

# Information Technology in Business and Society

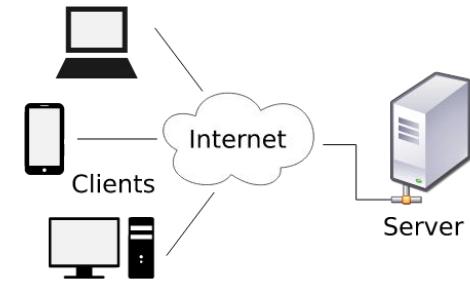
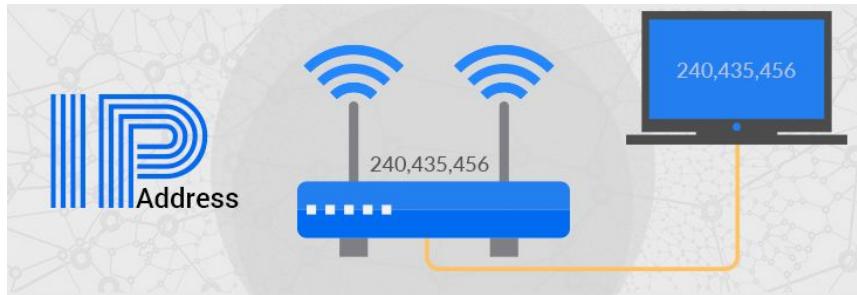
## - Internet & PageRank

Pearl Yu



# Some Motivations

- Hear about these terms all the time. But what do they mean?



You'll understand all  
these in half an  
hour.

# Some Motivations

- Kinda amazing how the Internet literally connects the whole world.
- How does it work?



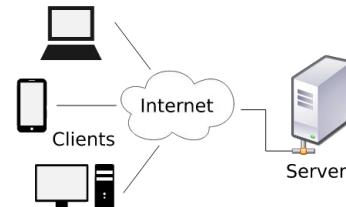
**FROM 1G TO 5G**

**How the Internet Has Changed the World**

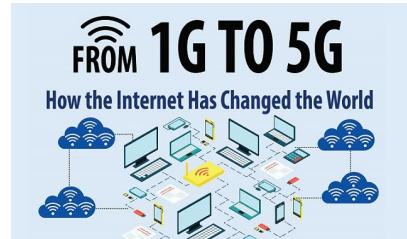


# Some Motivations

- Hear about these terms all the time. But what do they mean?



- Kinda amazing how the Internet literally connects the whole world. How does it work?



- We want to simplify the super detailed technical details.

# Outline - Technical Aspect of Internet

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- Network structure
- Network Protocols
- WWW
- Ranking & Evaluating the importance of web pages
- Characteristics of the Internet

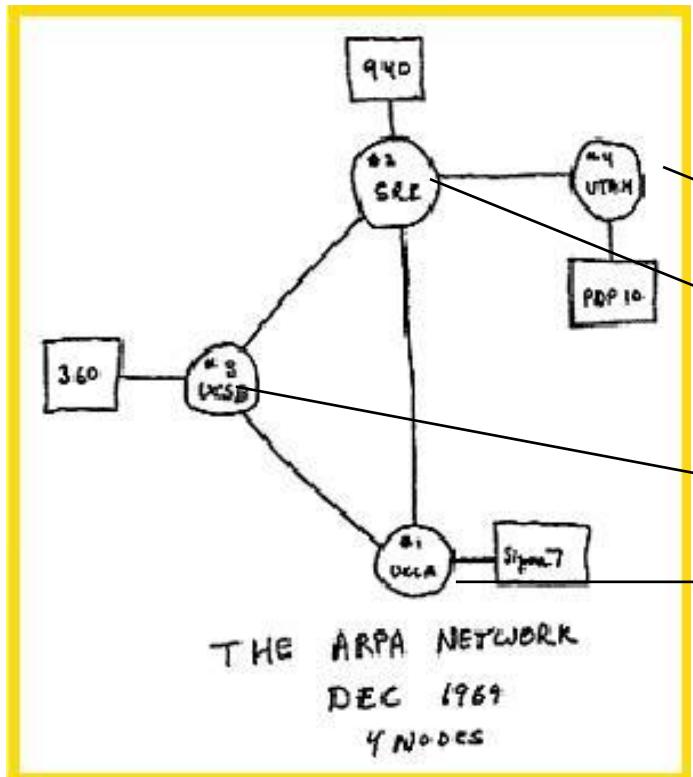
# What is Internet?



- A very large set of **computers** that follow communication **protocols**
- All **connected** to each other (hence a “network”)
- Information exchange between two computers may pass through several other computers

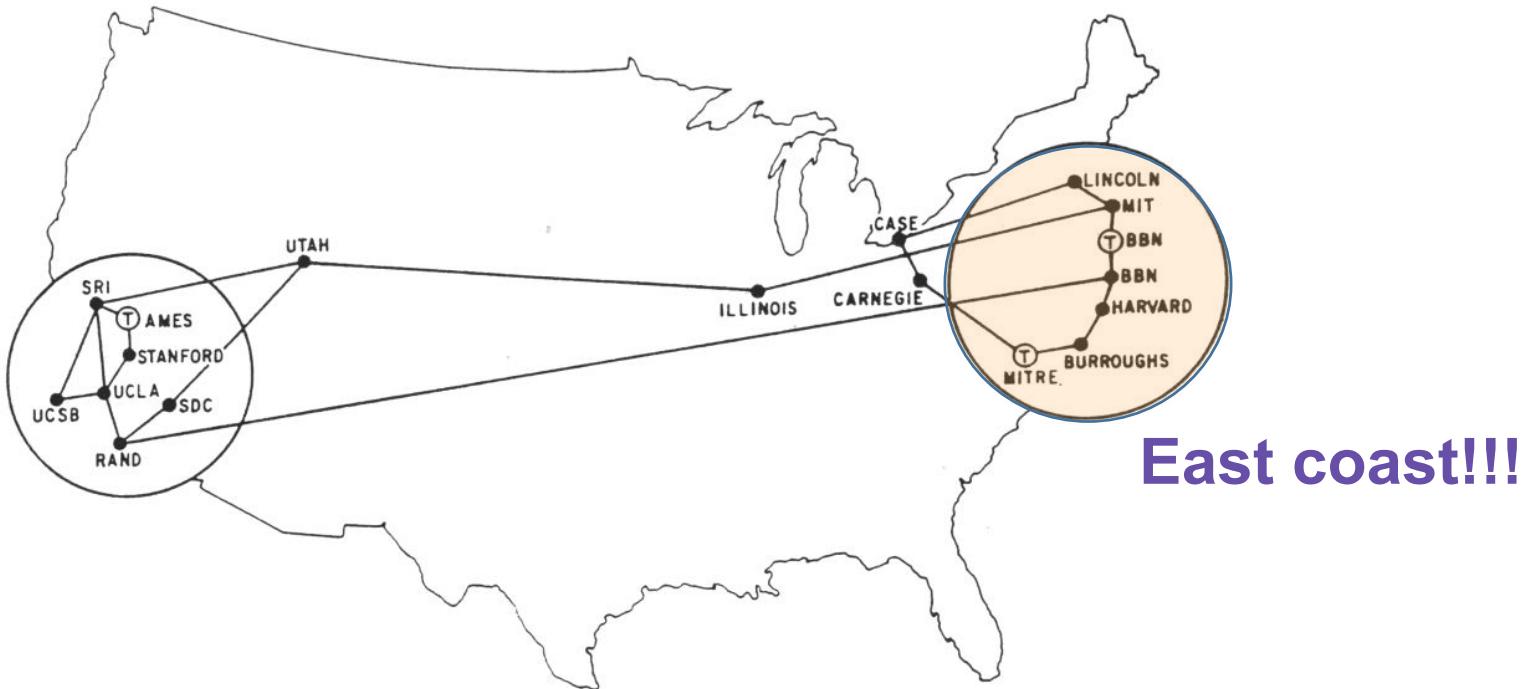
## The Origin: ARPA 1969

- Developed under the U.S. Advanced Research Projects Agency (ARPA).



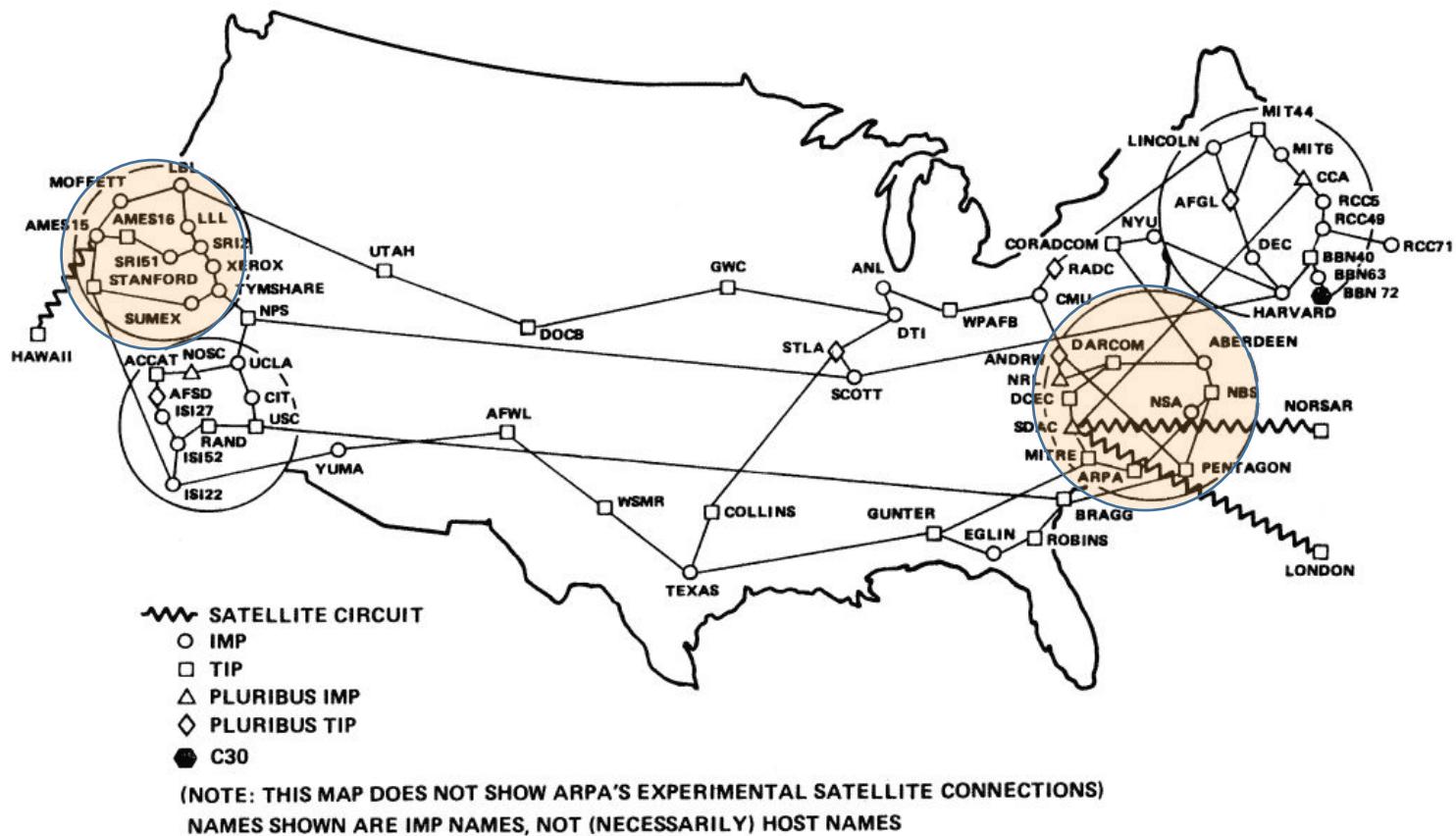
**Interface Message Processors (IMPs) –** packet switching nodes used to connect to ARPANET

# ARPANET 1971

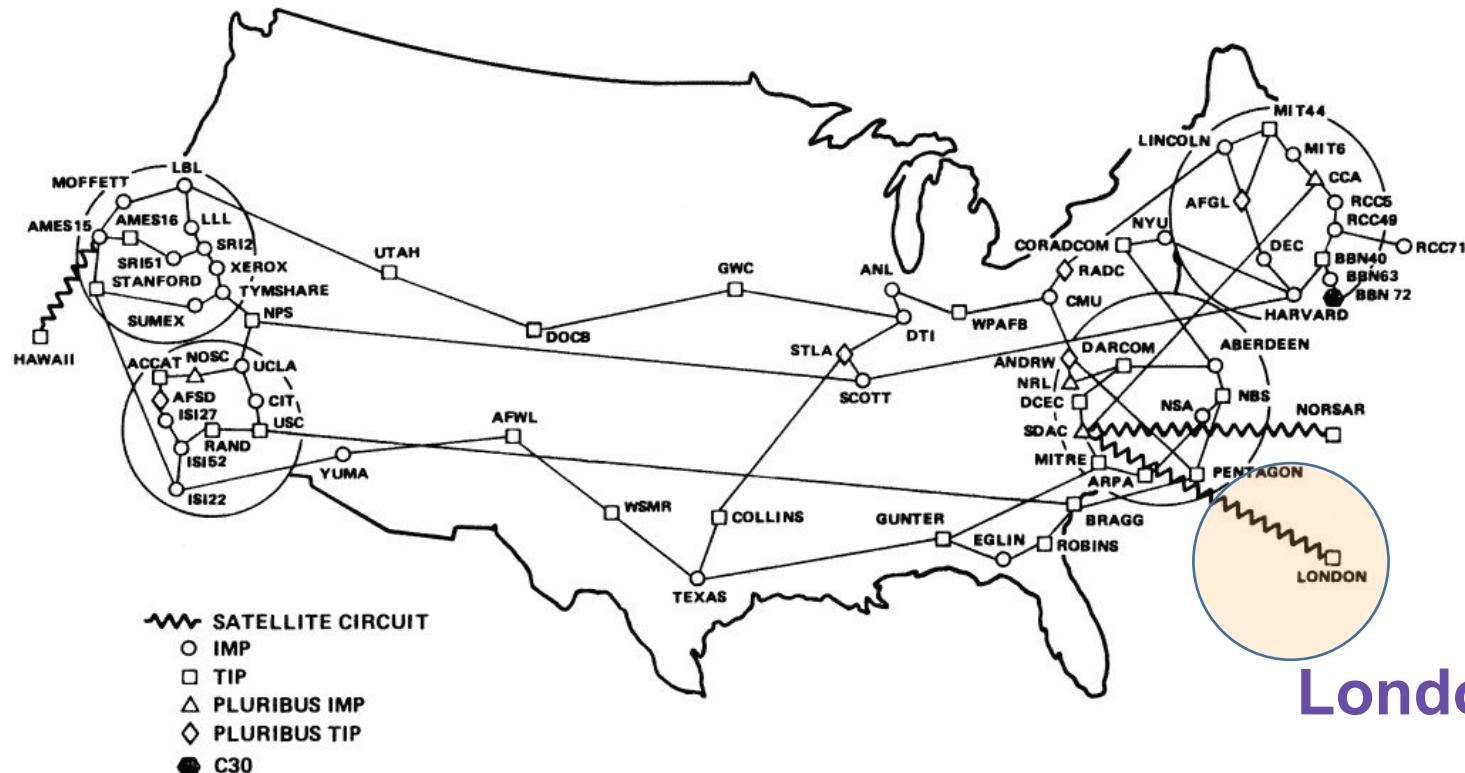


MAP 4 September 1971

# ARPANET 1980



# ARPANET 1980



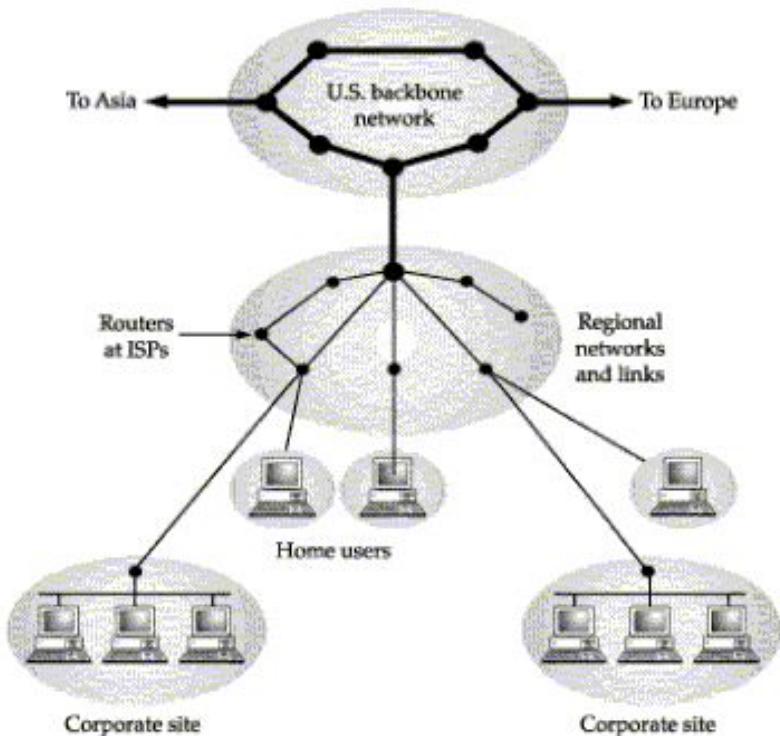
London!!!

# Internet Structure

Objective:

Understand the hierarchical structure of the Internet

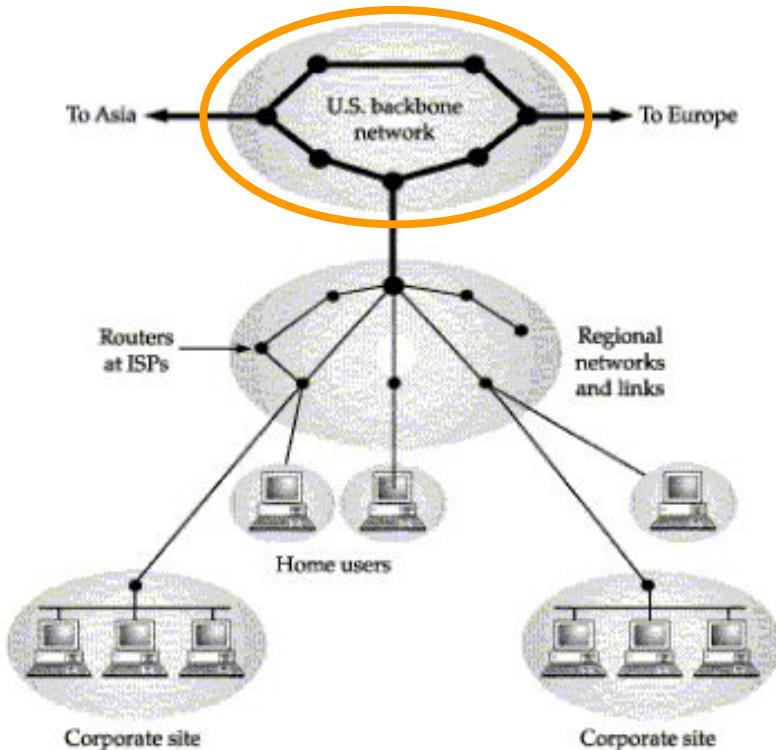
# Basic Structure of the Internet



## Hierarchy of the Internet networks:

- Backbone
- ISP (Internet Service Provider) networks
- Local access networks

# Basic Structure of the Internet



## Hierarchy of the Internet networks:

- **Backbone:** High speed, Connects continents, cities, countries, with network access points.



AT&T

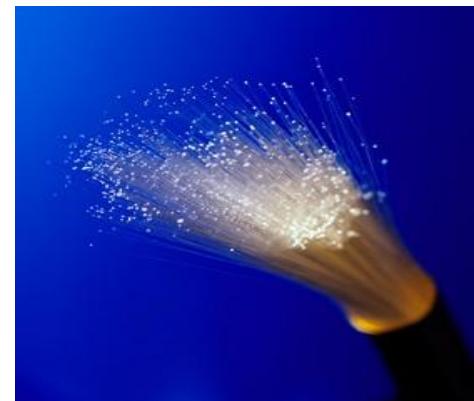
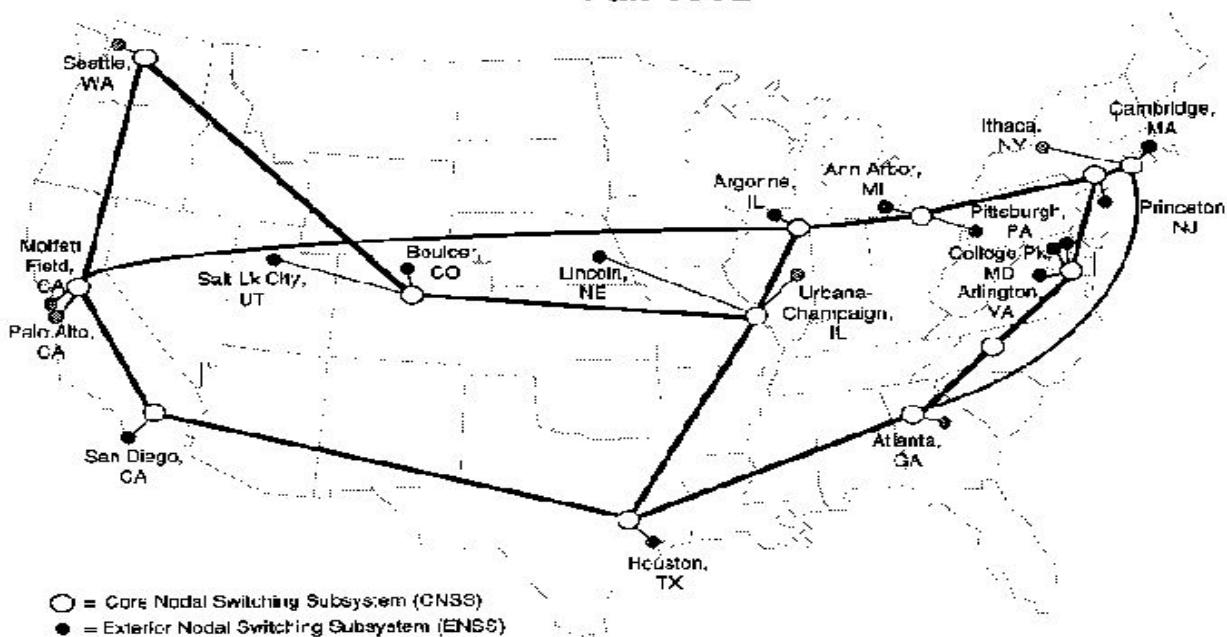


Level(3)<sup>®</sup>

# Backbone network

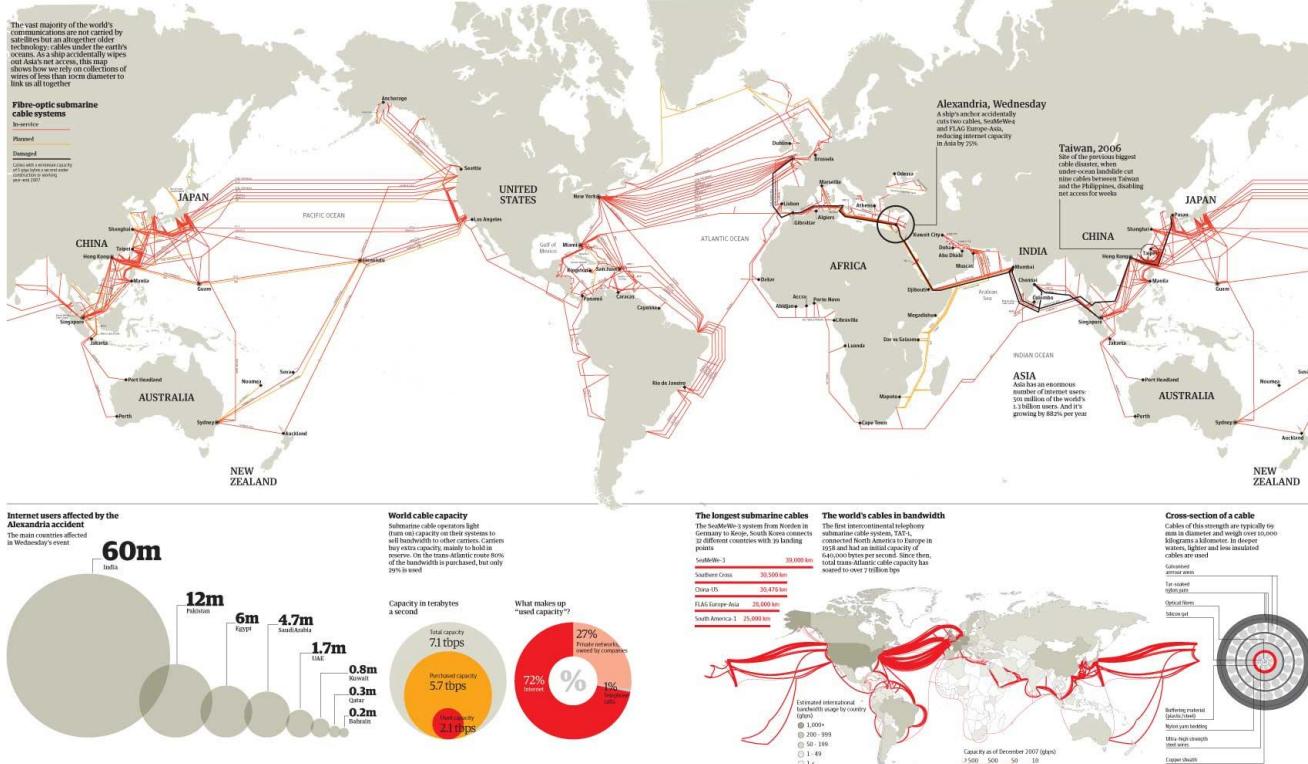
- Backbones are fiber optic cables that are buried underneath

**NSFNET T3 Backbone Service**  
**Fall 1992**



# Global Internet Backbone

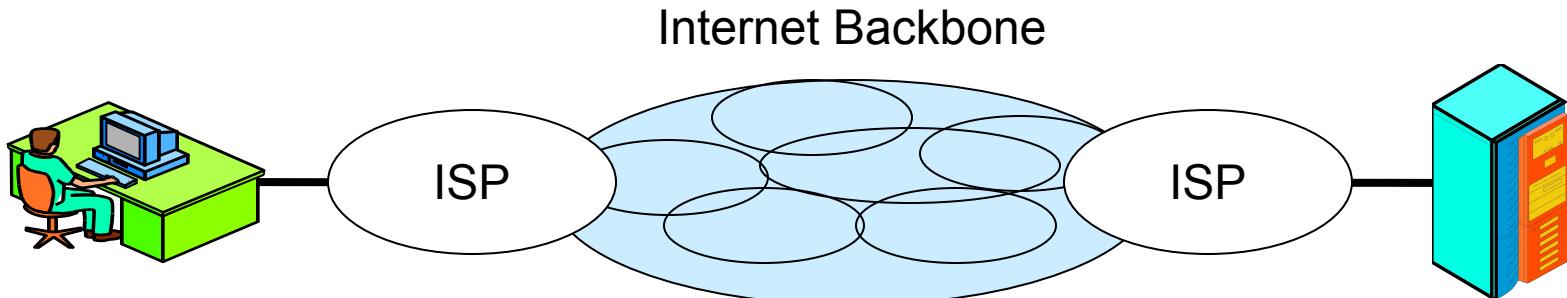
## The internet's undersea world



SOURCE: TELEGRAPH.COM SUBMARINE CABLE MAP 2006. INTERNET STATISTICS FROM INTERNET BACKBONE.COM

# Internet Backbone - Network Access Point

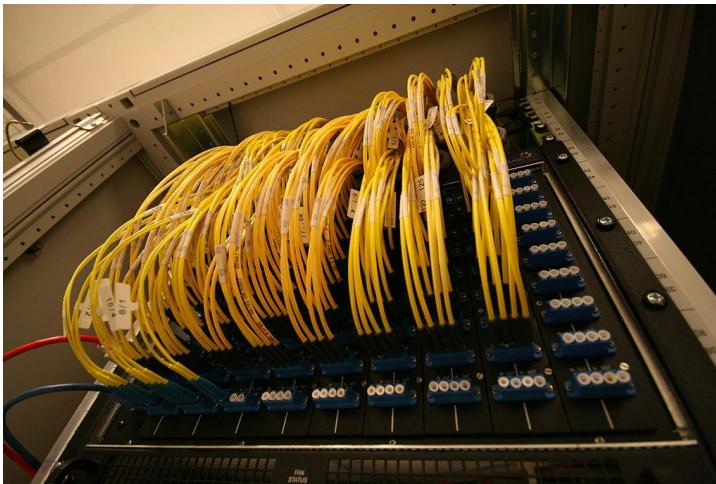
- The backbone of the Internet actually consists of sections of high-speed fiber-optic cabling that are owned by different carriers (including AT&T, Sprint, and MCI WorldCom).
- NAPs are places at which these carriers **interconnect their lines** so that the Internet can function as a single entity.
- NAPs contain high-speed **switching facilities** for transferring traffic from one carrier's lines to another's.



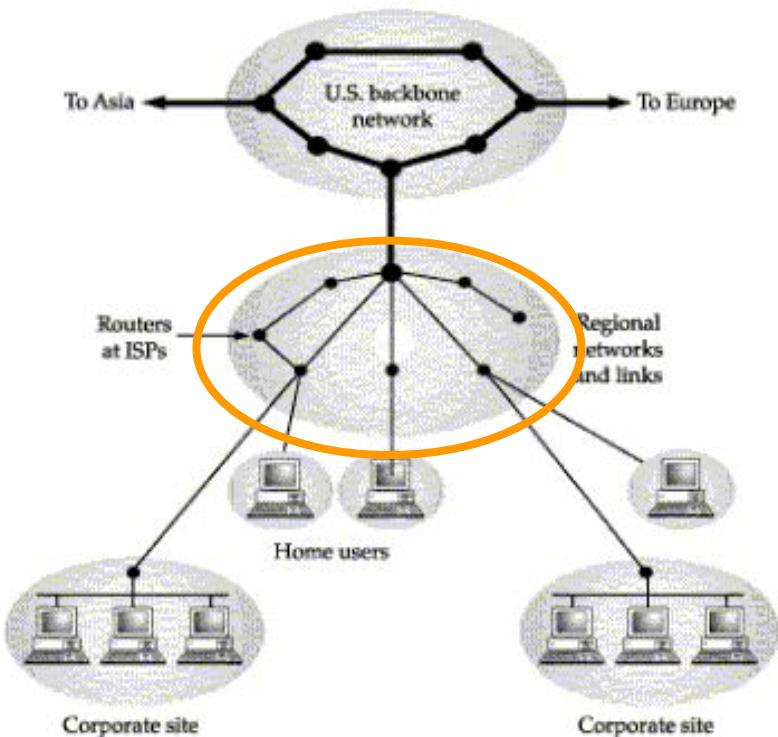




VERIZON TERREMARK



# Basic Structure of the Internet



## Hierarchy of the Internet networks:

- **Backbone:** High speed, Connects continents, cities, countries, with network access points.
- **ISP (Internet Service Providers):** Companies that connect local areas to backbone (typically providing access to consumers)



COMCAST



Spectrum

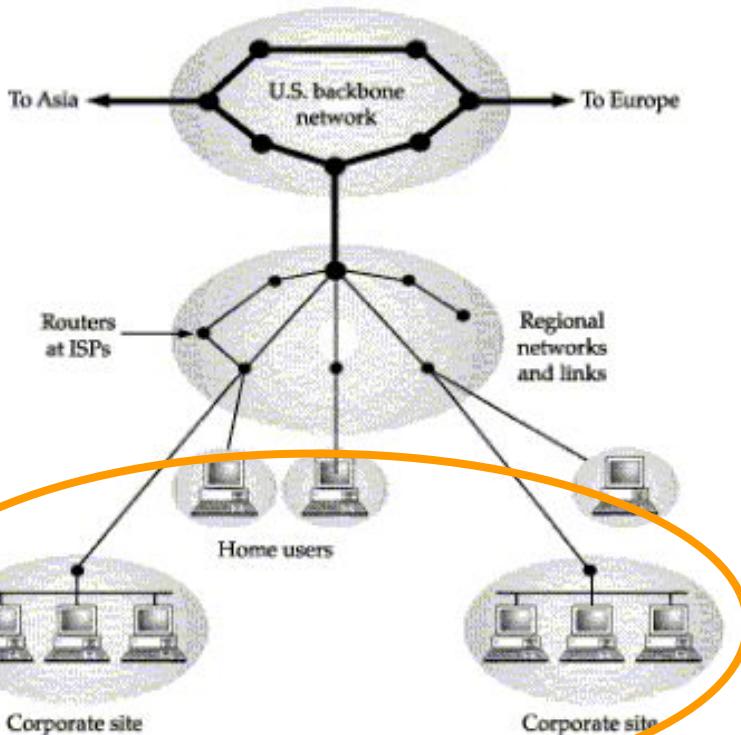


Charter  
COMMUNICATIONS



Time  
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# Basic Structure of the Internet



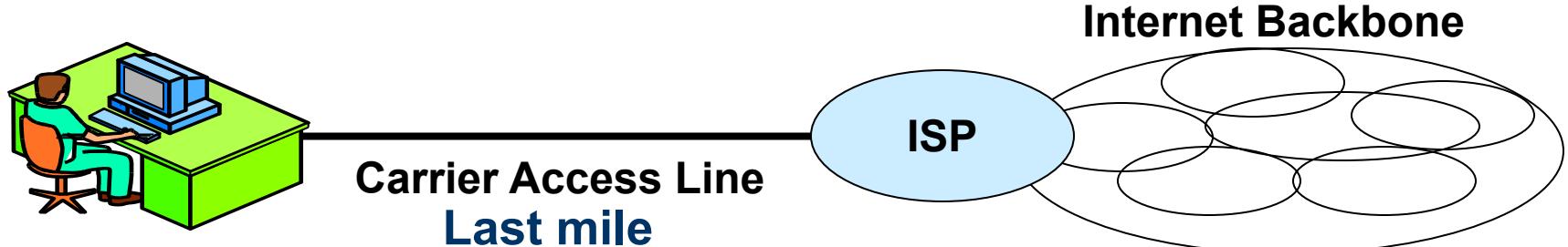
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- **Backbone:** High speed, Connects continents, cities, countries, with network access points.
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- **Local access networks:** Access to individual computers

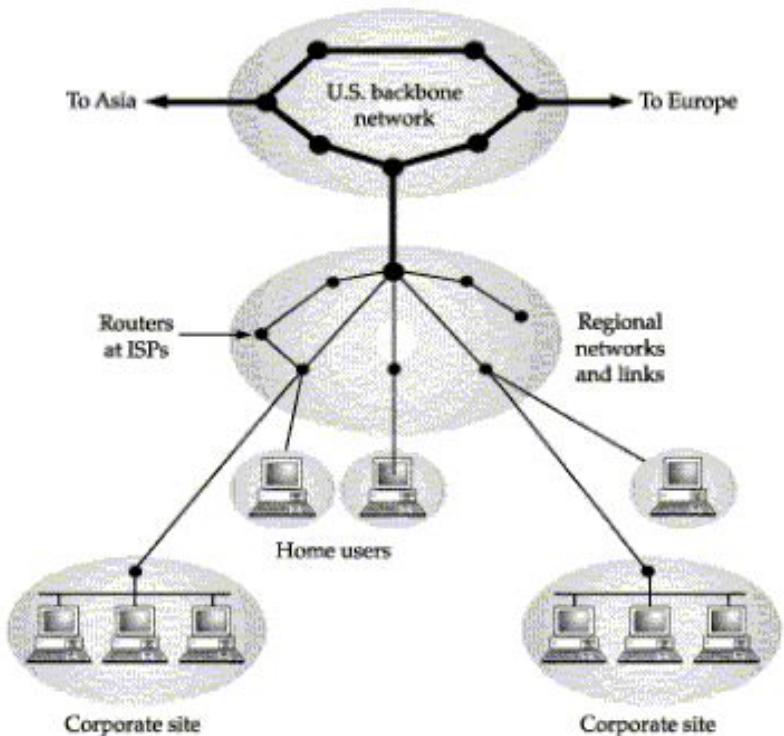
# The Last Mile

## *Carrier Access Line*

- Usually provided by local telephone or Cable TV carrier
- Connects you to the ISP's PoP (Point of Presence, where *connections from the user are accepted and authenticated*)



# Basic Structure of the Internet

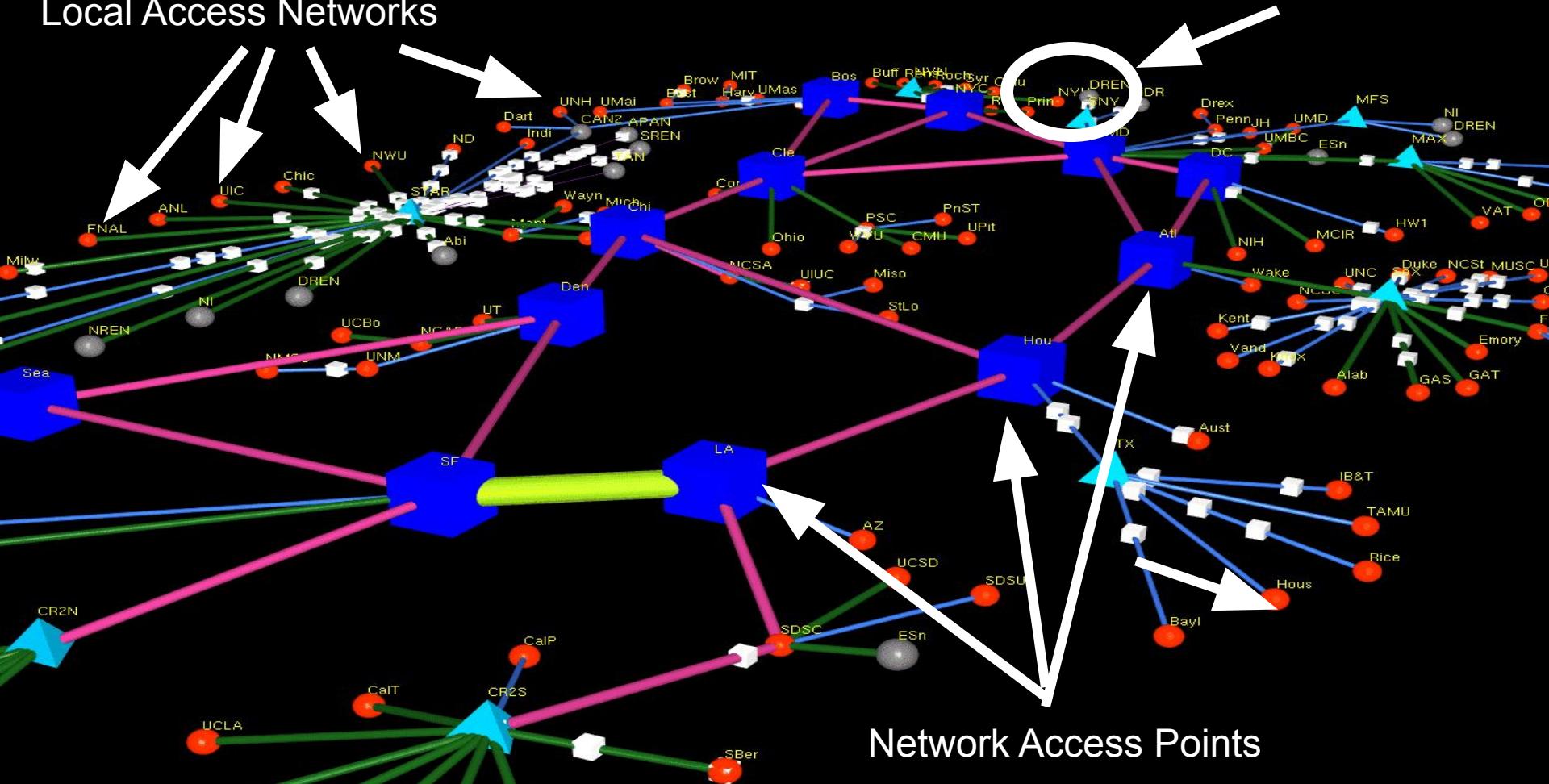


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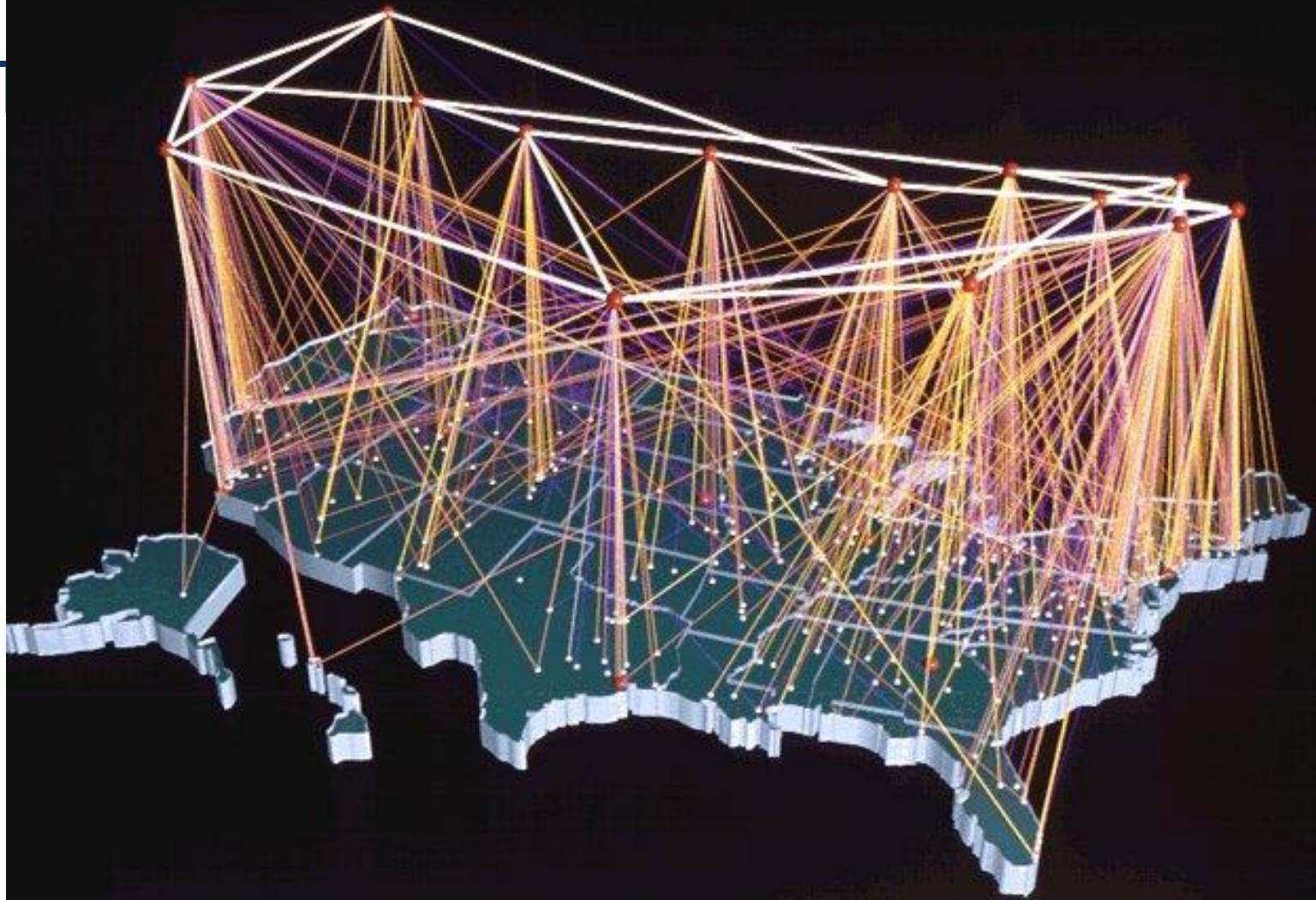
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Local Access Networks

We are here



Network Access Points



# What is Internet again?

[How mobile wireless internet works](#)



- A very large set of **connected** computers that follow communication **protocols**

# Internet Protocols

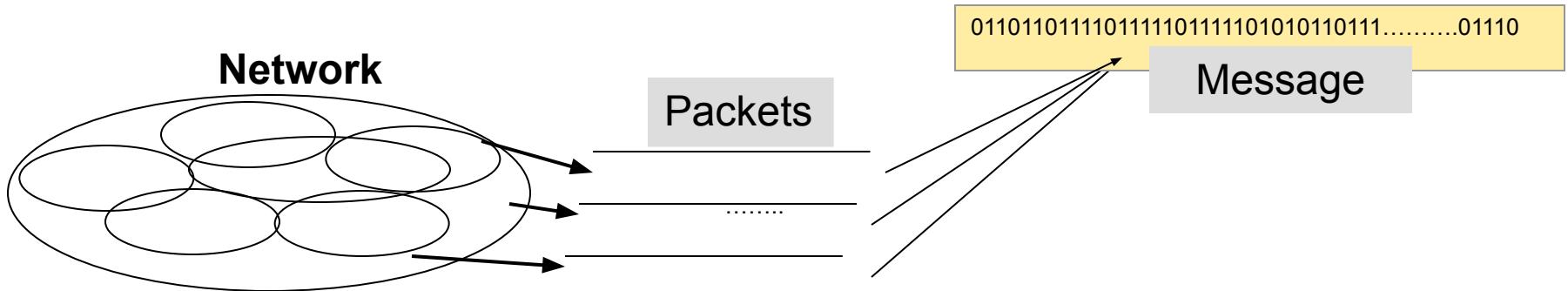
Objective:

How is data transmitted on the Internet?

# Data on the Internet

**Data is sent as a sequence of ‘packets’**

- Packetize => transmit => reassemble



# Rules for Data Transmission

*Effective communication requires rules:*

- Protocol: A set of rules for transmitting data between computers
- **TCP/IP:** Transmission Control Protocol (TCP) & the Internet Protocol (IP)

*The ‘rules’ in a protocol answer questions such as:*

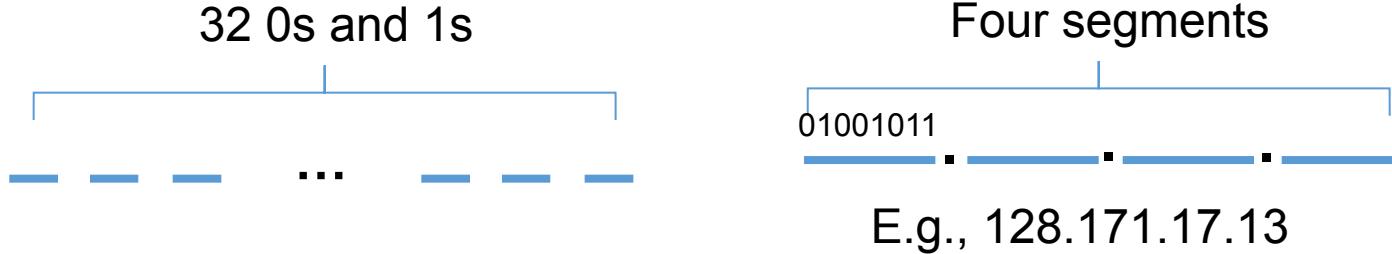
- How do I represent the address of the computer to send my packet to?
- Where do I forward the next packet I receive, if needed?
- How do I detect the beginning of a new packet?
- How do I detect an error in transmission?

*IP address:*

- 32-bit number given to each device connected to the Internet

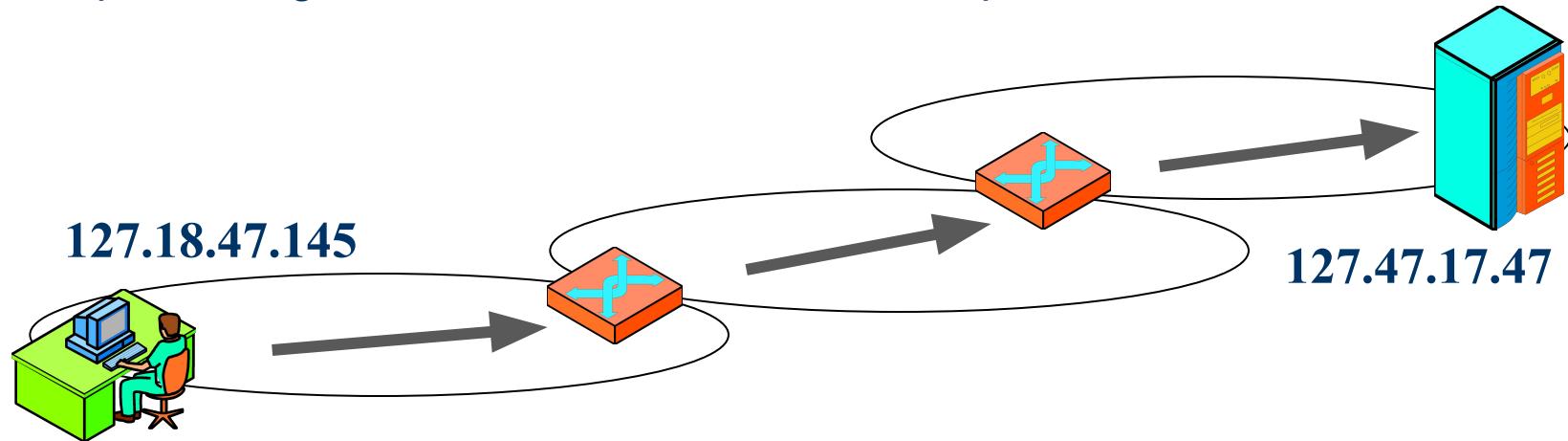
# IP Address

- Each Internet computer (host) has an IP address
  - Unique identifier: **32-bit binary number** given to each device connected to the internet
  - Break into 4 segments (32/4: each segment has 8 bits), separated by dots
  - Then each segment converted into a **decimal** number.



# IP Address

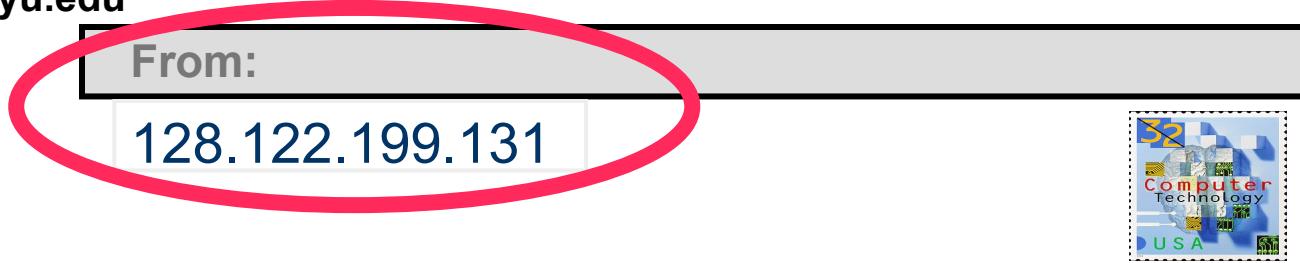
- Each Internet computer (host) has an IP address
  - Unique identifier: 32-bit binary number
  - IP names (e.g., www.nyu.edu) correspond to IP addresses
- Routers
  - Connect the Internet's individual networks (subnets)
  - Cooperate to give an end-to-end route for each packet



# TCP / IP

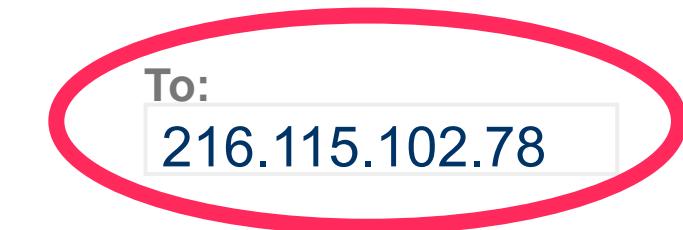
- TCP/IP basically defines how do you write the address, where do you put the address, what is the format of address etc.

[www.stern.nyu.edu](http://www.stern.nyu.edu)



**IPXpress**

Internet Delivery Envelope



[www.google.com](http://www.google.com)

# DNS: Domain Name System

- DNS maps IP names (www.nyu.edu) to IP addresses □ directory system
- A computer's IP name tells you a lot. e.g., the type of organization supporting the Website
- **Top-level domain: the last part of IP names**, e.g.,
  - com – commercial or for-profit business
  - edu – educational institution
  - gov – U.S. government agency
  - mil – U.S. military organization
  - net – Internet administrative organization
  - org – professional or non-profit organization
  - biz – business
  - pro – accountants, doctors, and lawyers, to start
- Internet Corporation for Assigned Names and Numbers (ICANN) manages most top-level domains.

# The island nation of Tuvalu is being kept afloat by its domain name

— OUR tiny neighbouring nation of Tuvalu is ticking along thanks to millions in revenue from two tiny letters: .tv.

Samantha Beech

News Corp Australia Network • MARCH 7, 2016 6:16AM

OUR tiny neighbouring nation of Tuvalu is ticking along thanks to millions in revenue from two tiny letters: .tv.

Tuvalu's unique country code domain name, ".tv", attracts interest from many individuals, entities and television companies around the world.

According to *Domain Typer*, some have been willing to pay big bucks for internet addresses such as pedestrian.tv or Hollywood.tv. The scheme got off to a rough start, but it's now the South Pacific nation's largest source of income.



Tiny Tuvalu ... Aerial view of the South Pacific Islands of Tuvalu Picture: Google Earth Source:News Corp Australia



advertisement

- Internet structure
- Internet Protocols

# Internet: Web

Objective:

What is world wide web

What are HTTP & HTML

# Internet vs. World Wide Web (WWW)

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- The World Wide Web works on top of the Internet infrastructure.

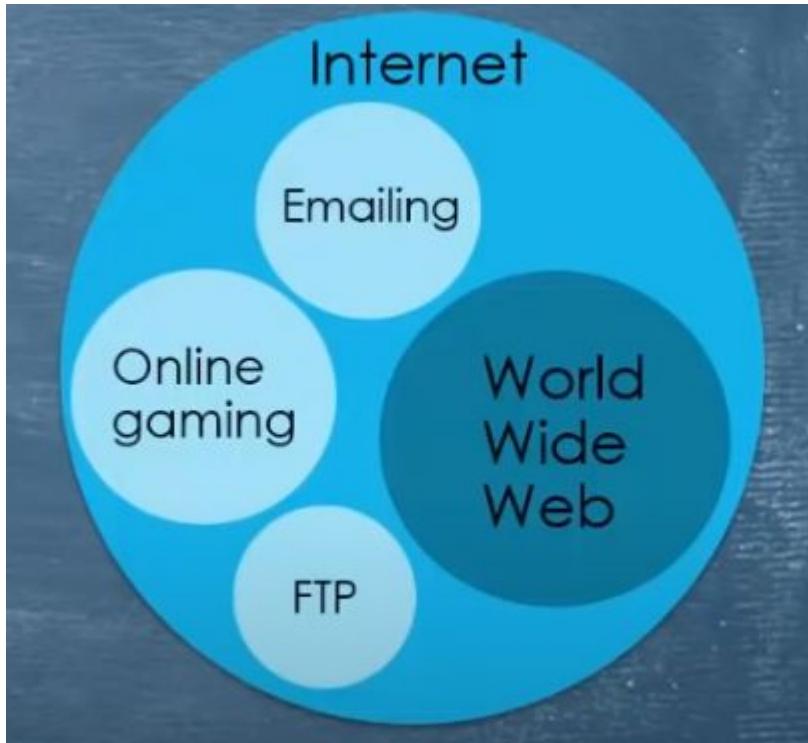
**Internet:** computers and wires for sharing information using a certain set of rules (TCP/IP protocol)

**Web:** information – a collection of websites

- a way of organizing files to be easily found and displayed using certain set of rules
- It follows a HTTP protocol (Hypertext Transfer Protocol)

# Internet vs. World Wide Web (WWW)

- The World Wide Web works on top of the Internet infrastructure.

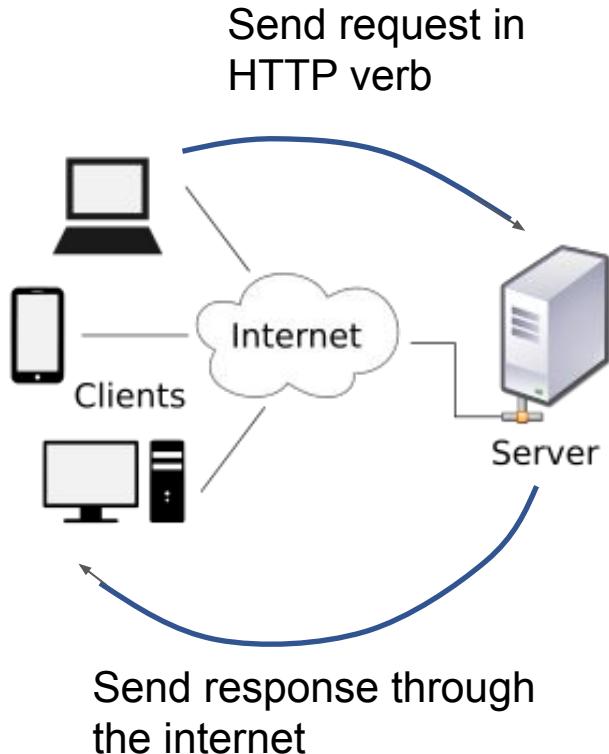


# HTTP

- **HTTP** Hypertext transfer protocol
  - The rules governing how computers should talk to one another.
  - The conversation happens through a Web **client** and a Web **server** model.
  - Specifies the **request–response interaction** between the client and the server.



# Client Server Architecture



**Clients:** The end devices.

In the case of web browsing, Clients are PCs (with software applications such as browsers that can make requests).

**Servers:** are **powerful computers** that can run server programs to offer functionality and services (such as website content) to the clients.

The server receives **requests** from the client, then **respond** to them.

# An HTTP conversation

## Client

I would like to open a connection

**HTTP format**

## Server

OK

GET <website information>

Send page or error message

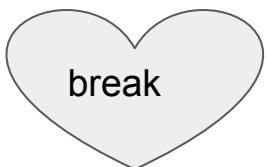
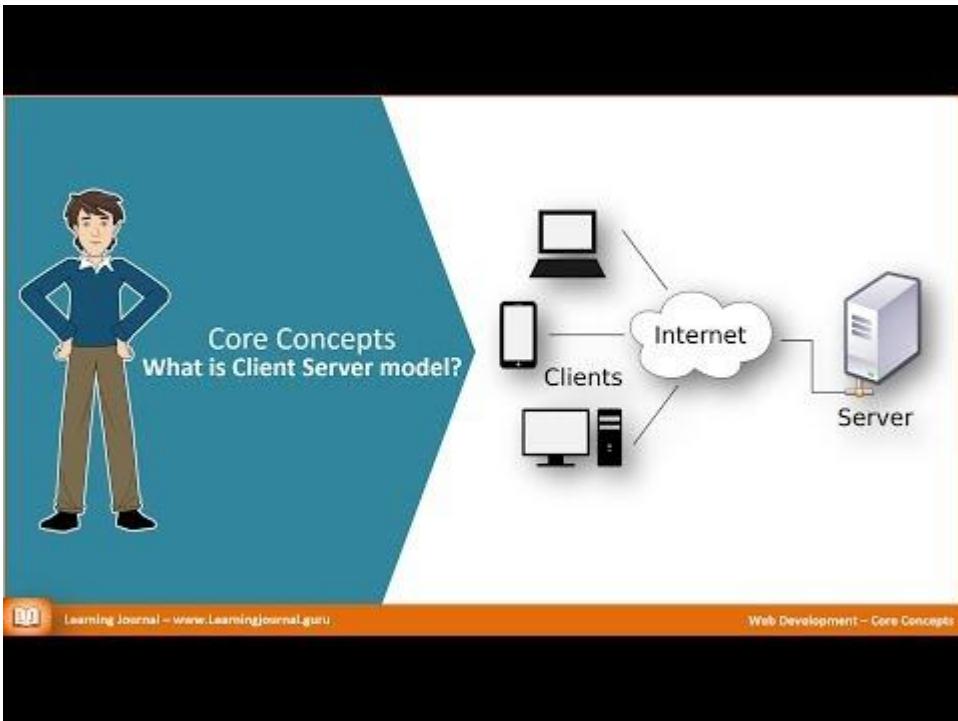
Display response  
Close connection

OK

# Client Server Architecture

## Why use this client-server architecture?

- We need a server to keep listening to requests and respond.
- There could be other architectures such as peer-to-peer structure. (e.g. bittorrent services)
  - Unlike the centralized client-server architecture, p2p is distributed.



# HTML

Can click  
on links.

Things you use to markup normal English to indicate things. Like underline, highlight, formatting..

- “Hypertext Markup Language (HTML) is the standard markup language for creating web pages and applications.”
  - HTML tells (suggests) how to **display** the content (Formatting)
- HTML use **pairs** of ‘**tags**’, like <h1> and </h1>
- Web browsers receive HTML documents from a web server and render them into web pages.

PATIENT CARE, PRESS RELEASES | JULY 26, 2022

# NYU Langone Health Ranks No. 1 in New York & No. 3 in the Nation

NYU Langone Is Also the No. 1 Hospital in the Country for Neurology & Neurosurgery

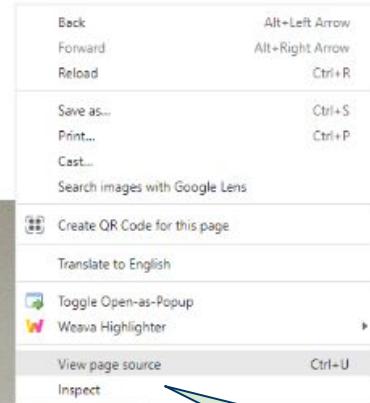


NYU Langone Health NewsHub Filter News by Category ▾ Search News 

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View page source.

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▼ Today (4)



NYU Langone  
Health Ranks No.  
1 in New York &  
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34
35     </head>
36     <body class="path-node page-node-type-article-import tmpl-article nyuuninav--page-newshub">
37         <div id="privacy-banner" class="nyuuninav--privacy-banner nyuuninav--privacy-banner--hide">
```

# HTML – defines a set of tags

---

- All HTML tags must enclosed within < > these brackets.
- Every tag in HTML perform different tasks.
- If you have used an open tag <**tag**>, then you must use a close tag </**tag**> (except some tags)

# HTML – defines a set of tags

## HTML Documents

All HTML documents must start with a document type declaration: `<!DOCTYPE html>`.

The HTML document itself begins with `<html>` and ends with `</html>`.

The visible part of the HTML document is between `<body>` and `</body>`.

```
<!DOCTYPE html>
<html>
<body>

<h1>My First Heading</h1>

<p>My first paragraph.</p>

</body>
</html>
```

## My First Heading

My first paragraph.

# HTML – defines a set of tags

## HTML Headings

HTML headings are defined with the `<h1>` to `<h6>` tags.

`<h1>` defines the most important heading. `<h6>` defines the least important heading:

```
<!DOCTYPE html>
<html>
<body>

<h1>This is heading 1</h1>
<h2>This is heading 2</h2>
<h3>This is heading 3</h3>
<h4>This is heading 4</h4>
<h5>This is heading 5</h5>
<h6>This is heading 6</h6>

</body>
</html>
```

**This is heading 1**

**This is heading 2**

**This is heading 3**

**This is heading 4**

**This is heading 5**

**This is heading 6**

# HTML – defines a set of tags

## HTML Paragraphs

HTML paragraphs are defined with the `<p>` tag:

```
<!DOCTYPE html>
<html>
<body>

<h1>My First Heading</h1>

<p>My first paragraph.</p>

</body>
</html>
```

## My First Heading

My first paragraph.

# HTML

All HTML documents must start with a document type declaration: `<!DOCTYPE html>`

```
<!DOCTYPE html>
```

```
<html>
```

```
<body style="background-color:powderblue;">
```

```
<h1>My First Heading</h1>
```

```
<p>My first paragraph.</p>
```

```
<h2>My Second Heading</h2>
```

```
<p style="color:red;">This is a Red paragraph.</p>
```

```
</body>
```

```
</html>
```

The HTML document itself begins with `<html>` and ends with `</html>`

The visible part of the HTML document is between `<body>` and `</body>`

Heading

Defines style: background color

# My First Heading

My first paragraph.

## My Second Heading

This is a Red paragraph.

# HTML

## HTML Images

HTML images are defined with the `<img>` tag.

The `src` attribute specifies the URL (web address) of the image:

```

```

```
<!DOCTYPE html>
<html>
<body style="background-color:powderblue;">

<h1>My First Heading</h1>

<p>My first paragraph.</p>

<h2>My Second Heading</h2>

<p style="color:red;">This is a Red paragraph.</p>



</body>
</html>
```

## My First Heading

My first paragraph.

## My Second Heading

This is a Red paragraph.



# HTML

---

## HTML Links

HTML links are defined with the `<a>` tag:

```
| <a href="url">link text</a>
```

```
<!DOCTYPE html>
<html>
<body>
<p><a href="http://www.cnn.com">This is a link to CNN Homepage</a></p>
</body>
</html>
```

This is a link to CNN Homepage

Reply Reply all Forward Archive Delete Set flag ...



## ISPOC Series

*IS Student Presentations Over the Cloud*

Dear friends and colleagues,

We invite you to our next session of ISPOC 2022 (IS Student Presentations Over the Cloud) on Friday, July 29th, 2022, at 11:30 AM Eastern time. In this session, **Wen Wang** ([Profile](#)) will present the following paper:

**TITLE:** Deep Reinforcement Learning for Sequential

Targeting \_\_\_\_\_

**SPEAKER:** Wen Wang (CMU >> UMD)

**DATE:** Friday, July 29th, 2022

**TIME:** 11:30 AM ET (US and Canada)

**TO RECEIVE ZOOM LINK:** [Register here](#)

**ZOOM MEETING ID:** 918 8813 2425

[To get on our mailing list and get notified about future seminars, please fill out this form.](#)

***I***To avoid bad actors from disrupting the Zoom meeting, we request that you **do not post the meeting details publicly**. Also, we encourage you to invite other students in your program by **forwarding this email** to them.



HTML

CSS

JAVASCRIPT

SQL

PHP

BOOTSTRAP

JQUERY

ANGULAR

W3.CSS

XML

## HTML5 Tutorial

### HTML HOME

HTML Introduction

HTML Editors

HTML Basic

HTML Elements

HTML Attributes

HTML Headings

HTML Paragraphs

HTML Styles

HTML Formatting

HTML Quotations

HTML Comments

HTML Colors

HTML CSS

HTML Links

HTML Images

HTML Tables

HTML Lists

HTML Blocks

HTML Classes

HTML Iframes

HTML JavaScript

HTML File Paths

HTML Head

HTML Layout

HTML Responsive

HTML Computercode

HTML Entities

◀ Home

With HTML you can create your own Web site.

This tutorial teaches you everything about HTML.

HTML is easy to learn - You will enjoy it.

## Examples in Every Chapter

This HTML tutorial contains hundreds of HTML examples.

With our online HTML editor, you can edit the HTML, and click on a button to view the result.

### Example

```
<!DOCTYPE html>
<html>
<head>
<title>Page Title</title>
</head>
<body>

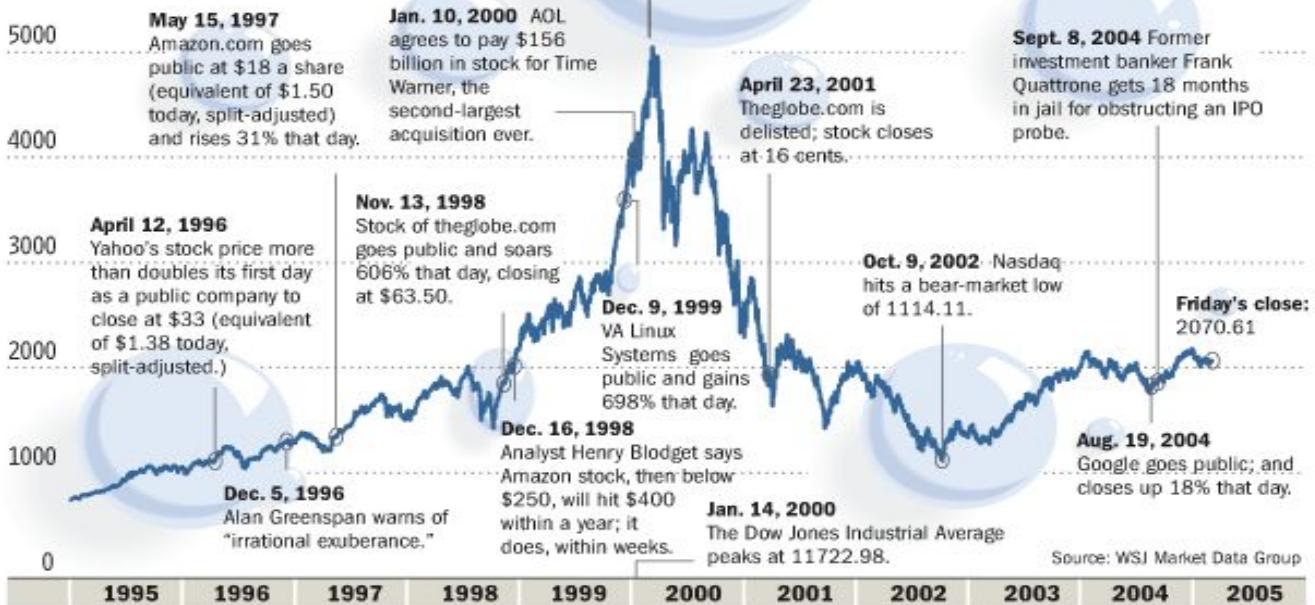
<h1>This is a Heading</h1>
<p>This is a paragraph.</p>

</body>
</html>
```

# The Internet Bubble

## The Rise and Fall

The Nasdaq Composite Index, daily close

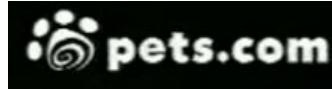


# The Internet Bubble

---

- Internet bubble, or the dot-com bubble: 1997 - 2001, a period when many startups were founded, filling the WWW with content.
- The financial market had excessive speculation of these newly-founded Internet-based companies; many quickly failed after 2001.
- But this period has **enriched the information on the Internet**. The companies that survived became highly competitive (e.g., Amazon).
- This period had also **shaped people's behavior** and provided a foundation for the rise of a new breed of IT giants, such as Google.

# The Biggest Flops



- CNN: No. 1 flop - Pets.com.
- Famous for marketing campaign. Pets.com ran ads of a dog sock puppet interviewing people on the street.
- The mascot appeared in a Super Bowl commercial and even got its own balloon in the Macy's Thanksgiving Day parade in 1999.



# The Internet Bubble

**CNN Money U.S. +** Business Markets Tech Media Personal Fin

## 10 big dot.com flops

**Garden.com**

It took just 14 months for the dot.com bust to kill off gardening products retailer Garden.com.

The company's stock climbed above \$20 in September 1999, just days after its initial public offer. But a year later, Garden.com announced it would cut 40% of its workforce, after the company lost \$9.9 million in the third quarter of 2000.

As part of a last-ditch effort to stay afloat, Garden.com set up a business-to-business unit that delivered supply-chain technology and services to customers. But it wasn't to be.

By November 2000 -- a week after Pets.com folded -- Garden.com was trading at 9 cents per share and was forced to shut down.

NEXT

**CNN Money U.S. +** Business Markets Tech Media Personal Fin

## 10 big dot.com flops

**eToys.com**

When eToys.com shares hit a high of \$84.35 in October 1999, who could have guessed that just 16 months later, the company would warn investors that its stock was "worthless?"

The online toy retailer was founded in 1997 and quickly became one of the most visited Web sites for holiday shopping. It spent tens of millions of dollars on marketing campaigns and partnerships as it jockeyed for position with other retailers like Toysrus.com, Amazon.com and Walmart.com. But eToys just couldn't keep up.

After reporting a \$74.5 million loss in the last quarter of 2000, the company said it had just enough cash to last until March 31, but after that it would require "an additional, substantial capital infusion."

It never found a white knight. Citing debt of \$247 million, eToys said in February 2001 it had no alternative but to file for bankruptcy.

The site was bought out of bankruptcy by KB Toys, which later filed for bankruptcy itself. But eToys.com lives on, hoping the third time's a charm.

NEXT: GeoCities

- Internet bubble has added content to the Internet, and shaped consumer behavior.
- Internet became a leading platform for information, shopping, socializing.

# Google!

BETA

Search the web using Google!

Google Search

Special Searches  
[Stanford Search](#)  
[Linux Search](#)

[Help](#)  
[About Google](#)  
[Company Info](#)  
[Google! Logos](#)

Get Google!  
updates monthly:

Copyright ©1998 Google Inc.




[Advanced Search](#)  
[Preferences](#)

Web

Results 1 - 10 of about 871,000 for "digital camera" cheapest, (0.24 seconds)

**Digital Cameras \$9.95**

[www.ecameralfilms.com](#) Sale - Bargain - All Brands Quantity Discounts - Free Ship

**Cheap Digital Camcorder**

[www.TheFlip.com](#) Post your videos on YouTube With The Flip Video Camcorder!

**Techbargains - dell coupons discount computer sale buy cheap ...**

TechBargains.com - Technology products shopping guide. Find dell coupons, discount computers, cheap digital camera. Find cheap ipods, cheap laptops, ...  
[www.techbargains.com/](#) - 280k - [Cached](#) - [Similar pages](#)

**Cheap Digital Cameras, Discount Digital Cameras, Kodak Digital ...**

Kodak ZD710 7.1MP 10x OptiZoom Digital Zoom Digital Camera .... Kodak 8.2MP Digital Camera Kit w/2GB SD Card Picture Frame! Kodak 8.2MP Digital Camera Kit ...  
[www.geeks.com/products.asp?cat=CAM](#) - 410k - [Cached](#) - [Similar pages](#)

**Cheap Digital Camera - Find Cheap Digital Camera items for sale on ...**

eBay - Find Cheap Digital Camera on eBay. ... PayPal, - Buy It Now, \$30.00 \$50.00.  
 Olympus Camedia D 540 Zoom 3.2MP Digital Camera Cheap! PayPal, -, \$5.00 ...  
[popular.ebay.com/nis/Cameras-Photo/Cheap+Digital+Camera.html](#) - 41k -  
[Cached](#) - [Similar pages](#)

**Digital Cameras from Overstock.com**

We have lots of **digital camera** accessories too. Cheap digital cameras don't need to be cheap quality. Overstock.com has lots of great deals on compact ...  
[www.overstock.com/Electronics/Digital-Cameras/813/cat.html](#) - 130k -  
[Cached](#) - [Similar pages](#)

**\$0.00 - \$200 - Digital Cameras - BizRate - Compare prices, reviews ...**

Stores Selling Digital Cameras. (Sponsored Links). Cheap Digital Cameras .... This is my second **digital camera**. My old Fuji camera is about 5 years old. ...  
[www.bizrate.com/digitalcameras/products\\_maxprice=200\\_minprice=0.html](#) - 127k -  
[Cached](#) - [Similar pages](#)

**Canon PowerShot SD300 digital camera specifications: Digital ...**

Canon PowerShot SD300 digital camera specifications. Canon PowerShot SD300. Image, Canon PowerShot SD300. More information. Announced 21-Sep-04 ...  
[www.dpreview.com/reviews/specs/Canon/canon\\_sd300.asp](#) - 29k - [Cached](#) - [Similar pages](#)

**How to choose a digital camera - the HP Digital Camera buying guide**

Digital camera demos and recommendations. Everything you need to compare and choose an HP digital camera. Learn more about which features to look for and ...  
[www.hp.com/united-states/consumer/digital\\_photography/buying\\_guides/digital\\_camera\\_f.html](#) - [Similar pages](#)

Sponsored Links

Sponsored Links

**Cheap Digital Camera**

Find Great Deals on Cameras & More.  
 Shop Now & Save at AOL® Shopping!  
[Shopping.AOL.com](#)

**Digital Camera Cheapest**

We Have 800+ Digital Cameras.  
**Digital Camera Cheapest** on Sale!  
[www.NexTag.com/Digital-Cameras](#)

**Discount Canon Digital**

Shop RadioShack for Canon Digital Cameras & Accessories Today!  
[www.RadioShack.com](#)

**Cheap Camcorders Here**

Wide Range of Digital Camcorders  
 Same Day Shipping, Buy Now!  
[www.TigerDirect.com](#)

**Digital Cameras Discount**

Buy Digital Cameras.  
 Compare Prices and Save.  
[PriceGrabber.com](#)

**Discount Digital Camera**

Save time. Save money. Go digital.  
 Digital Cameras \$100 to \$500.  
[BizRate.com](#)

**Buy Digital Camera**

Great Bargains on Digital Cameras.  
 Digital Cameras starting at \$55!  
[www.Newegg.com](#)

**Cheapest Digital Camera**

Buy Quality Digital Cameras Below  
 Market Price! Top Customer Service.  
[BHPVideoVideo.com/DigitalCameras](#)

**Time:**

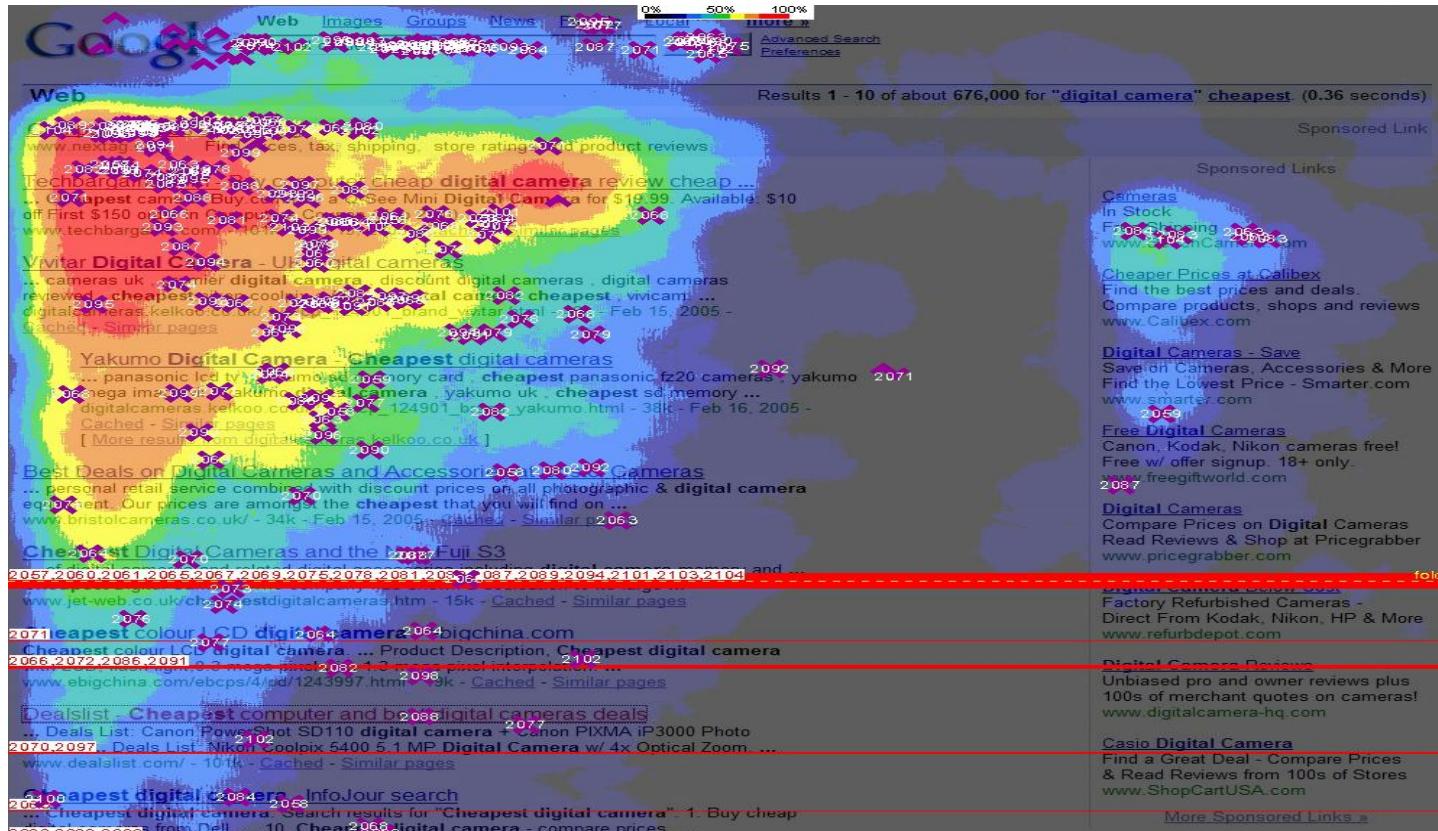
Average time spent on a search page was 14 to 15 seconds total.

**Scope:**

Searchers only look at the top few results.

100% of people tested would scan the first 4 listings and 80% would make a click within the first four results.

# Search Engine Results - Ranking



**Path: “Golden Triangle”**

# Ranking - Why do companies care?

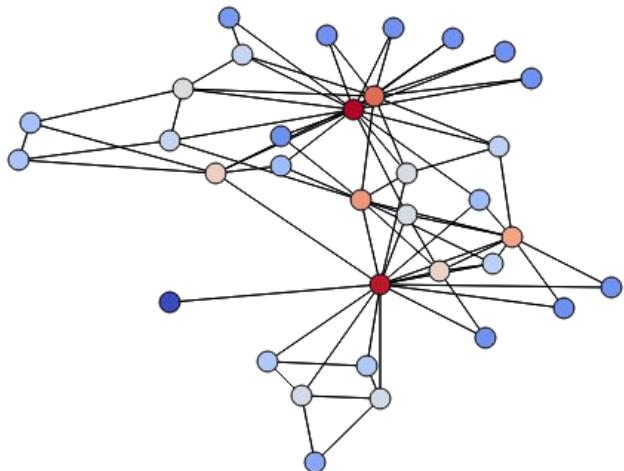


More than half of the people click the links that are highly ranked by search engine

Google - customer satisfaction  
Websites - I want to rank high!

Therefore, understanding ranking algorithm is very important!

# Ranking - Why do engineers/ researchers care?



WWW: Hyperlinks link together the pages. It's a network!

Engineers - We want to automate the ranking process. Fast and accurate!  
**Can we use the network structure?**

Researchers - Ranking, is **evaluating the importance of nodes** in network.  
How to evaluate that?

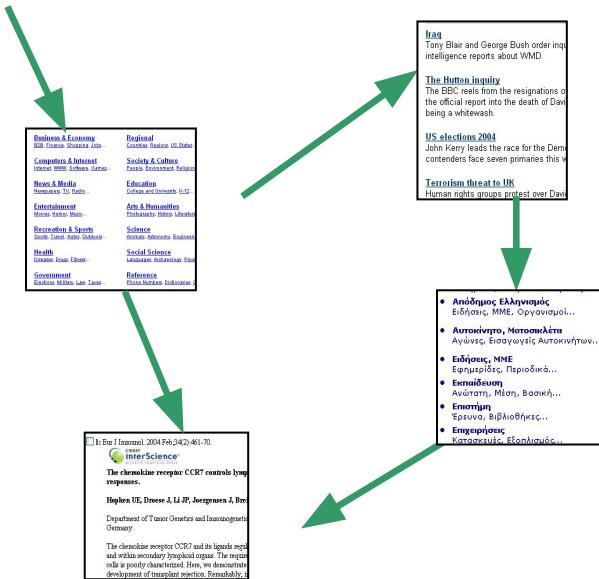
# Internet: Ranking & Evaluating the importance of webpages

Objective:

Pagerank.

# How Search Engines Work

Search engine's work begins long before you type your search into google



## Data collection:

- Search engines discover new pages by **following links**

## As you search:

- Type the keywords >> Google's algorithm begin to find the relevant information.
- Keyword matching: Search engines need to **match** the user's query with content in the webpages.

## Return a ranked list:

- **Ranking matters:** Text content is important: But is not enough.

# Ranking Pages

---

- Are the following websites important?
  - Woot.com
  - Souq.com
  - ACX.com

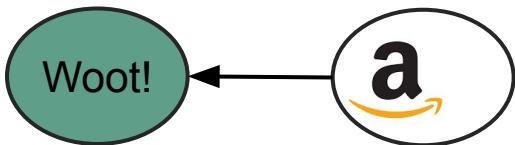
# Importance of Links



English

United States

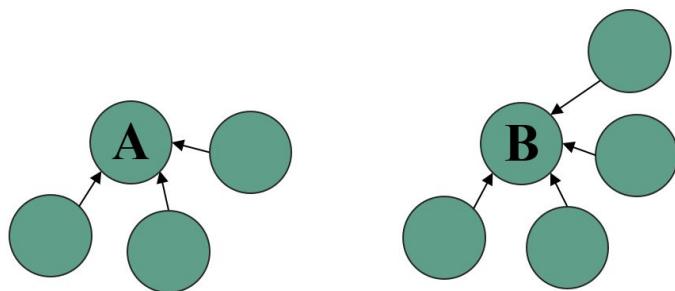
<b>Amazon Music</b> Stream millions of songs	<b>Amazon Drive</b> Cloud storage from Amazon	<b>6pm</b> Score deals on fashion brands	<b>AbeBooks</b> Books, art & collectibles	<b>ACX</b> Audiobook Publishing Made Easy	<b>Alexa</b> Actionable Analytics for the Web	<b>Amazon Business</b> Everything For Your Business
<b>AmazonFresh</b> Groceries & More Right To Your Door	<b>AmazonGlobal</b> Ship Orders Internationally	<b>Home Services</b> Handpicked Pros Happiness Guarantee	<b>Amazon Inspire</b> Digital Educational Resources	<b>Amazon Rapids</b> Fun stories for kids on the go	<b>Amazon Restaurants</b> Food delivery from local restaurants	<b>Amazon Video Direct</b> Video Distribution Made Easy
<b>Amazon Web Services</b> Scalable Cloud Computing Services	<b>Audible</b> Download Audio Books	<b>AudiobookStand</b> Discount Audiobooks on Disc	<b>Book Depository</b> Books With Free Delivery Worldwide	<b>Box Office Mojo</b> Find Movie Box Office Data	<b>ComiXology</b> Thousands of Digital Comics	<b>CreateSpace</b> Indie Print Publishing Made Easy
<b>DPRReview</b> Digital Photography	<b>East Dane</b> Designer Men's Fashion	<b>Fabric</b> Sewing, Quilting & Knitting	<b>Goodreads</b> Book reviews & recommendations	<b>IMDb</b> Movies, TV & Celebrities	<b>IMDbPro</b> Get Info Entertainment Professionals Need	<b>Jungle.com</b> Shop Online in India
<b>Kindle Direct Publishing</b> Indie Digital Publishing Made Easy	<b>Prime Now</b> FREE 2-Hour Delivery on Everyday Items	<b>Prime Photos</b> Unlimited Photo Storage Free With Prime	<b>Shopbop</b> Designer Fashion Brands	<b>TenMarks.com</b> Math Activities for Kids & Schools	<b>Warehouse Deals</b> Open-Box Discounts	<b>Whisperc</b> Discover & Distribute Digital Content
<b>Whole Foods Market</b> America's Healthiest Grocery Store	<b>Withoutabox</b> Submit to Film Festivals	<b>Woot!</b> Deals and Shenanigans	<b>Zappos</b> Shoes & Clothing	<b>Souq.com</b> Shop Online in the Middle East	<b>Subscribe with Amazon</b> Discover & try subscription services	

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Incoming links (citations) transfer legitimacy.

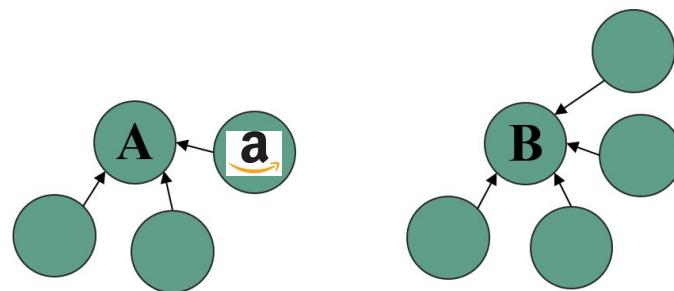
# How to Rank Search Results

- Is website A or B more likely to be legitimate?



B > A?

More incoming links, I'm more important.

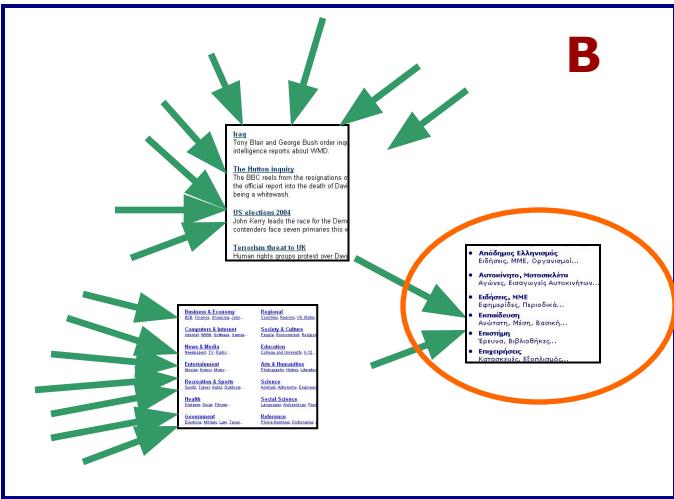
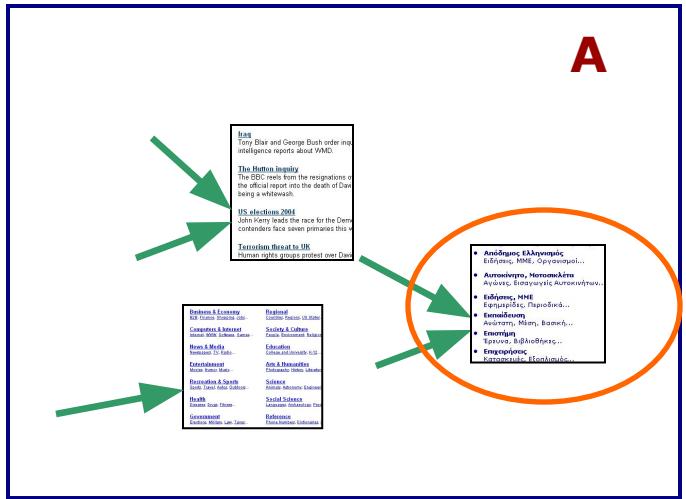


B > A?

An incoming link **from an important website** transfer more legitimacy

# How to Rank Search Results

- Is website A or B more likely to be legitimate?



More incoming links, I'm more important.

If I'm more important, and I refer my friend, my friend is more important.

**Iteratively**...Maybe we need to look at the **whole network** of webpages.

# PageRank Algorithm

- Intuition: Incoming links are important. Important pages are likely to receive more links from other websites.
  - Measure the importance of websites by counting the **number** and **quality** of links.

10 recommendation letters are better than 1.

A rec from a person who has 10 recs (She's important!) is better than a rec from a person who has 1 rec.

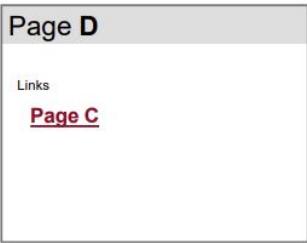
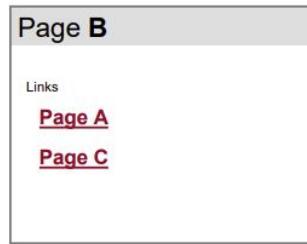
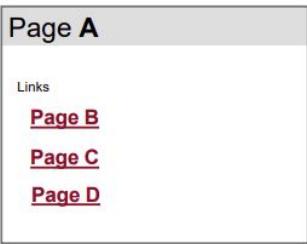
# PageRank Algorithm

---

- Google's Method:
  - PageRank is **initialized** to the same value for all pages. All pages have equal weights in the beginning.
  - Each page's outgoing links **transfer weights** to its target page.
  - The PageRank computations require several passes, called "**iterations**", to adjust approximate PageRank value until the values are stable.

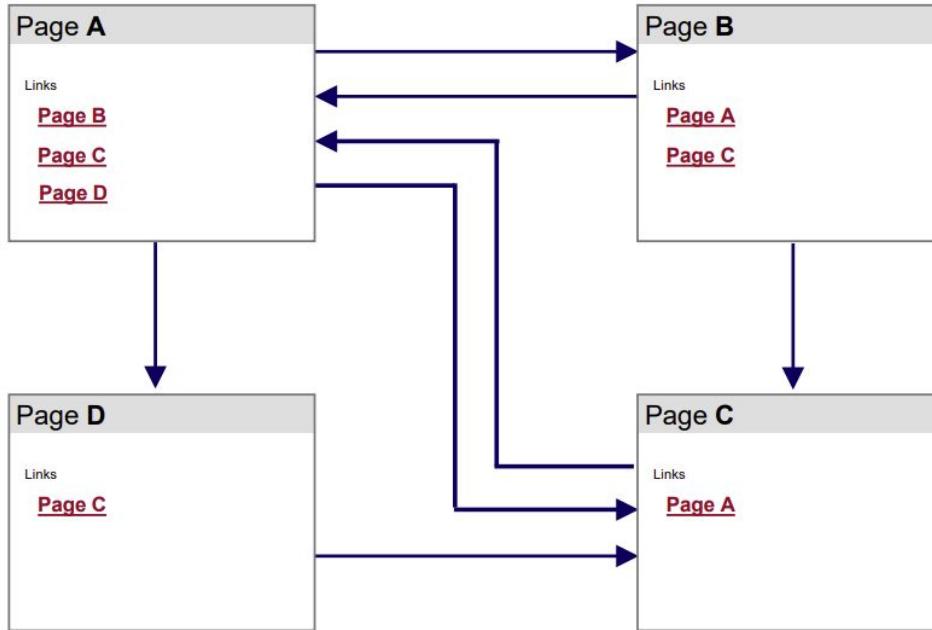
# Computing PageRank

**Assumption:** the universe has 4 webpages



# Computing PageRank

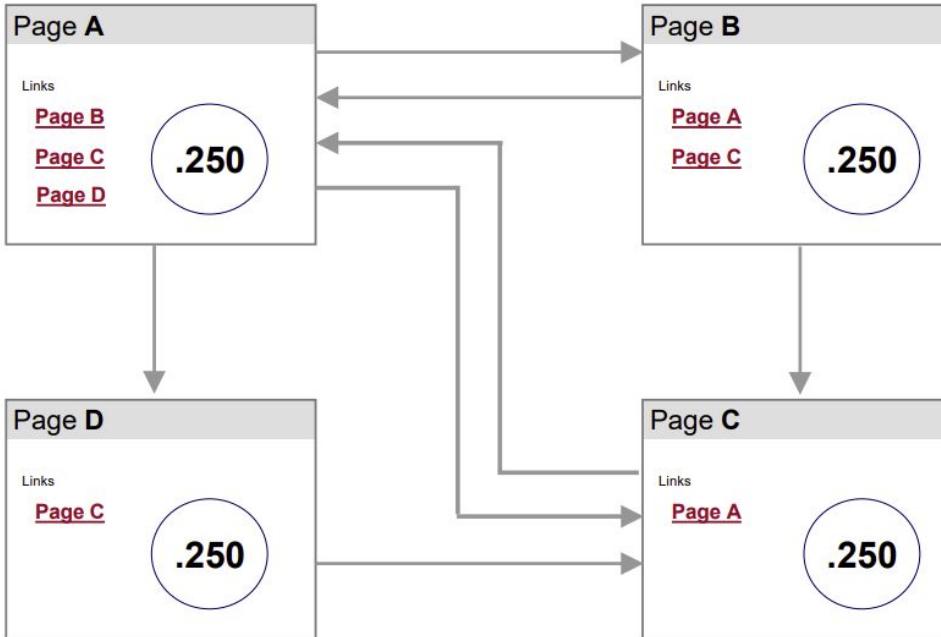
**Assumption:** the universe has 4 webpages



\*The direction of the links is critical

# Computing PageRank

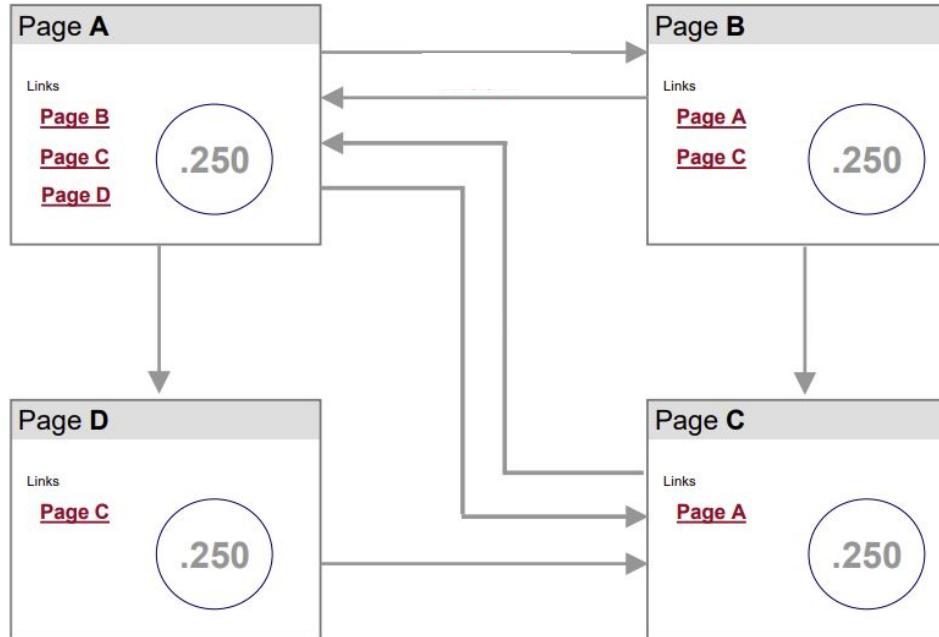
- 1) Initialization: Assign **equal weights** to the pages (sum = 1)



# Computing PageRank

$$\text{PageRank of site} = \sum \frac{\text{PageRank of inbound link}}{\text{Number of links on that page}}$$

- 2) First iteration: Each link **transfers** a fraction of the weight to the other page  
 = Original weight divided by number of outgoing links

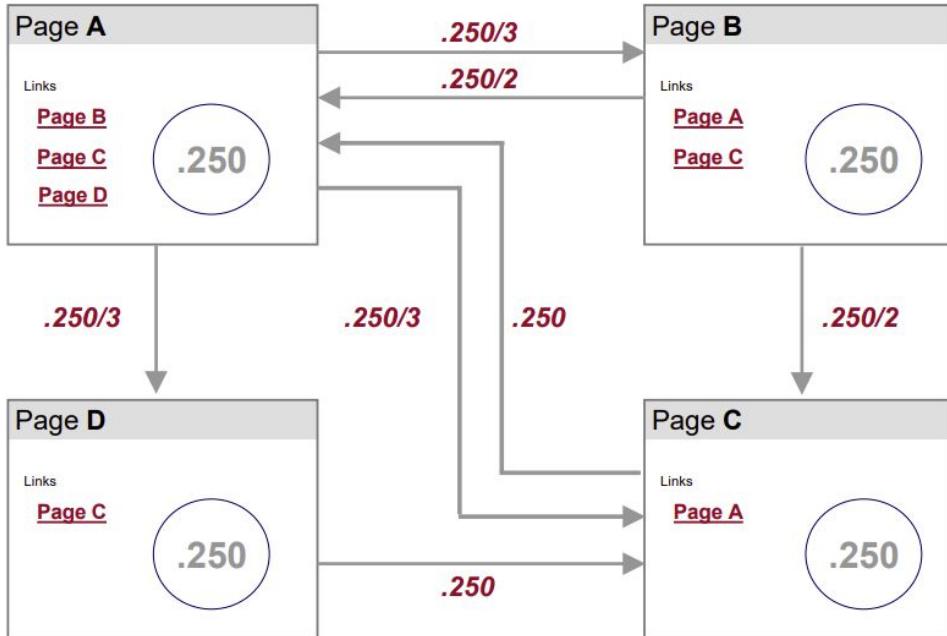


\*The direction of the links is critical

# Computing PageRank

$$\text{PageRank of site} = \sum \frac{\text{PageRank of inbound link}}{\text{Number of links on that page}}$$

3) First iteration: Compute **new weight** of pages= Sum of weight transferred from incoming links



(ignore the old page weights.)

New weight of A?

$$0.250/2 + 0.250 = 0.375$$

New weight of B?

$$0.250/3 = 0.83$$

New weight of C?

$$0.250/2 + 0.250/3 + 0.250 = 0.458$$

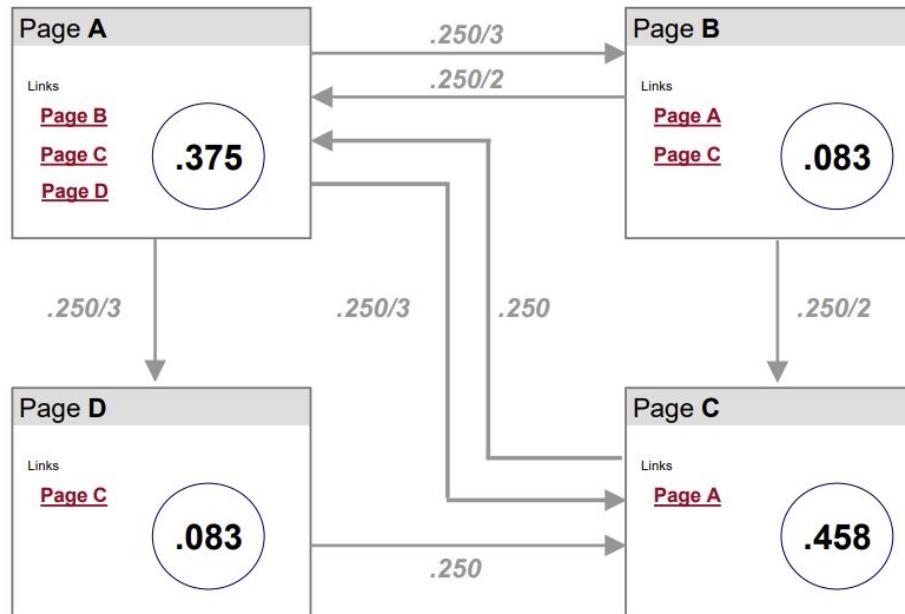
New weight of D?

$$0.250/3 = 0.83$$

# Computing PageRank

$$\text{PageRank of site} = \sum \frac{\text{PageRank of inbound link}}{\text{Number of links on that page}}$$

- 3) First iteration: Compute **new weight** = Sum of weight transferred from incoming links

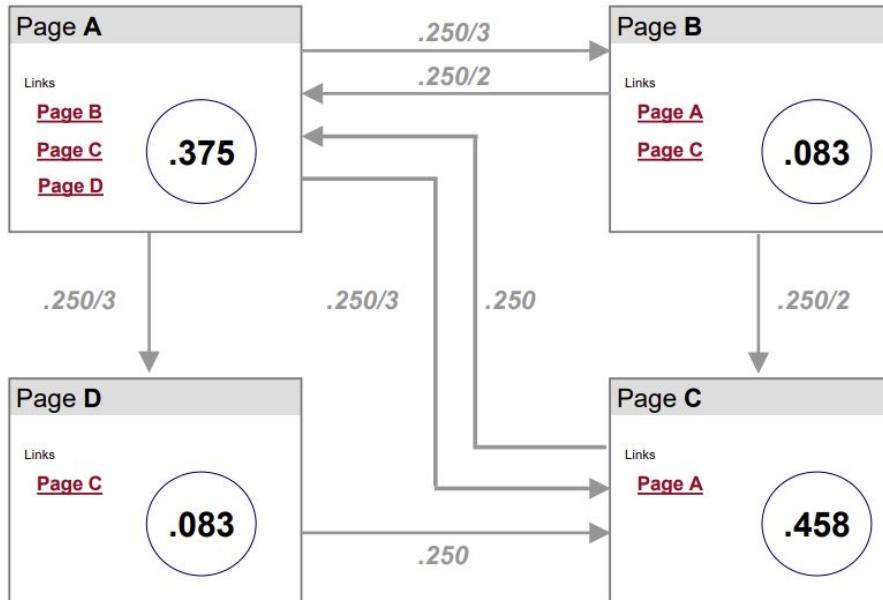


# Computing PageRank

$$\text{PageRank of site} = \sum \frac{\text{PageRank of inbound link}}{\text{Number of links on that page}}$$

Repeat the process to update the weights.

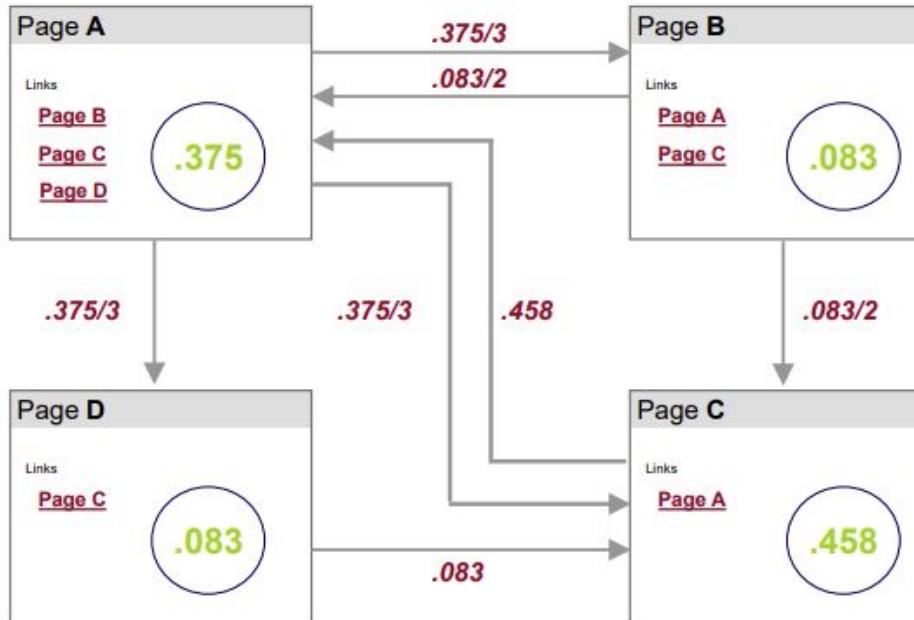
Exercise: What're the new weights after a second iteration?



# Computing PageRank

$$\text{PageRank of site} = \sum \frac{\text{PageRank of inbound link}}{\text{Number of links on that page}}$$

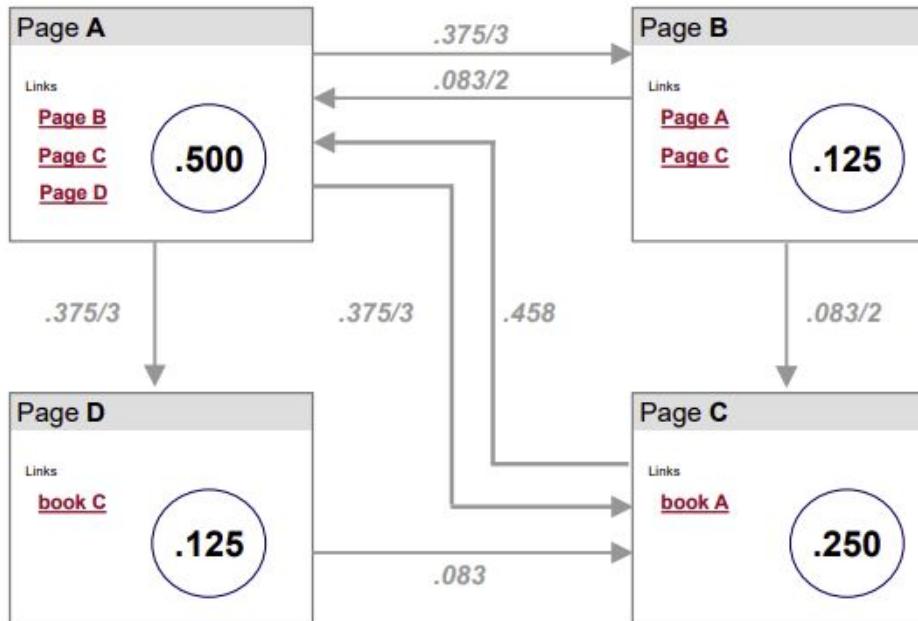
Repeat the process to update the weights.  
Second iteration - Update link weights:



# Computing PageRank

$$\text{PageRank of site} = \sum \frac{\text{PageRank of inbound link}}{\text{Number of links on that page}}$$

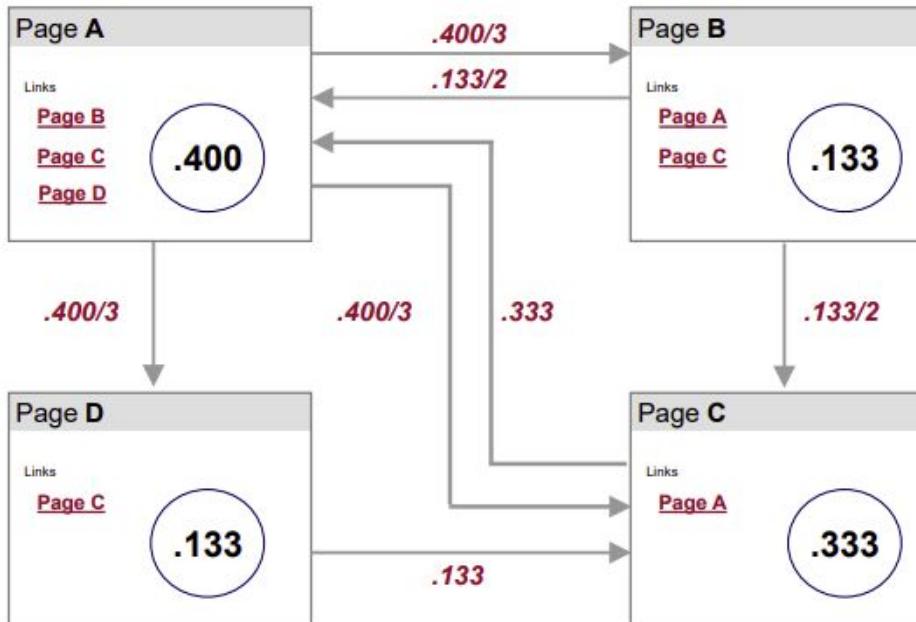
Repeat the process to update the weights.  
Second iteration - Update page weights:



# Computing PageRank

$$\text{PageRank of site} = \sum \frac{\text{PageRank of inbound link}}{\text{Number of links on that page}}$$

Those values will slowly converge and so we repeat the process until we reach a steady state.



# PageRank - Key Features

- **Structure** of the page network is most important determinant of pages' ranking.
- The Page Rank algorithm **iteratively** computes the PR score of each page until the score converges.
- A page can get a high ranking by 1). either having many incoming links or 2). having an incoming link from a highly ranked page.



# Other Ranking Factors

---

- Location
  - Query words in first few sentences, title.
  - Anchor text <a href=http://www.xyz...> An important article about IT Strategy </a>
- Frequency
  - The more frequent the query words, the better
- Click through measurement
  - How often users click on your URL, when they see it
  - How long do users stay

# Other Ranking Factors

SEO / What is SEO

## What Is SEO? The 2022 Guide to Search Engine Optimization

Kelly Lyons Feb 09, 2022 23 min read

A white line-art illustration of a person with short dark hair, wearing a white collared shirt, pointing with their right hand towards a large rectangular screen. The screen displays a map of a city with various locations marked by small icons like a gear, a house, and a person. The background behind the person and the screen is a light yellow color.

## What Is SEO?

Search engine optimization (SEO) refers to the process of improving your site's organic traffic and ranking on search engines such as Google, Bing, and other search engines.

This includes creating high-quality content in addition to monitoring your site's technical health, gaining links from other sites to your site, maintaining your site's local search presence, and more.

# Characteristics of Internet

# Internet is “Organic”

## ***The Internet is not an ‘intelligent’ network***

- Its role is simply to get data packets from one computer to another

## ***The intelligence of the Internet is at the ‘edges’***

- Edges: the devices (like computers) connected to the Internet

**Great enabling technology:** *WWW, Messaging, Email, VoIP, iTunes, iTV, Peer-to-peer..., etc.* are built on top of the Internet

# Internet is “Strategic”

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- ***Content agnostic***
  - Content creators do not need to think about the structure of the Internet
- ***Resilient***
  - One node of the Internet goes down; others don’t.
- ***Extensible***
  - More lines can always be added.

# Internet is Critical

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***It is easy to run new Internet-based applications***

***The Internet doesn't discriminate between applications***

# Key Takeaways

- The internet: A collection of interconnected computers following certain communication protocols
  - Network structure: It has three layers, the backbone, the ISP and the local access networks.
  - The TCP/IP protocol defines the rules to transmit data. (in packets, IP addresses, routing..)
- WWW is a collection of websites, a way of organizing files to be easily found and displayed. Runs on top of the internet.
  - The HTTP protocol governs how computers talk to each other. It specifies the client-server architecture.
  - We use HTML to create the web pages. It uses pairs of tags to suggest how to display the content.
- Important web pages are likely to receive more links from other pages. Pagerank algorithm can be used to evaluate the importance of websites automatically just based on the network structure.