



AIRA
AMERICAN IMMUNIZATION
REGISTRY ASSOCIATION

CS-102: Networks & Connections

Connecting Systems

Network Topologies

How computers connect to each other.

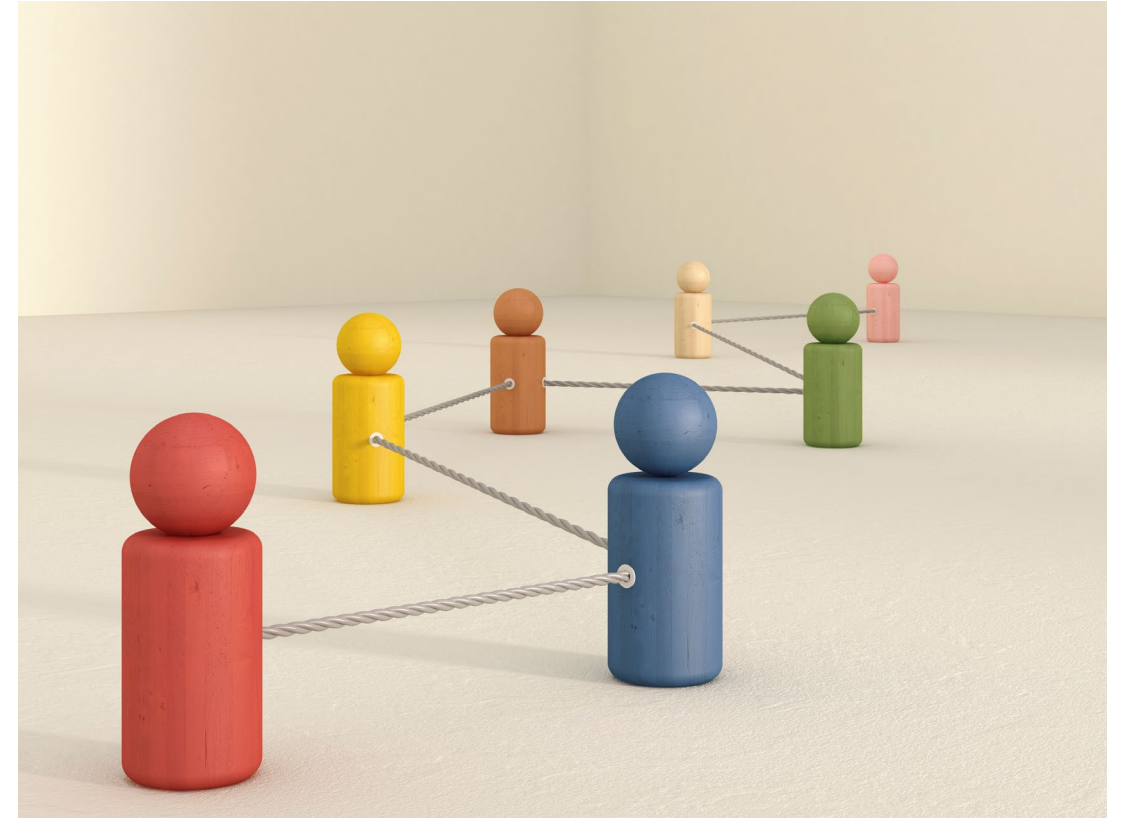




Network

A group or system of interconnected people or things.

- Google Dictionary





Topology

The way in which constituent parts are interrelated or arranged.

- Google Dictionary





Passing Notes in Class

- A computer network is like students in class
 - You must stay in your seat.
 - Can pass notes to neighbors.
 - Neighbors can pass note onwards to your friend.





Passing Notes in Class

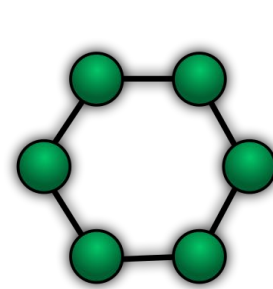
- A computer network is like students in class
 - You must stay in your seat.
 - Can pass notes to neighbors.
 - Neighbors can pass note onwards to your friend.
- One major difference:
 - Students pass paper.
 - Computers repeat information.



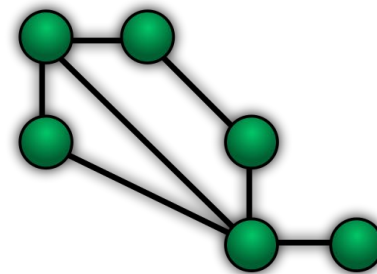


Network Topologies

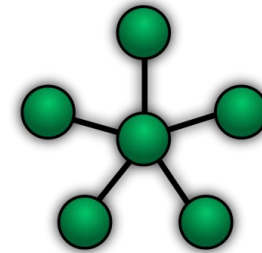
Network structure is important.



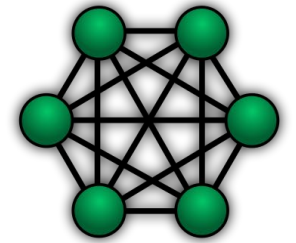
Ring



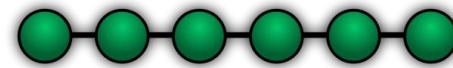
Mesh



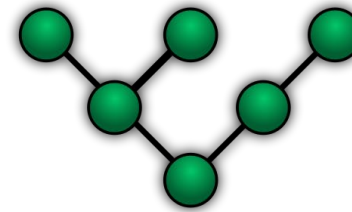
Star



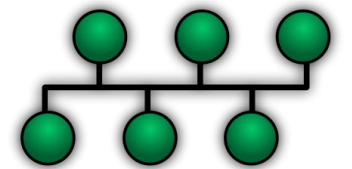
Fully Connected



Line



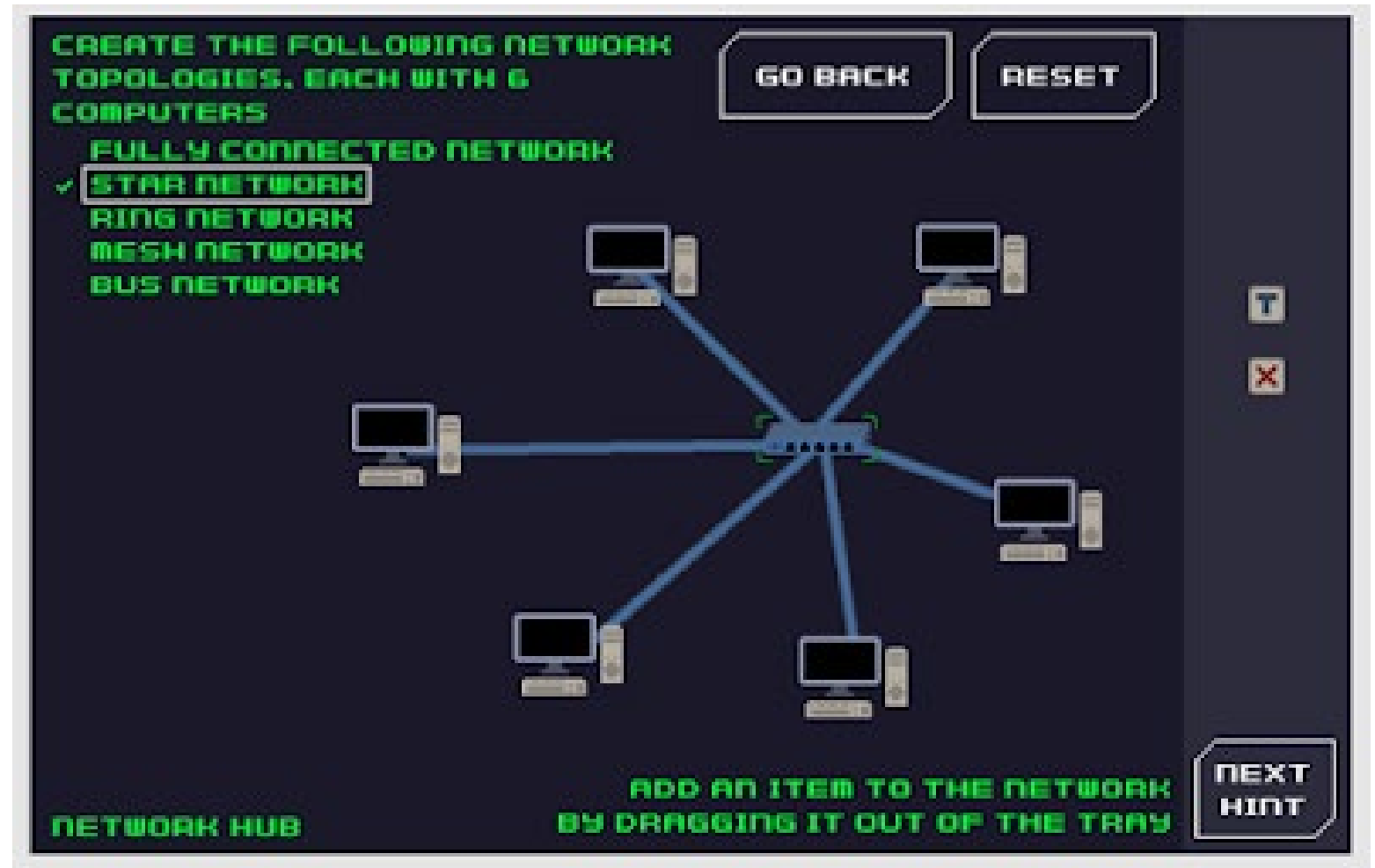
Tree



Bus



Network Topologies Exercise



<https://cybergamesuk.com/topologies>



Direct Electrical Connections

- Original telephone system
 - Direct electrical connection between phones.



Victory Switchboard – Potsdam Conference

<https://www.nationalww2museum.org/war/articles/potsdam-womens-army-corps>



Direct Electrical Connections

- Original telephone system
 - Direct electrical connection between phones.
 - Each call required wires to be connected.



PFC Gladys Bellon – Tests lines in frame room

<https://www.nationalww2museum.org/war/articles/potsdam-womens-army-corps>



Direct Electrical Connections

- Original telephone system
 - Direct electrical connection between phones.
 - Each call required wires to be connected.
 - This was the job of switchboard operators.



S. Sgt. Lorraine Robitaille – Switchboard supervisor
<https://www.nationalww2museum.org/war/articles/potsdam-womens-army-corps>



Connecting Computers

- First long-distance connections used US telephone system.
 - Long distance phone call.
 - Computers talked to each other through a “MODEM”.
 - Both systems had to remain “on the line” to stay connected.



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Connecting Computers

Computers	Phone Lines	Connections
2	1	1
3	2	2
4	3	6
5	4	



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Connecting Computers

Computers	Phone Lines	Connections
2	1	1
3	2	2
4	3	6
5	4	24



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Connecting Computers

Computers	Phone Lines	Connections
2	1	1
3	2	2
4	3	6
5	4	24
10	$(n - 1)$	$(n - 1)!$



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Connecting Computers

Computers	Phone Lines	Connections
2	1	1
3	2	2
4	3	6
5	4	24
10	9	362,880



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Connecting Computers

Computers	Phone Lines	Connections
2	1	1
3	2	2
4	3	6
5	4	24
10	9	362,880
100	99	
1,000	999	
20 billion	20 billion - 1	



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Connecting Computers

Computers	Phone Lines	Connections
2	1	1
3	2	2
4	3	6
5	4	24
10	9	362,880
100	99	9.3×10^{155}
1,000	999	!!!!
20 billion	20 billion - 1	!!!!

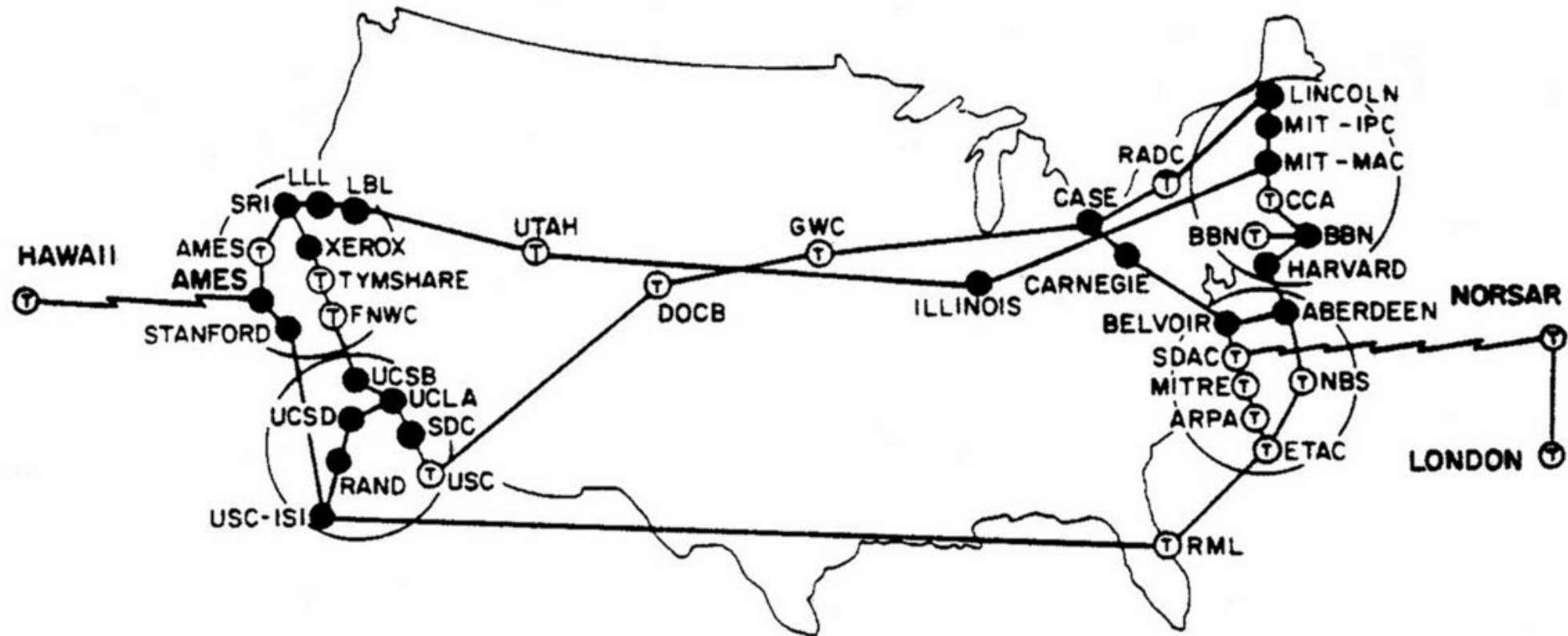


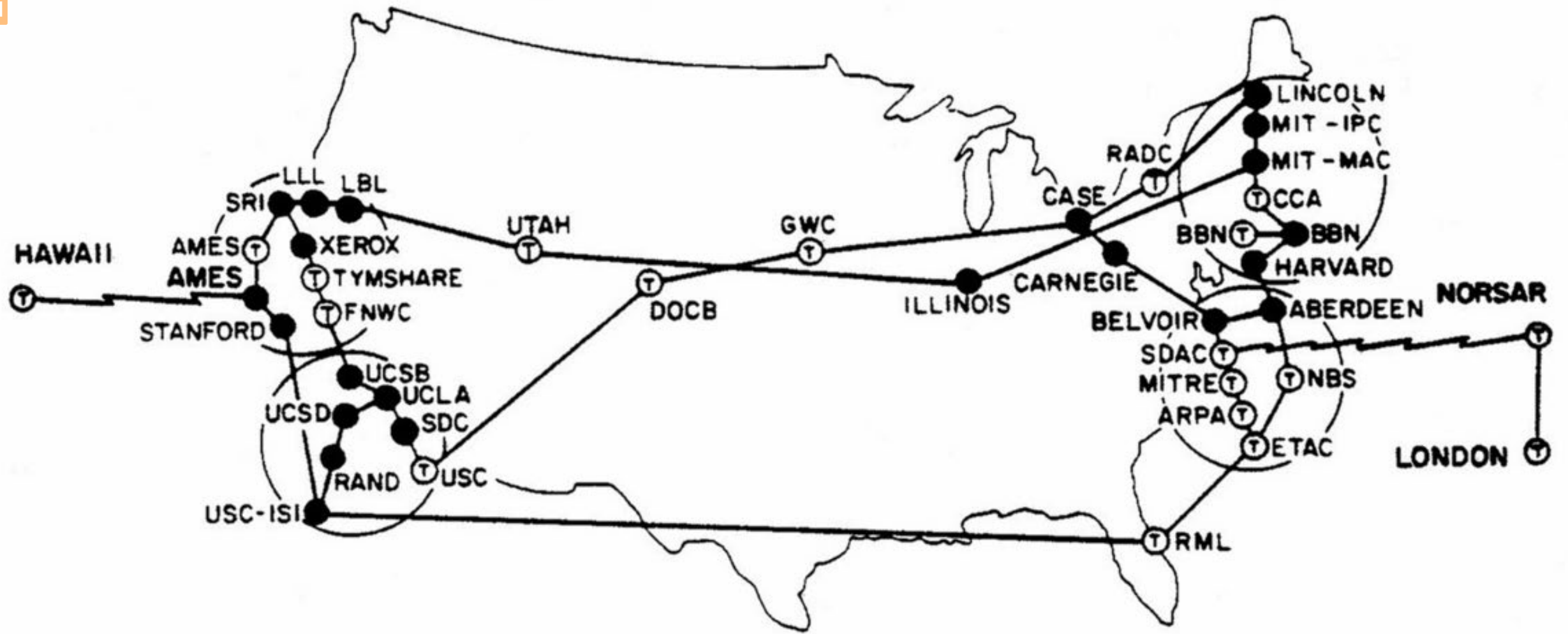
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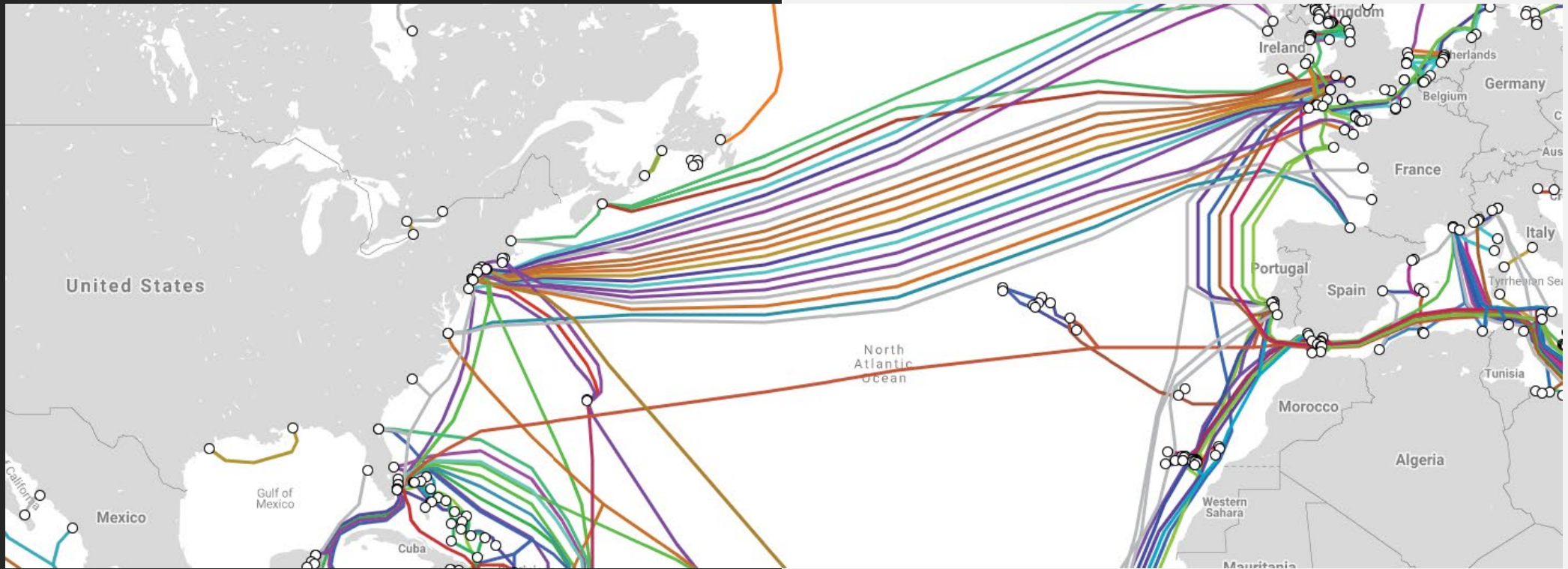


Internet Baby Picture - 1973

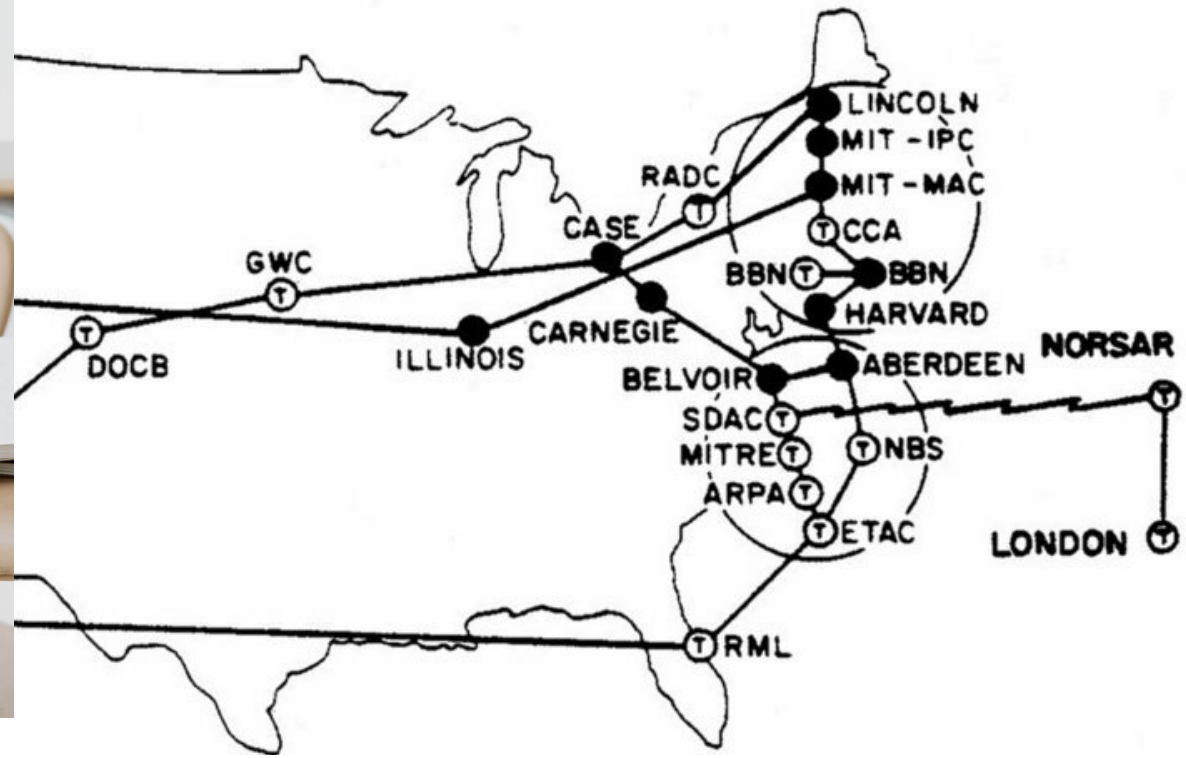
Computers
connected to create
a network







Submarine Cables Today



- No direct connections.
- Depends on the goodwill of the network.



TCP/IP & Packets

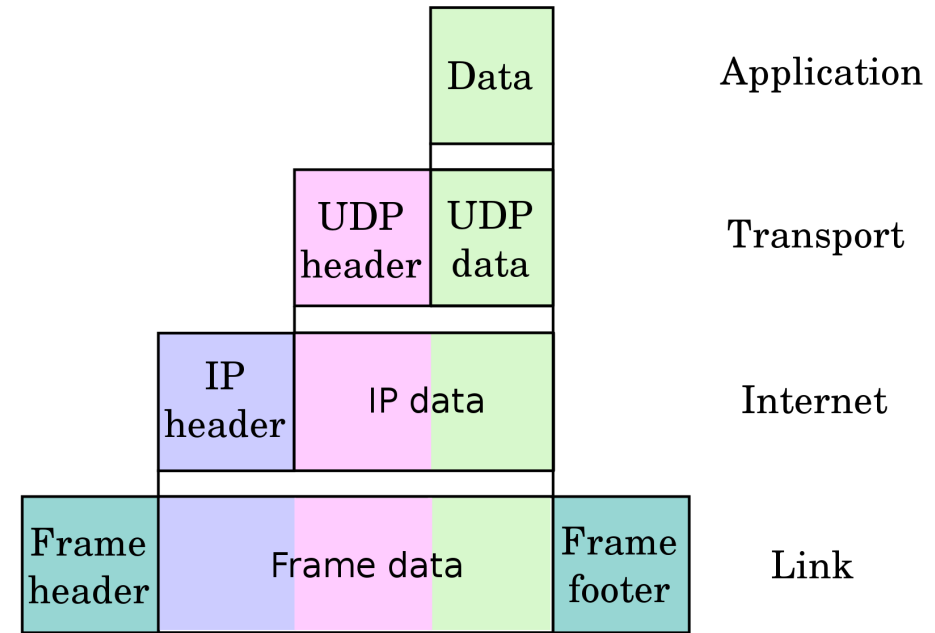
How the Internet works.



What is TCP/IP?

A foundational set of rules that governs the connection of computer systems to the internet.

TCP/IP specifies how data should be packaged, addressed, transmitted, routed, and received.



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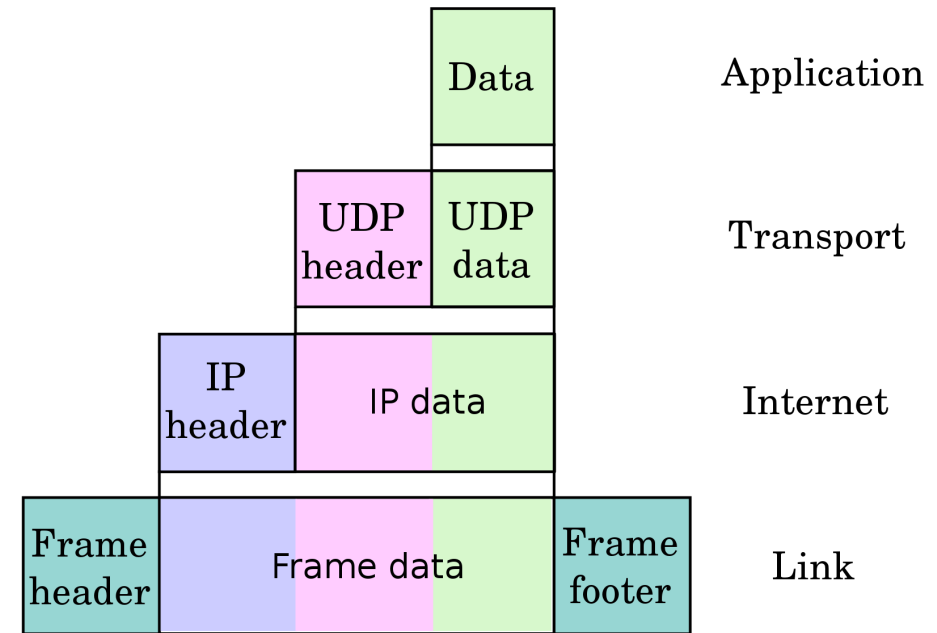
TC/IP is like human speech

- Spoken human language:
 - Vocal chords vibrate air.
 - Ears hear vibrations.
- Supports many different:
 - Languages
 - Dialects
 - Uses



Data goes in packets

All data is broken up and put into packets of data that are intended to be routed to a final destination.



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Shipping

- Stevedores would load boats by hand.
 - Slow turn around time.
 - Many hands needed.
 - Some items might go missing.
 - Difficult to find efficiencies and thus lower costs.



By Buonasera - Foto stammt vom Eigentümer und Rechteinhaber des Bildes (Fotografen) und wurde frei gegeben - Buonasera, CC BY-SA 3.0, <https://commons.wikimedia.org/w/index.php?curid=25122811>



Containerization

- Standardized containers for
 - Ship
 - Rail
 - Truck
- Very fast loading/unloading.
- Dramatically reduced shipping costs.
- Enabled modern connected world.



By Captain Albert E. Theberge, NOAA Corps (ret.) -
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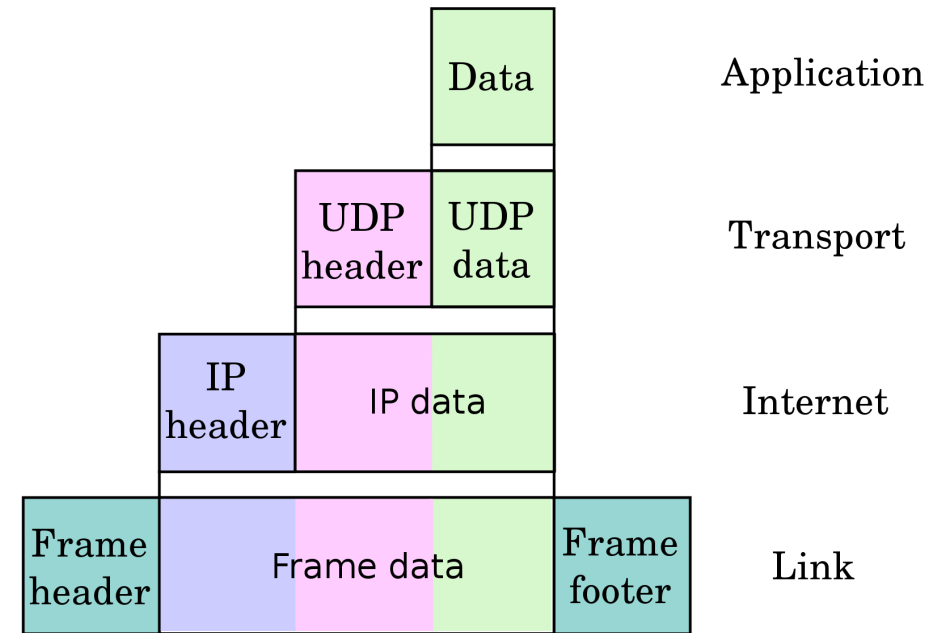


Data goes in packets

Each packet is a limited size.

A single data load might be broken into many packets.

TCP/IP defines how these packets are routed between systems.



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TCP/IP is like the US Mail

- How is grandma doing?
 - Write a letter on paper
 - Put in envelope with stamp
 - Place in mailbox
 - Routed through USPS network
 - Truck, Vans, Planes, Trains, Boats
 - Delivered to grandma
 - Envelope discarded; letter read



By Jessie Willcox Smith (1863 – 1935) -
<https://socialistreadinggroup.wordpress.com/2018/07/08/little-red-cap-and-brier-rose/>, Public Domain,
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TCP/IP is like the US Mail

Letter	HL7
Write a paper on paper	Create an HL7 message
Put in envelope	Create data packet
Place in mailbox	Send across Internet
Routed through USPS network (truck, vans, planes, trains, boats)	Routed through Internet (fiber, copper, satellite, microwave)
Delivered to grandma	Received by state registry
Envelope discarded; letter read	HL7 message read from packet; data saved in IIS



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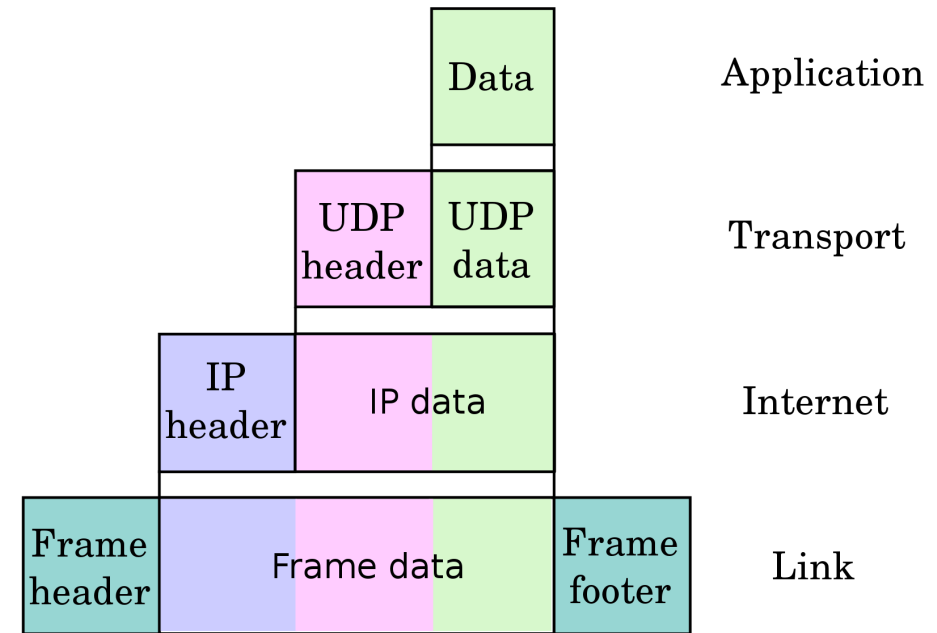


Layers of Connection

At each layer information is wrapped/unwrapped.

Each layer focus on a different level of the problem.

This rigorous division of tasks allows for a robust global network of computers.



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A Connection is an Illusion

How to know when you really are connected, and when you are not.

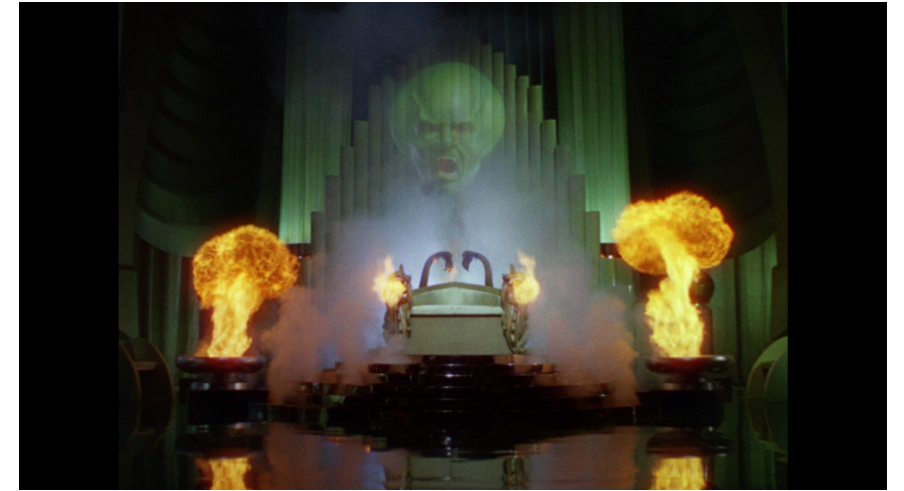


What is an illusion?

An illusion is a distortion of the senses, which can reveal how the human brain normally organizes and interprets sensory stimulation.

Although illusions distort our perception of reality, they are generally shared by most people.

- Wikipedia



"I am Oz, the great and powerful!"
Wizard of Oz (1939) – Metro-Goldwyn-Mayer



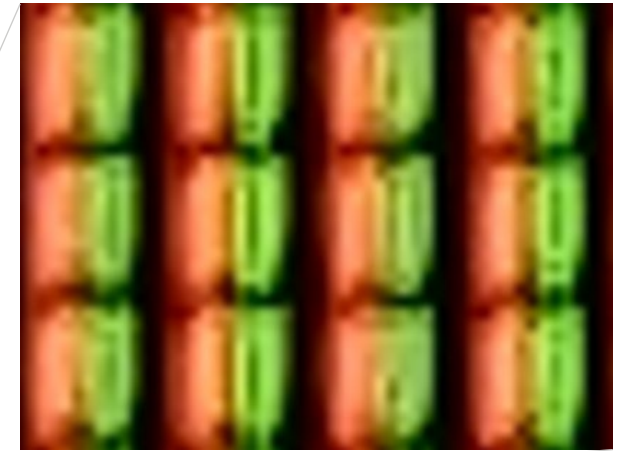
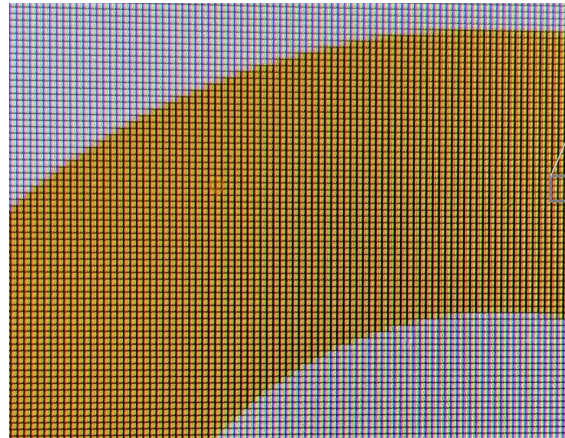
Connected?

- Laptop connected to wi-fi
 - Logged into a research database.
-
- Is she connected directly to that research database?



Examples of Illusions

- Yellow on computer screen
 - Only red and green



Examples of Illusions

- Yellow on computer screen
 - Only red and green
- Movies show moving images
 - Still images



Examples of Illusions

- Yellow on computer screen
 - Only red and green
- Movies show moving images
 - Still images
- Rainbow in the sky
 - Scattered sun-light



Examples of Illusions

- Yellow on computer screen
 - Only red and green
- Movies show moving images
 - Still images
- Rainbow in the sky
 - Scattered sun-light
- The letter A says “ahh”
 - People make the sound



Leapfrog: Letter Factory

<https://www.amazon.com/Leapfrog-Factory-Roy-Allen-Smith/dp/B018N0JXGU>



A Connection is an Illusion

- The Internet is virtual
 - No physical connection
 - Information is being copied
- Many systems in the middle
 - Invisible to end users
- Receiving the right packets at the right time supports the illusion of connectivity
- Different degrees and qualities of “being connected”



MC Escher

<https://www.architecturaldigest.com/gallery/mc-escher-architecture-show>

Is Grandma okay?

- Write grandma a letter every week.
 - How is your health?
- Grandma writes back when she can.
- Are you connected? Is she okay?
- Last letter received:
 - 3 years ago.
 - 3 weeks ago.
 - 3 days ago.
 - Today.



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Is Grandma okay?

- When it works it feels like you are connected.
- When it stops working you have many more questions than answers.
 - Is my mail not making it?
 - Is her mail not making it back?
 - Is she not feeling well?
 - Has she decided to disown me?
 - Maybe she's in trouble?



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<https://socialistreadinggroup.wordpress.com/2018/07/08/little-red-cap-and-brier-rose/>, Public Domain,
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A Connection is an Illusion

- When connections work, it feels seamless.
- When they don't you can feel very lost.
- Knowing that it is an illusion can help you better understand what is going on.



"Pay no attention to the man behind the curtain"
Wizard of Oz (1939) – Metro-Goldwyn-Mayer

