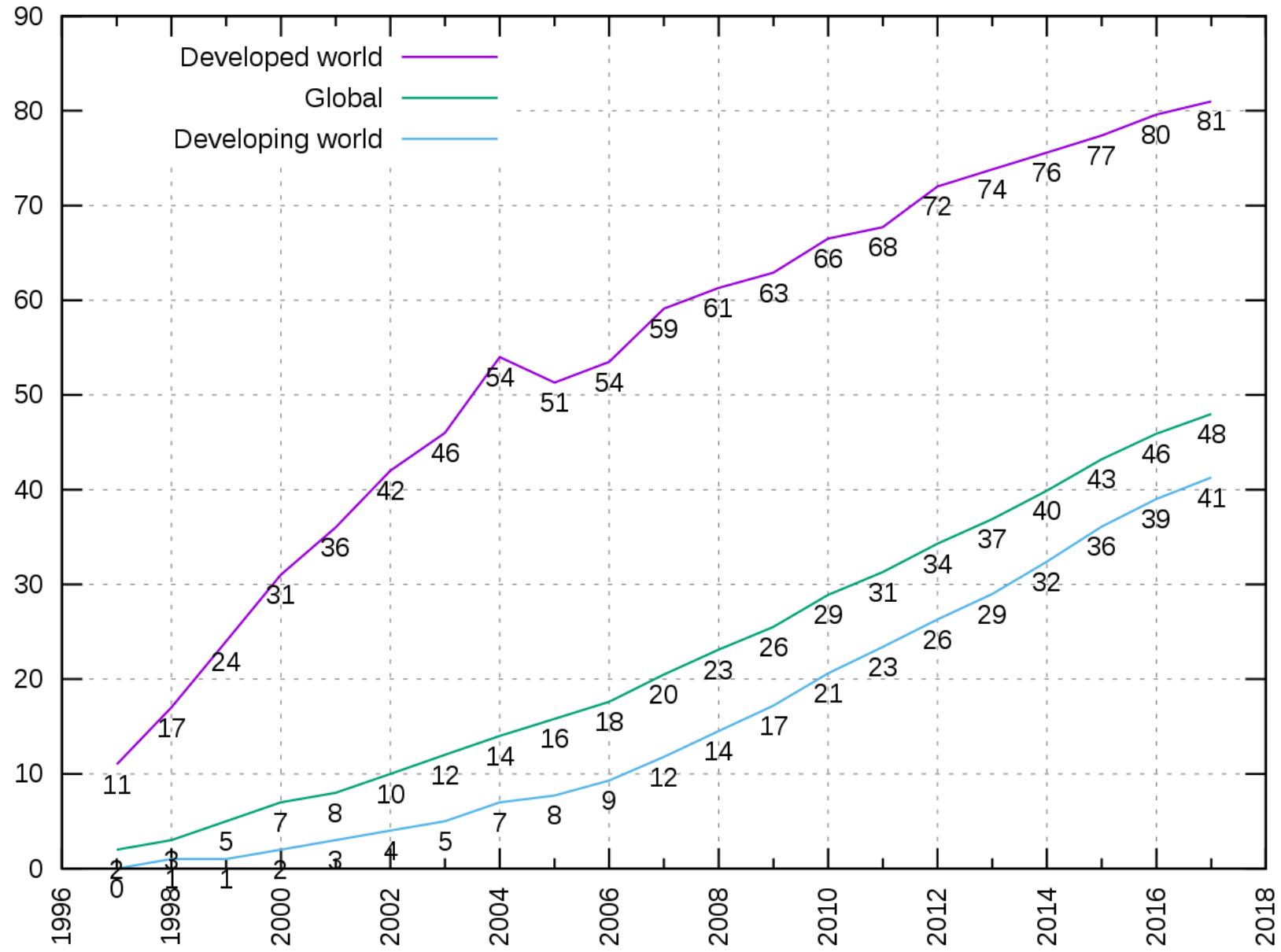


29 OCT 69	2100	LOADED	OP. PROGRAM CSK
		FOR BEN BARKER	
		BBN	
22:30		<u>talked to SRF</u>	CSL
		Host to Host	
		Left op. program CSL	
		running after sending	
		a host dead message	
		to imp.	

ARPA NETWORK, LOGICAL MAP, MAY 1973



Internet Users Per 100 Inhabitants



The Internet is a Tense Place

Cybersecurity

Cyber-Attack Hits U.S. Health Agency Amid Covid-19 Outbreak

By [Shira Stein](#) and [Jennifer Jacobs](#)

March 16, 2020, 8:37 AM EDT *Updated on March 16, 2020, 4:35 PM EDT*

- ▶ NSC tweet on disinfo
- ▶ Cyber intrusion coverage



An official website of the United States government

[Here's how you know](#) ▾

[REPORT](#) [SUBSCRIBE](#) [CONTACT](#) [SITE MAP](#)



**CYBERSECURITY
& INFRASTRUCTURE
SECURITY AGENCY**



[cisa.gov/uscert](#)

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JCDC FOCUSED ON PERSISTENT COLLABORATION AND STAYING AHEAD OF CYBER RISK IN 2023

Original release date: January 26, 2023

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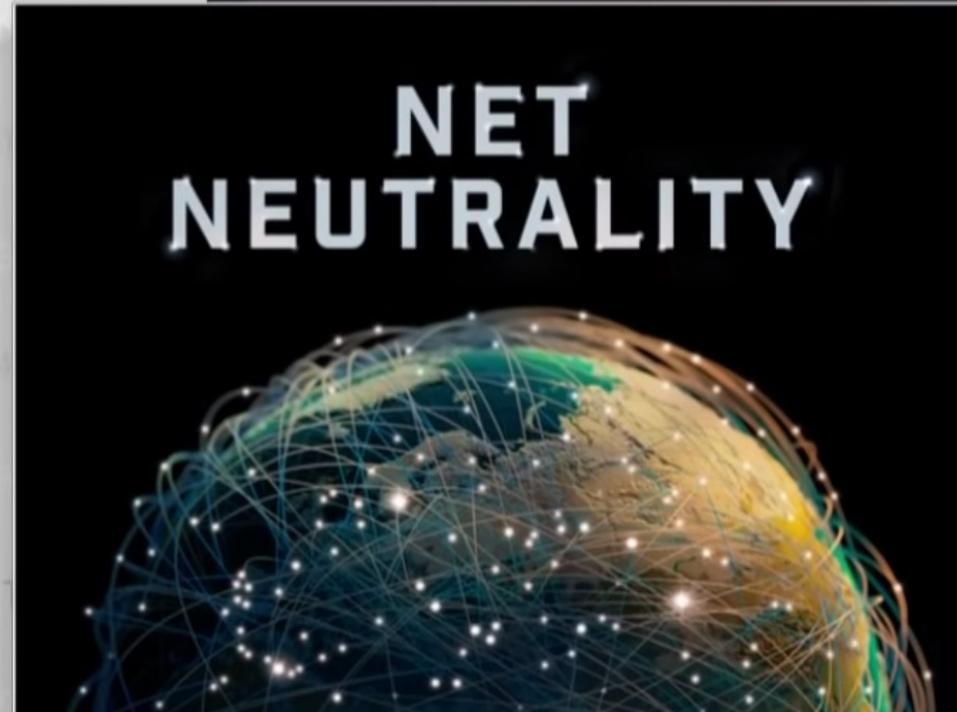
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July 2020



Big Tech C.E.O.s Face Lawmakers on Disinformation

March 25, 2021

Give this article

Speaking: jack dorsey

Tech Executives Testify on Disinformation

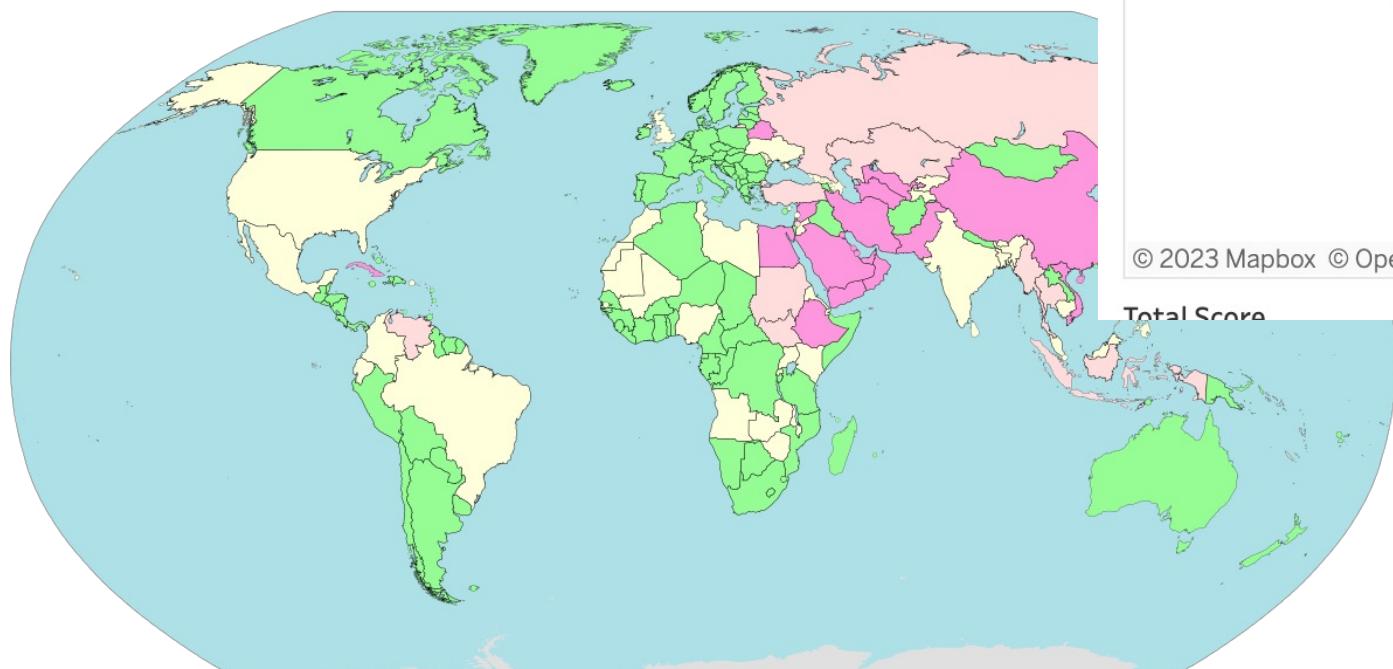
This block contains a screenshot of a news article from March 25, 2021, featuring Jack Dorsey. The headline reads "Big Tech C.E.O.s Face Lawmakers on Disinformation". The date "March 25, 2021" is visible, along with social sharing icons. A video thumbnail for "Speaking: jack dorsey" is also present.

March 2021



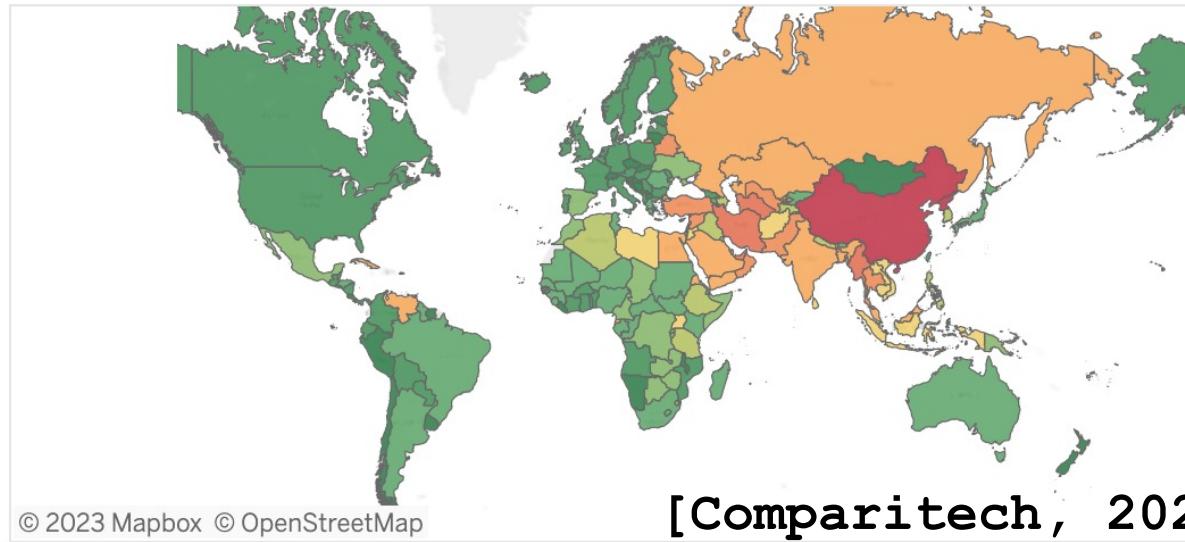
October 2019

Which Countries Are the Most Censored in the World?



Internet censorship and surveillance by country (2018)

- | | | | |
|---------------------|--|----------------|---|
| [Pink square] | Pervasive censorship and/or surveillance | [Green square] | Little or no censorship and/or surveillance |
| [Light pink square] | Substantial censorship and/or surveillance | [Grey square] | Not classified / No data |
| [Yellow square] | Selective censorship and/or surveillance | | |



[Comparitech, 2023]

How does the design of
the Internet **create** or
exacerbate these tensions?

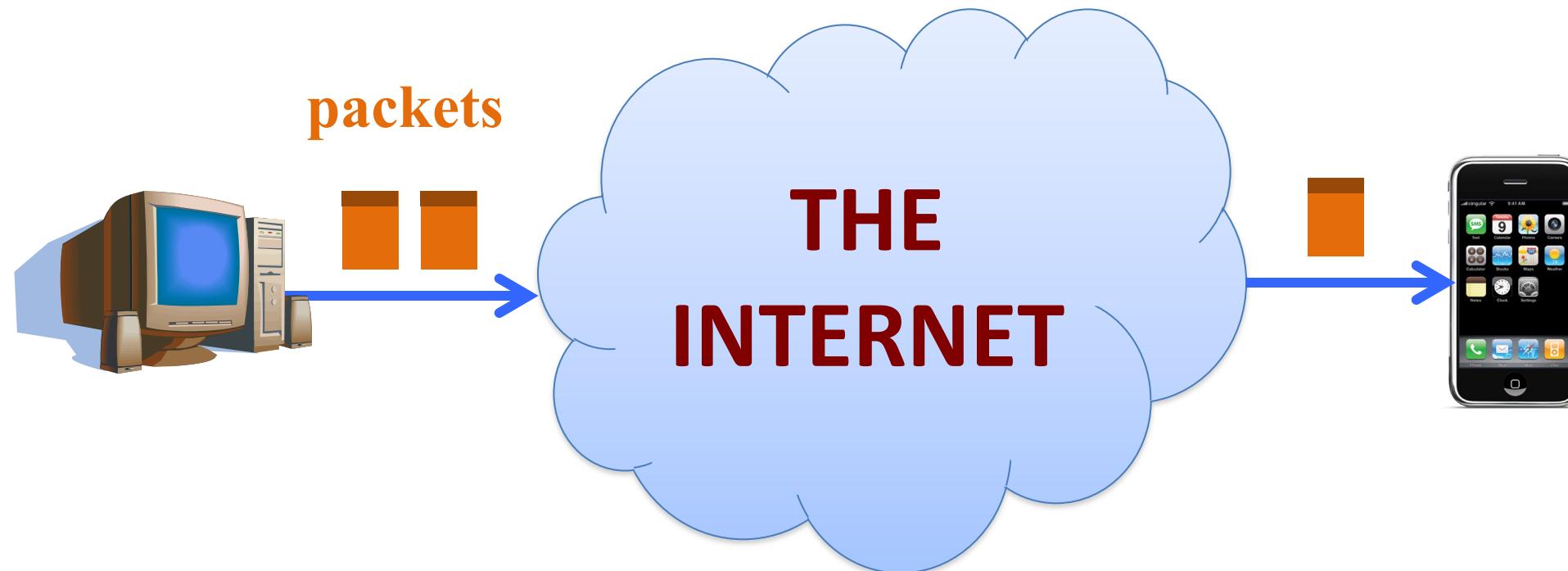
What is the Internet?

<http://en.wikipedia.org/wiki/Internet>

The Internet is the worldwide, **publicly accessible** network of interconnected computer networks that transmit data by **packet switching** using the **standard** Internet Protocol (IP).

It is a "**network of networks**" that consists of millions of smaller domestic, academic, business, and government networks, which together carry **various information and services**.

“Best-Effort Packet Delivery Service”



Power at the Edge

End-to-End Principle

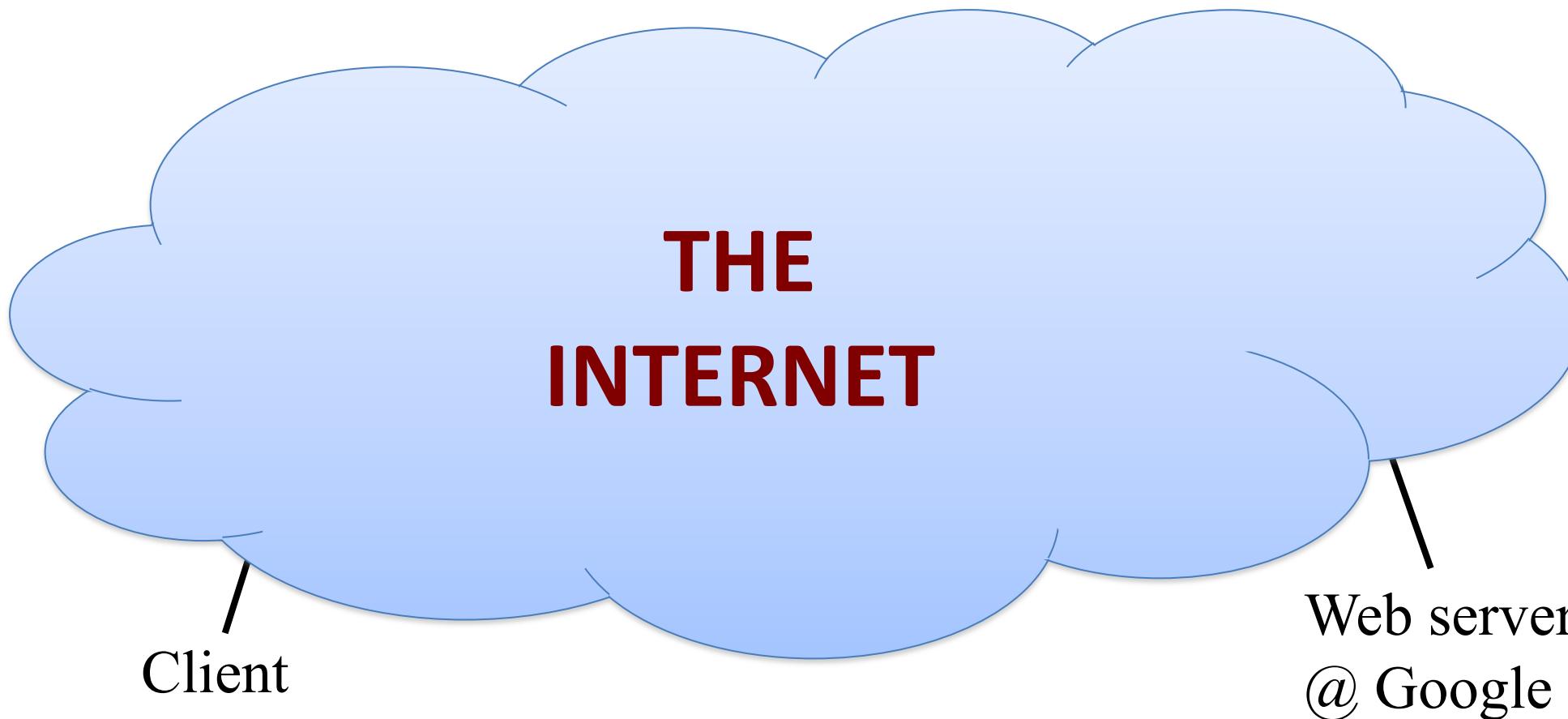
Whenever possible, communications protocol operations should be defined to occur at the **end-points** of a communications system.

Programmability

With programmable end hosts, new network services can be added at **any time, by anyone**.

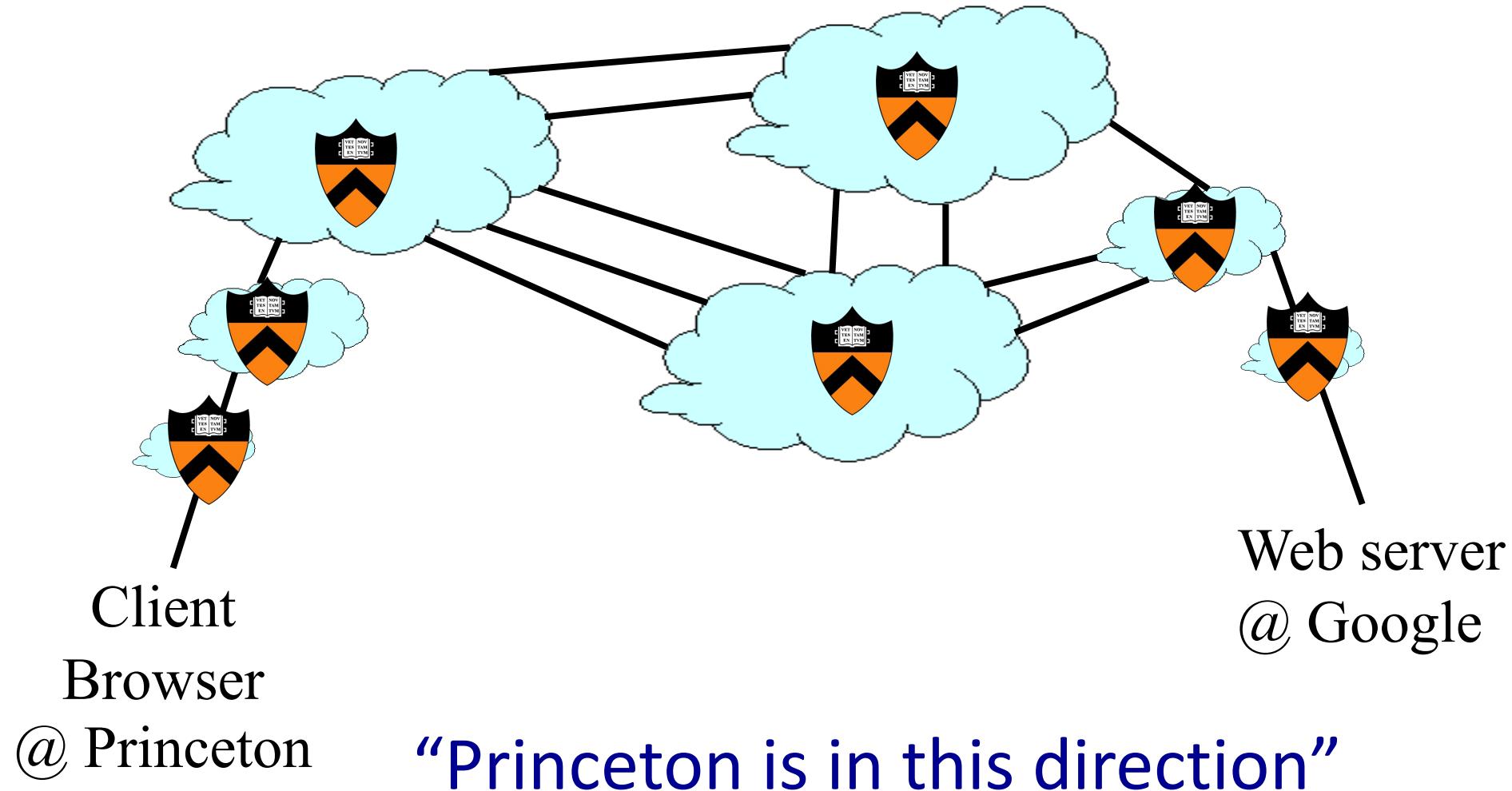
And end hosts became powerful and ubiquitous....

“A Network of Networks”

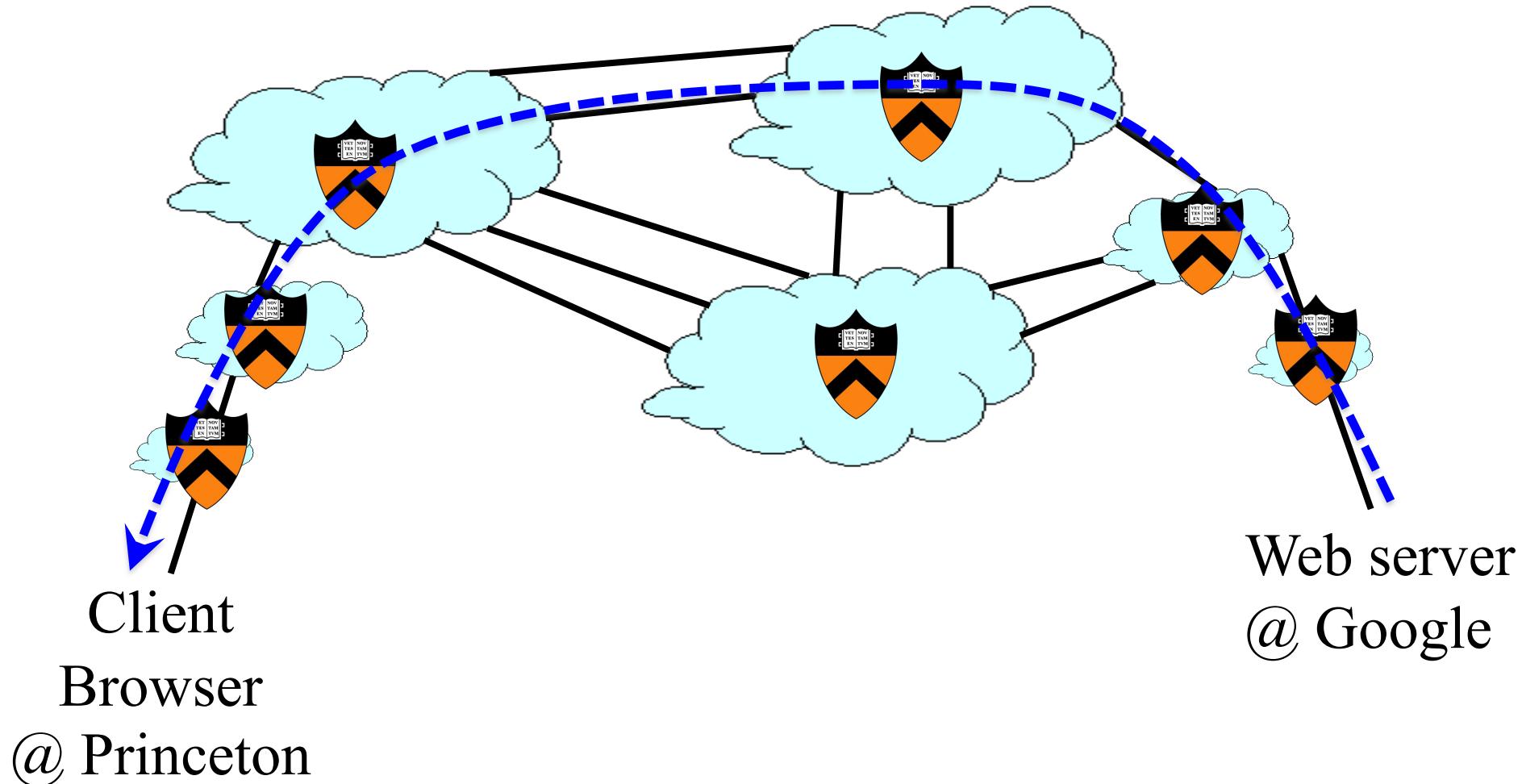


- How do you name?
- How do you find a name?

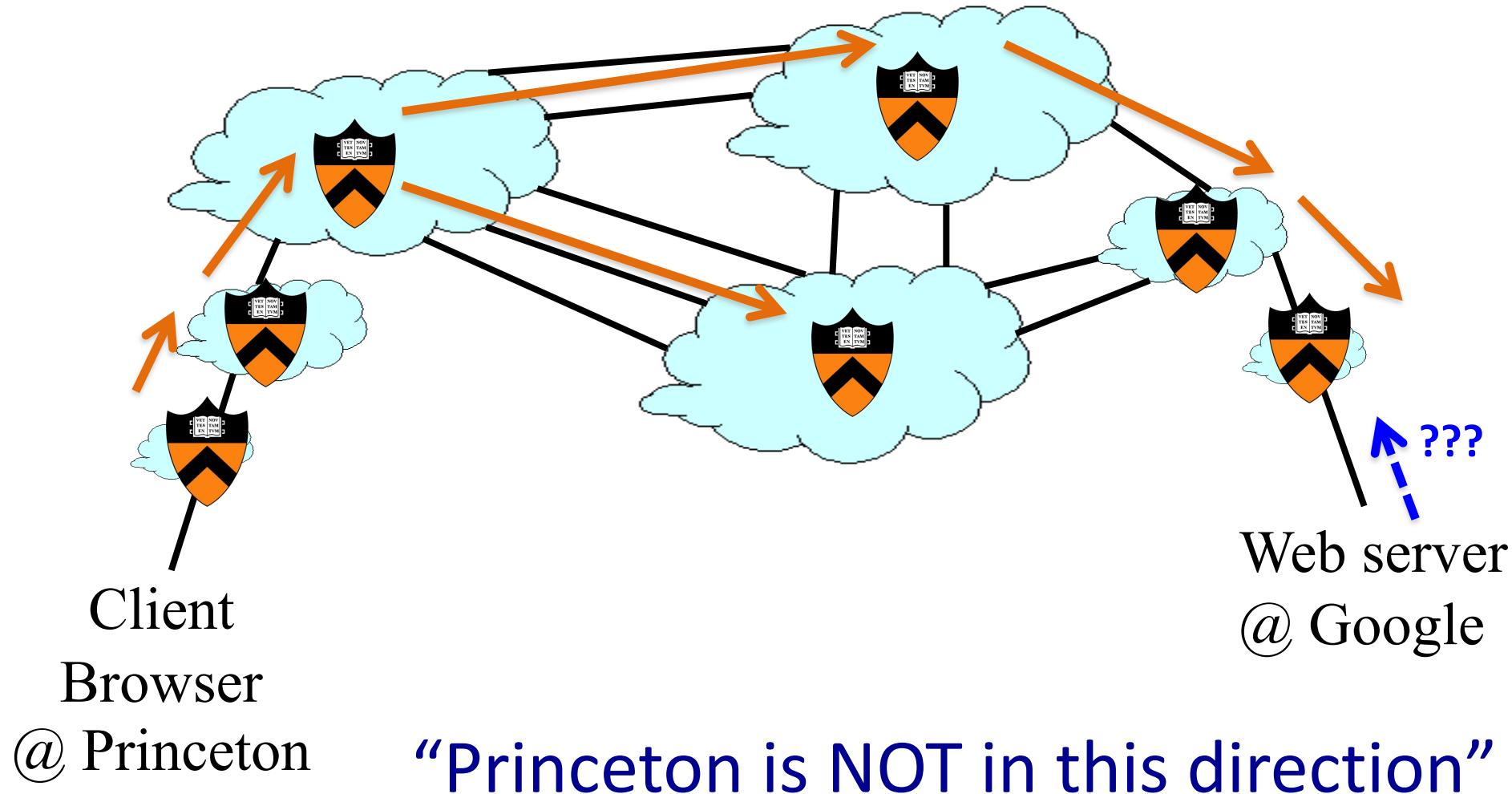
Announcing a Route



Forwarding Traffic



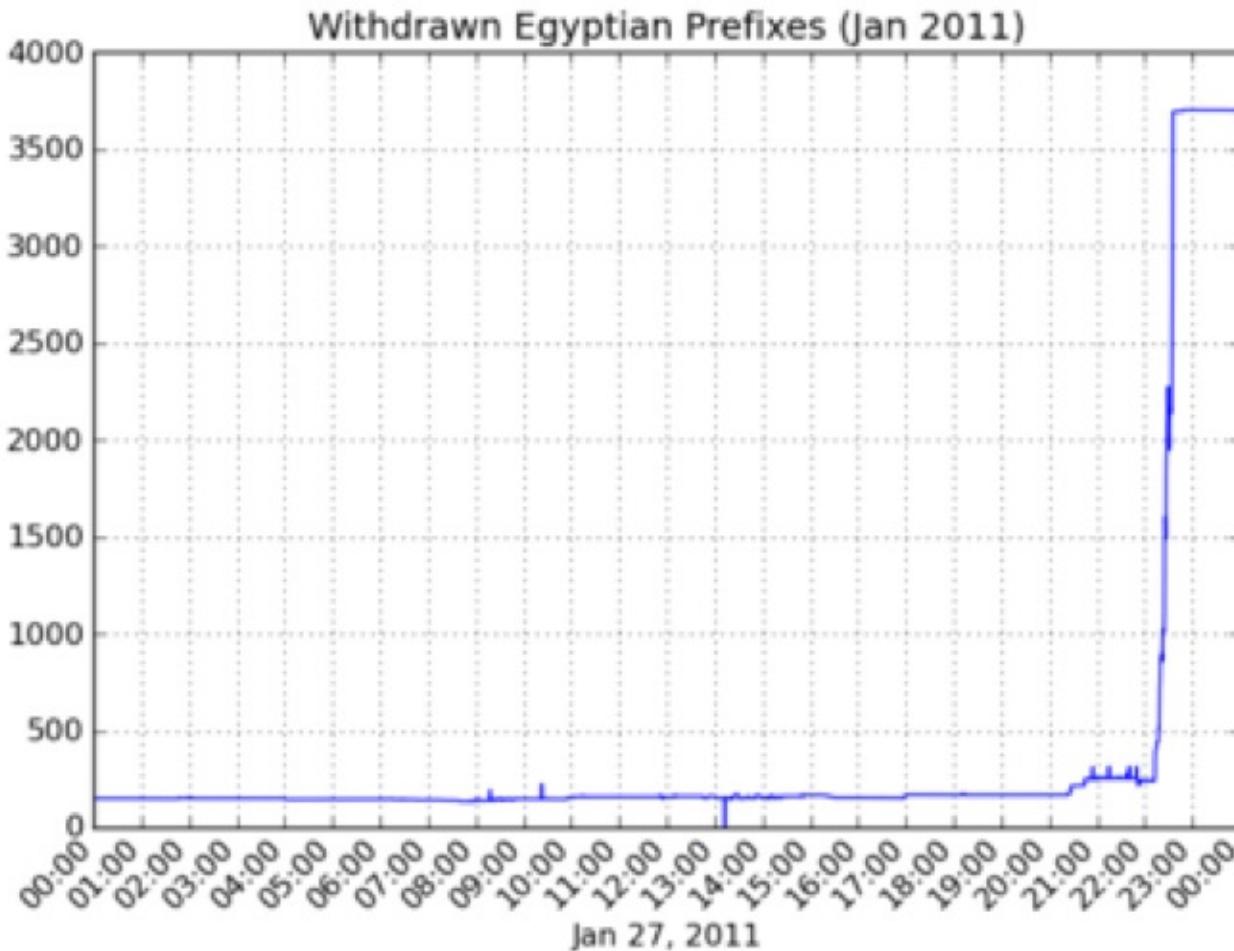
Withdrawing a traffic route



Egypt Leaves the Internet

By James Cowie on January 27, 2011 7:56 PM

At 22:34 UTC (00:34am local time), Renesys observed the virtually simultaneous withdrawal of all routes to Egyptian networks in the Internet's global routing table. Approximately 3,500 individual BGP routes were withdrawn, leaving no valid paths by which the rest of the world could continue to exchange Internet traffic with Egypt's service providers. Virtually all of Egypt's Internet addresses are now unreachable, worldwide.



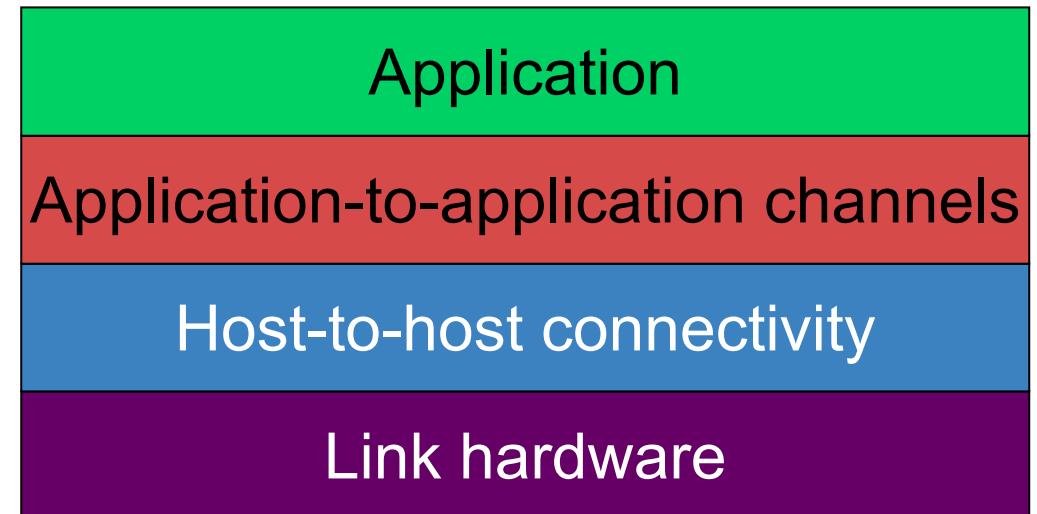
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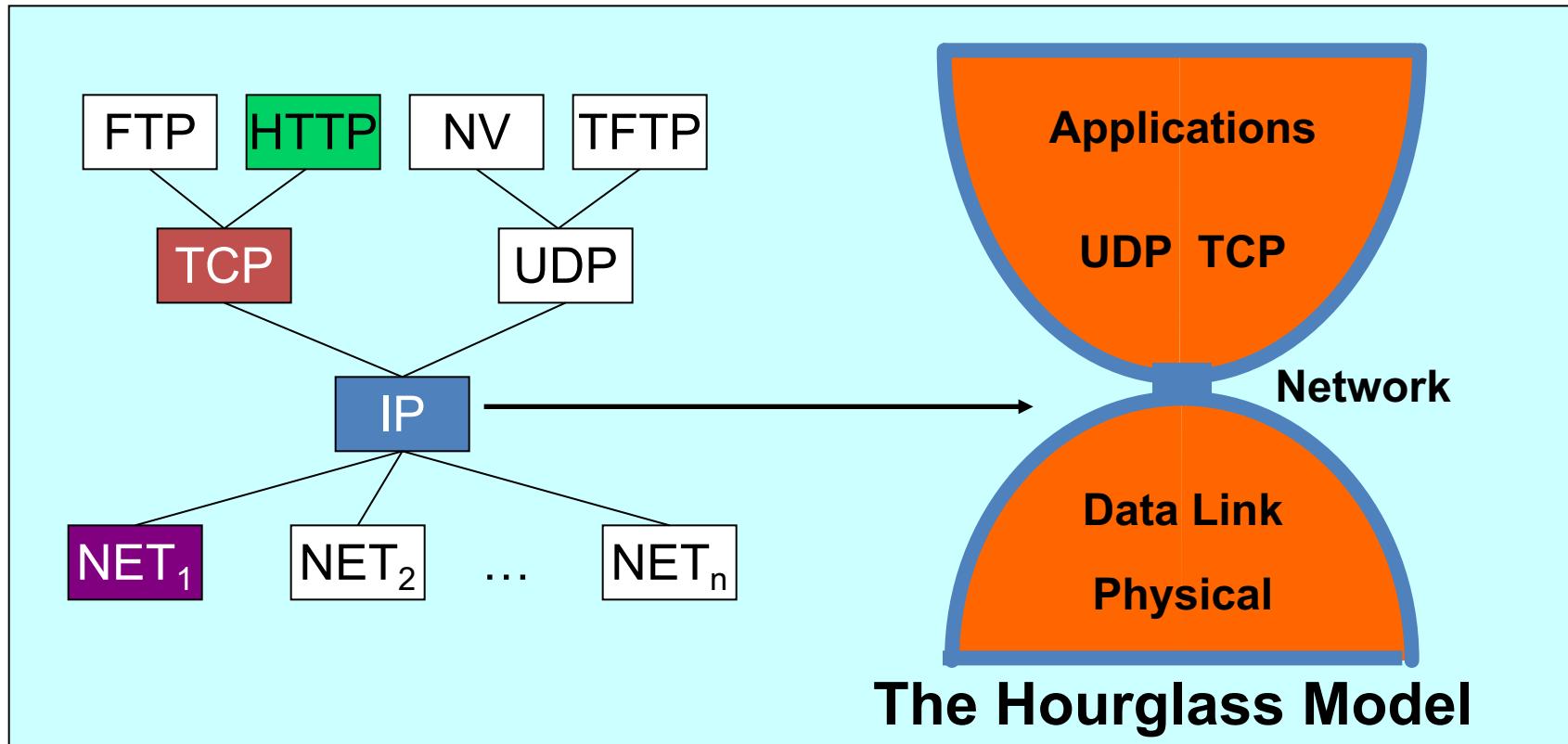
How does the design of the Internet
support **growth** and foster **innovation**?

Abstraction through Protocol Layering

- Layers partition the system
 - Each layer **solely** relies on services from layer below
 - Each layer **solely** exports services to layer above
- Interface between layers defines interaction
 - Hides implementation details
 - Layers can change without disturbing other layers



The Internet Protocol Suite



The thin Network layer facilitates **interoperability**

Application: HyperText Transfer Protocol

GET /courses/archive/spr20/cos461/ HTTP/1.1

Host: www.cs.princeton.edu

User-Agent: Mozilla/4.03

CRLF

Request

Response

HTTP/1.1 200 OK

Date: Mon, 4 Feb 2013 11:09:03 GMT

Server: Netscape-Enterprise/3.5.1

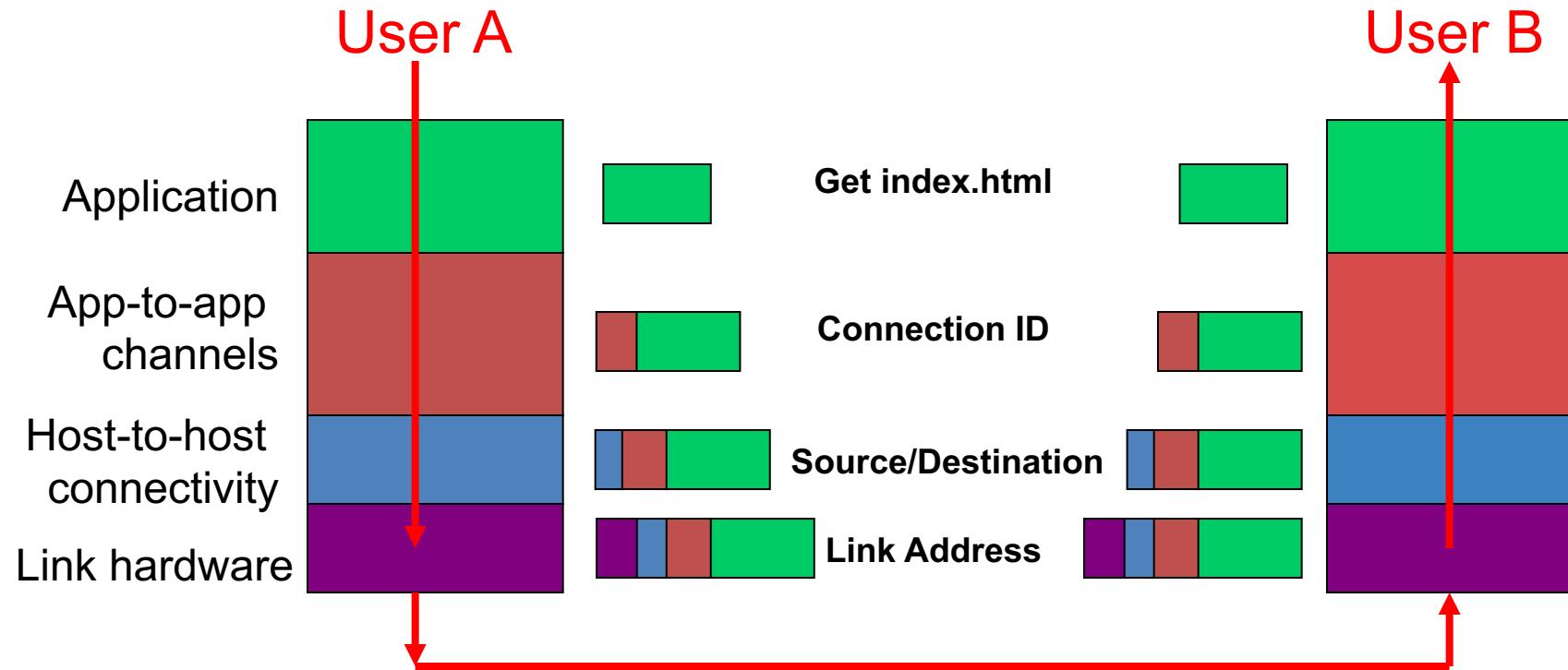
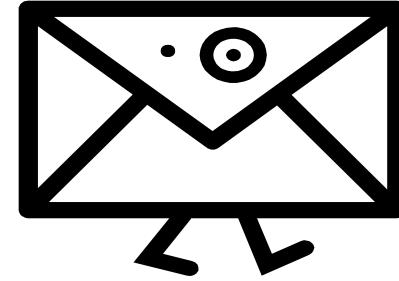
Last-Modified: Mon, 2 Feb 2013 19:12:23 GMT

Content-Length: 21

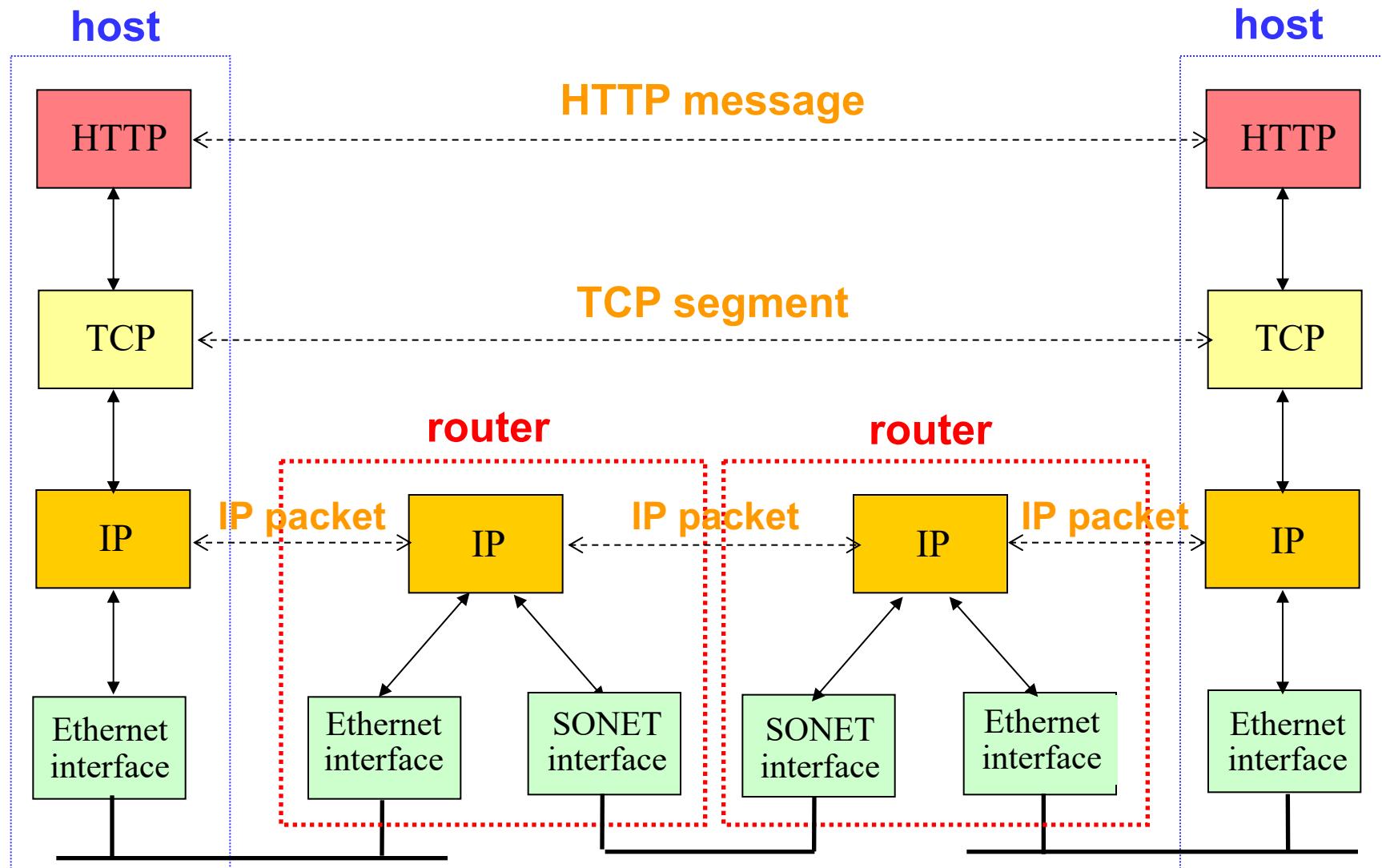
CRLF

Site under construction

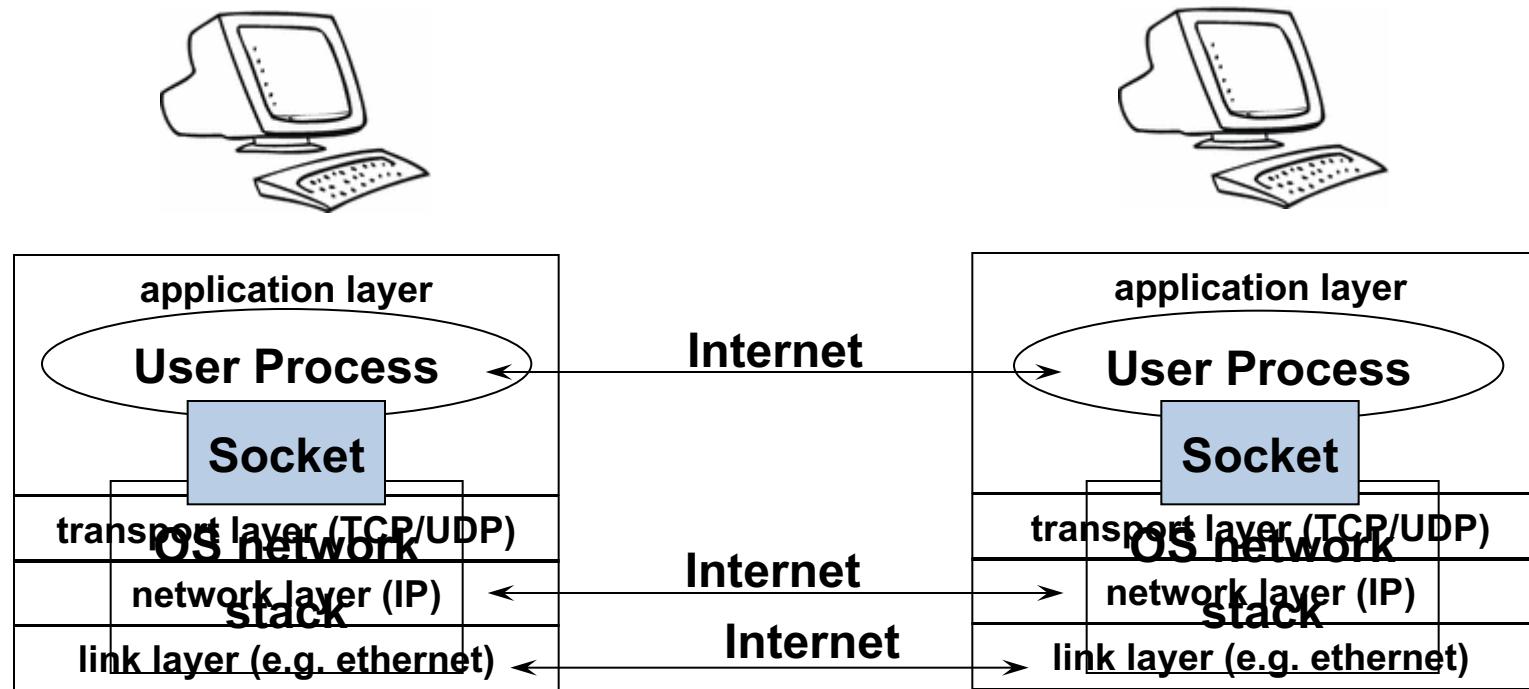
Layer Encapsulation in HTTP



End Hosts vs. Routers



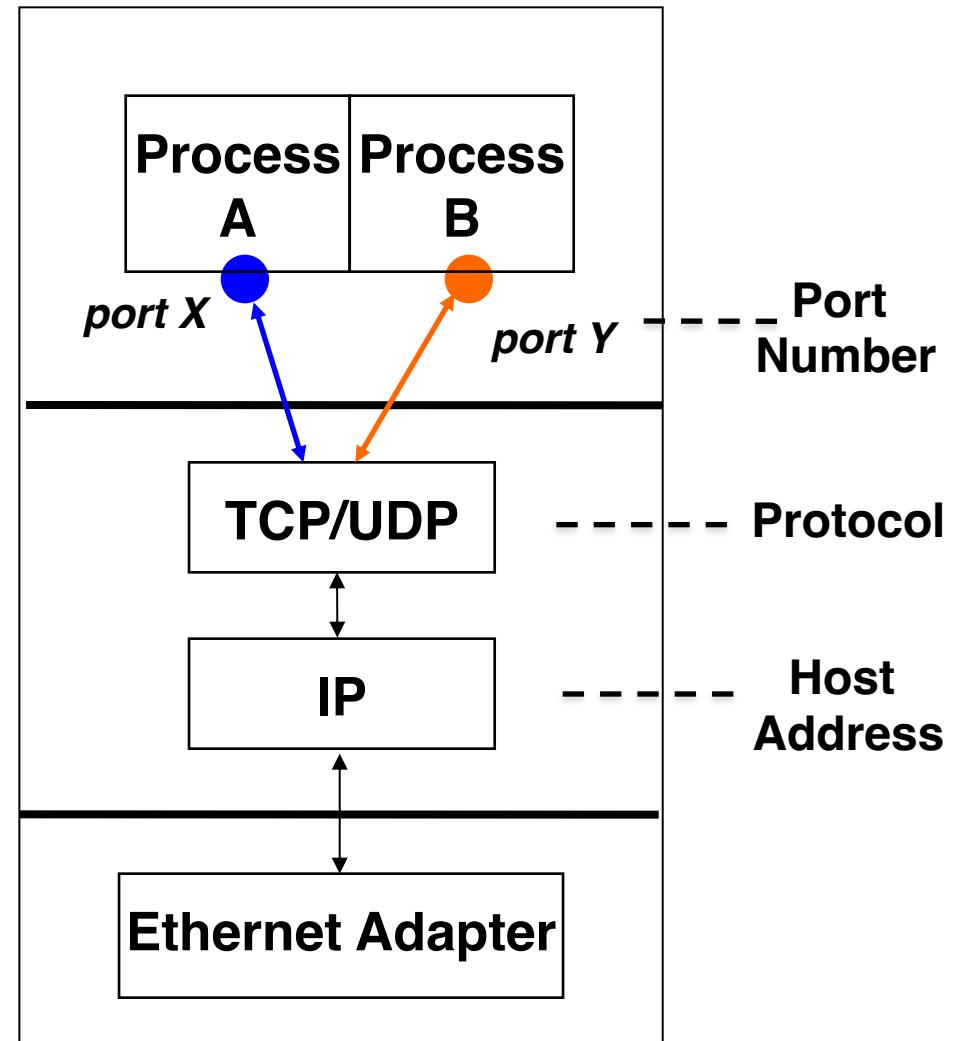
Socket and Process Communication



The interface that the OS provides to its networking subsystem

Socket and Process Communication

- Receiving host
 - Destination **address** that uniquely identifies host
 - **IP address**: 32-bit quantity (“1.2.3.4”)
- Receiving socket
 - Host may be running many different processes
 - Destination **port** that uniquely identifies socket
 - **Port number**: 16-bits (“80”)



Key Concepts in Networking

- Naming
 - What to call computers, services, protocols, ...
- Layering
 - Abstraction is the key to managing complexity
- Protocols
 - Speaking the same language
 - Syntax and semantics
- Resource allocation
 - Dividing scarce resources among competing parties
 - Memory, link bandwidth, wireless spectrum, paths

Today

1. Origins of the Internet
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461: What You Learn in This Course

- **Knowledge:** how the Internet works, and why
 - Protocol stack: link, network, transport, application
 - Resource allocation: congestion control, routing
 - Applications: Web, P2P, ...
 - Networks: enterprise, cloud, backbone, wireless, ...
- **Insight:** key concepts in networking
 - Naming, layering, protocols, resource allocation, ...
- **Skill:** network programming
 - Many nodes are general-purpose computers
 - Can innovate and develop new uses of networks

561: What You Learn in This Course

- **Knowledge:** how the Internet works, and why
- **Insight:** key concepts and state of the art in networking
 - Naming, layering, protocols, resource allocation, ...
 - Discuss classic & state of the art networking research papers, in depth. Tied to lecture topics in 461
- ~~**Skill: network programming**~~
- **Skill: network research**
 - Semester systems-building/research project, in groups
 - Reproduce a result (more common), or build a novel project

Course Organization: 461, 561

Full Information: See Class Meeting

Learning the Material: 461 & 561 Class Meetings

- **461** attend class meeting, view lectures, participate in Q&A
 - Recommendation: print slides and take notes
 - Not everything covered in class is on slides
 - You are responsible for everything covered in class
- **561** is responsible for all 461 lecture material, but not required to attend 461 class meeting or Q&A

Learning the Material: Precepts

- 461 precepts focus on programming assignments
 - Led by TAs
- 561 precepts discuss papers in depth
 - Discuss 1 research paper in depth each week; 5 *insightful* comments due on Perusall the evening before each precept (i.e., Thursday)
 - Topic will relate to that week's 461 lectures, but assumes 461 content as background
 - Precept attendance is critical
 - Let instructors know if you must miss, accommodations made

Learning the Material: Textbooks

- Main textbook
 - *Computer Networks: A Systems Approach*, by Peterson and Davie
 - Also online: <https://book.systemsapproach.org/>
- Additional books (may be of interest)
 - Networking textbooks
 - *Computer Networking: A Top-Down Approach Featuring the Internet*, by Kurose and Ross
 - *Computer Networks*, by Tanenbaum
 - Network programming references
 - *TCP/IP Illustrated, Volume 1: The Protocols*, by Stevens
 - *Unix Network Programming, Vol 1: Sockets Networking API*, by Stevens, Fenner, & Rudolf

Coming up in 461

- Lecture 2: Link Layer
- Lecture 3: Network Layer
- Lecture 4: Network Devices – Switches and Routers