What is internet?

The internet is a global network of interconnected computers and devices that communicates using standardized protocols like TCP/IP to share information and resources.

Sometimes we also say that Internet is a network of networks that allows machines to exchange data over long distances.

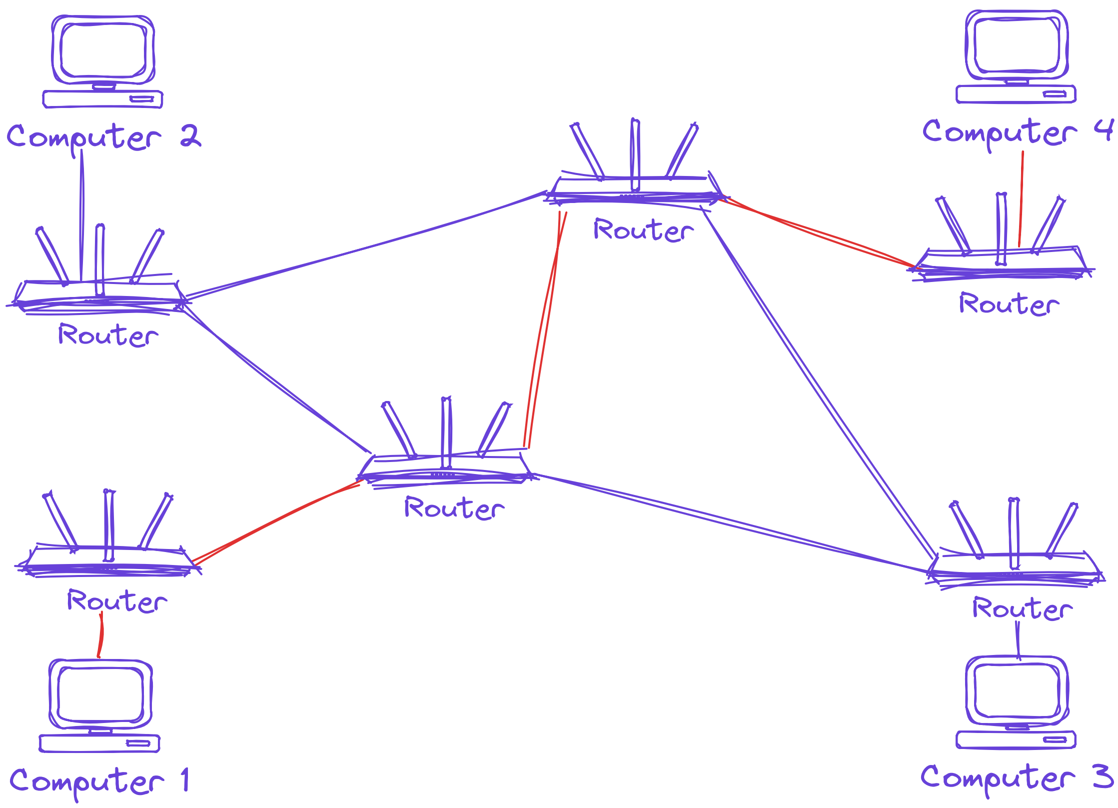

Figure 1. Computer 1 communicating with computer 4 through the network

Note:

In general, Network is a group of interconnected items. For example, Multiple people connected on social media also is a network.

The beginning

The cold war and Sputnik

- Sputnik (1957): The Soviet Union launched this tiny satellite, and the U.S. was like, “Wait, they’re beating us in space?” So there was a big push to invest in science and tech to catch up.

- The U.S. forms ARPA (Advanced Research Projects Agency) (1958) to fund crazy-cool research so they wouldn’t fall behind technologically.

Basically, Sputnik put some fire under the U.S. to get going on advanced ideas. One of these ideas? A communication network that wouldn’t collapse if part of it got destroyed, like, say, in a nuclear attack. Not a pleasant thought, but that’s the historical context.

Current technology was not enough

- Research collaboration and resource sharing:

  Most institutions had a single large mainframe computer. Mainframe computers were large and expensive. Users would either queue up to use it directly or submit jobs via punch cards.
  Communication between different computers was often done physically—people carrying tapes or punch cards from one place to another (sometimes jokingly called “sneakernet”).

- Decentralized, resilient communications:

  Communication system was centralised. They wanted a communications system that could survive or stay functional even if parts were destroyed in a potential nuclear attack.

Early Brainstormers: Licklider, Baran, and Davies

- J.C.R. Licklider at ARPA daydreamed about a global network where people could "log in" to different computers. He called it some sci-fi-ish name, like an "Intergalactic Computer Network."
- Paul Baran (in the U.S.) and Donald Davies (in the UK) were both thinking about something called packet switching.

Note:

Packet switching is the idea of splitting data into little packets so they can travel through a network along different routes. If one route's blocked, the packets just take a detour—awesome for resilience!

Basically, they were saying: "What if we chop data into pieces instead of sending it as one continuous stream?" This approach turned out to be a big deal.

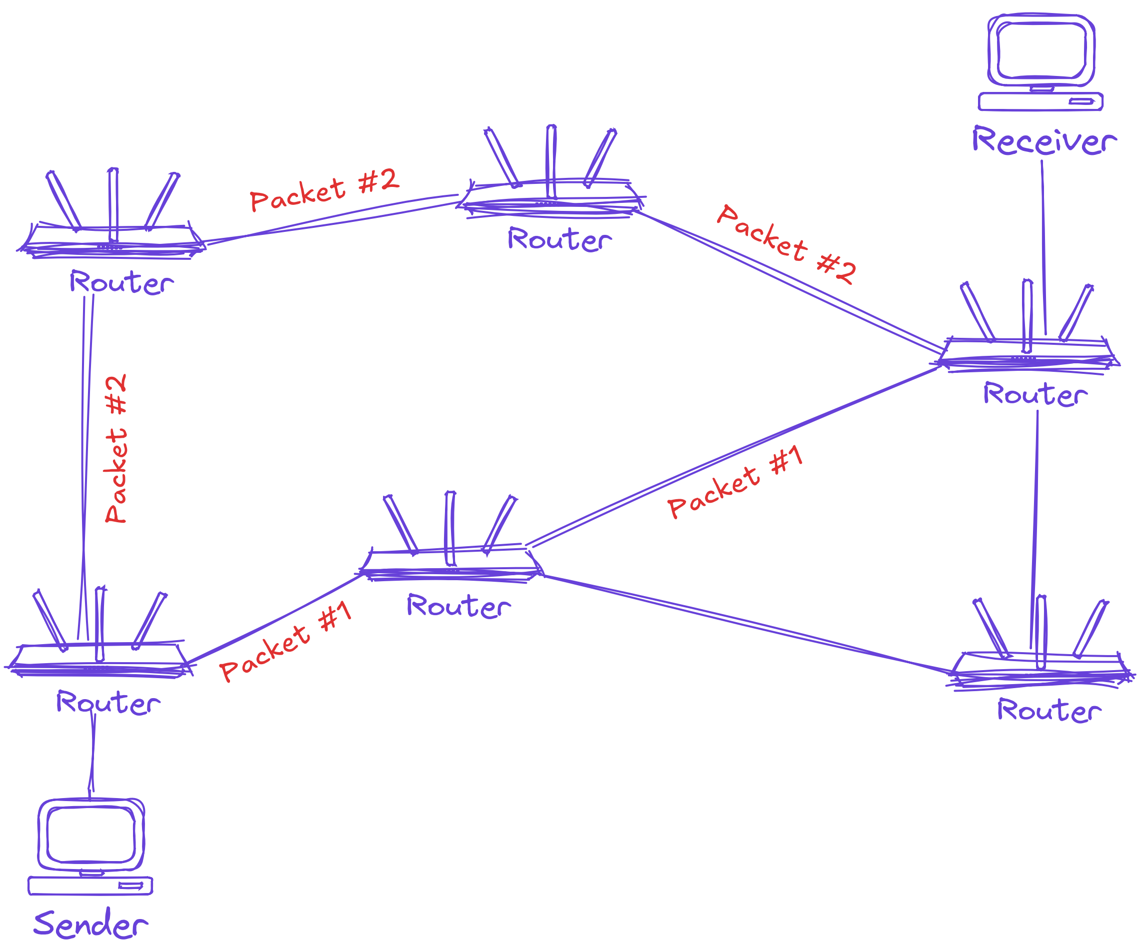

Figure: Showing packet switching

The First Big Experiment: ARPANET

- In 1969, ARPA funded a project connecting four universities: UCLA, Stanford Research Institute (SRI), UC Santa Barbara, and the University of Utah. They called this network ARPANET.
- They tested the idea of packet switching here.

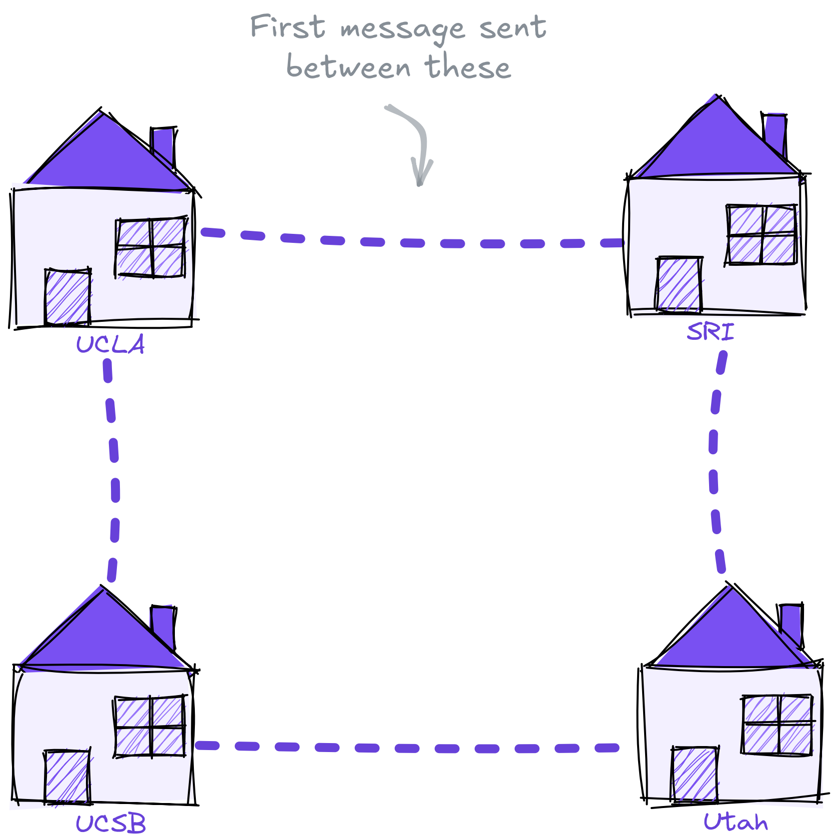

Figure: Initial ARPANET network

Fun fact:

The first message was sent on October 29, 1969, from UCLA to SRI. They tried to type "login," but the system crashed after sending "lo" So the very first message was basically "lo"—like saying "Hello" to the future.

Packet switching was decentralised

- The whole reason they wanted a decentralized system was so if one computer or node got destroyed (think: wartime scenario), the rest of the network would keep chugging along.
- With packet switching, if one path is down, the packets just find another route. It's like Google Maps rerouting you if there's a traffic jam.

NCP (Network Control Protocol)

- It was the host-to-host protocol on the ARPANET, meaning it handled communication between computers (hosts) connected to the network.
- NCP provided a bidirectional, flow-controlled data stream between two hosts.

Limitations of NCP

- NCP worked only on ARPANET. If another packet-switched network existed, it wasn't straightforward to route traffic between them.
- NCP was good enough for the early ARPANET but wasn't built to handle multiple interconnected networks globally.

Remember:

NCP was used throughout the early 1970s until January 1, 1983, when ARPANET officially transitioned to TCP/IP (the famous "Flag Day")

The Magic Protocols: TCP/IP

- As different networks popped up, people asked: “How do we get them all to talk to each other?”
- Vint Cerf and Bob Kahn developed TCP (Transmission Control Protocol) in the early ‘70s.
- Later, TCP was split into TCP + IP (Internet Protocol).

Think of it like this:

1. IP = gives an "address" to every device and decides where packets
should go.

2. TCP = makes sure the data gets there correctly and in the right order.

Flag Day – Birthday of modern Internet (1983)

- On January 1, 1983, ARPANET officially switched from its old protocol (NCP) to TCP/IP. This date is often considered the real “birthday” of the modern Internet, because now everything was using the same “language.”

By the early ‘90s, the government pulled back on running the main Internet “backbone,” leaving room for commercial Internet providers (ISPs).

Suddenly, more and more people could go online.

The World Wide Web

- Let’s fast-forward to 1989–1990. Tim Berners-Lee at CERN (in Switzerland) wanted a simpler way for scientists to share documents. He comes up with the World Wide Web.
- He invents HTML (HyperText Markup Language) and HTTP (HyperText Transfer Protocol). The idea: type a web address, and you get a “page” that can link to other pages with clickable text.

Remember:

The Internet is the big system (the infrastructure and protocols).

The Web (WWW) is one major service running on top of it. (Email, FTP, chat, etc., are other services.)

Mosaic, Browsers, and the Dot-Com Boom

- Mosaic (1993) was a graphical web browser that made the Web way more user-friendly. People could click links and see images—no more typing complicated commands.
- Soon, companies realized they could make money on the Internet → Dot-Com Boom in the mid-to-late '90s.
- By the end of the '90s, it was like everyone was jumping online, creating websites, and selling stuff.

Figure: NCSA Mosaic Browser 1.2

In a nutshell:

It's cool to see how it went from a defense project to a tool for universities to an entire world's communication backbone. Not bad for something that started with "lo."

Quick Timeline

4 October 1957
Sputnik satellite

7 Feb 1958
ARPA (Advanced Research Projects Agency)

Used to be centralized
(Connected to Mainframe computer)

16-28 Oct, 1962
Cuban Missile Crisis/
October Crisis

Needed decentralized
solution

1966
ARPANET project
started

29 Oct 1969
Sent first message ("lo") between
UCLA (University of California, Los Angeles) and
Stanford Research Institute

1971,
Text emails was possible between
governments, universities and labs

1973,
Text emails was possible even
happened out of the US

1974,
Cerf & Kahn's paper on TCP

1st Jan 1983,
ARPANET officially
switched from NCP to TCP/IP
Birthdate of modern Internet

1985,
DNS

1989-90,
World Wide Web

1993,
Mosaic browser launches,
popularizing the Web

1995,
commercial Internet era begins

Journey continues...

How internet works

When we talk about the Internet, we're talking about a huge network connecting millions of computers and devices worldwide. Every time you browse a website, send an email, or stream a video, your device is communicating with other computers over this global network.

Think of the Internet like a giant postal system but for digital data. Every device (phone, computer, etc.) has a unique address (IP address), just like a house has a street address. When you send or request information—say, asking for a web page—the data is broken into small "packets." Each packet is labeled with the destination's IP address (where it needs to go) and your device's IP address (where it came from).

These packets then travel through various "post offices" on the network, which we call routers. Routers read the address on each packet and decide the best path to send it along. This is called packet switching, and it's resilient: if one route is congested or offline, packets can go a different way.

Meanwhile, a system called the Domain Name System (DNS) acts like a phone book, translating the easy-to-remember website names (like "google.com") into the numerical IP addresses routers understand. Once the packets reach the right server (the final post office), that server sends back the information—again in packets—reassembled by your device into the webpage, video, or message you requested.

Behind the scenes, it all runs on a set of universal rules (protocols) called TCP/IP. IP handles the addressing, and TCP ensures the data is put back together reliably and in the right order. This combination of standardized addresses, packet switching, and DNS is why the Internet can connect billions of devices worldwide, across fiber optic cables, satellites, and wireless networks, without collapsing under its own size.

OSI Model

The OSI (Open Systems Interconnection) Model is a conceptual framework used to understand and design how different computer systems communicate over a network. It organizes network functions into seven distinct layers, each with specific responsibilities. By standardizing these layers, the OSI Model helps ensure interoperability between different hardware, software, and protocols.

Why Was the OSI Model Developed?

Historical Context:

- Before the OSI Model, different vendors used proprietary networking architectures (e.g., IBM's SNA, DECnet, etc.). This led to compatibility issues because each system spoke its own "language."

Need for Standards:

- The International Organization for Standardization (ISO) developed the OSI Model in the late 1970s and published it in 1984 as ISO 7498.
- Goal: Create a universal set of rules and guidelines so all devices could communicate regardless of internal design.

Remember:

The OSI Model isn't itself a protocol suite; it's a reference model. Real-world protocols map to one or more layers.

In practice, the TCP/IP Model is used more in real-world networking, but the OSI Model remains important as a teaching/reference tool to understand conceptual layering.

OSI model layers diagram

Provides services directly to end-user applications	Layer 7 - Application	HTTP, FTP, SMTP, DNS
Handles encryption, decryption, compression, translation	Layer 6 - Presentation	SSL/TLS, MIME
Manages sessions (start, maintain, end) between applications	Layer 5 - Session	NetBIOS, RPC, some implementations of APIs
Provides end-to-end communication, reliability (or not), flow control	Layer 4 - Transport	TCP (reliable), UDP (unreliable/faster)
Handles routing and logical addressing (IP addresses)	Layer 3 - Network	IP, ICMP, IPsec, Routing Protocols (OSPF, BGP)
Establishes reliable links between physically connected nodes	Layer 2 - Data link	Ethernet (802.3), Wi-Fi (802.11), PPP, VLANs
Governs physical transmission of raw bits over media (cables, radio waves)	Layer 1 - Physical	Ethernet cabling (twisted pair, fiber), Wi-Fi radio signals

Layer-by-Layer Explanation

Layer 7 Application:

- Closest to the end user. This layer interacts with software that implements a communicating component.
- Provides network services to end-user applications.
- Email (SMTP, IMAP), File transfer (FTP), Web browsing (HTTP/HTTPS).
- This layer doesn't handle the data transport itself—it mainly deals with the content of the message and the user interface part.
- HTTP, FTP, SMTP, Telnet, DNS (sometimes considered at Application, though sometimes mapped to other layers as well).

Figure. PDU at this layer

Layer 6 Presentation:

- Responsible for formatting, encryption, and compression of data.
- Ensures the data from the application layer of one system is readable by the application layer of another system.
- Character encoding (e.g., ASCII, EBCDIC, Unicode).
- Encryption/decryption (e.g., SSL/TLS can be conceptually placed here, although in practice it might straddle multiple layers).

Figure. PDU at this layer

Layer 5 Session:

- Controls interhost communication sessions.
- Establishes, manages, and terminates sessions between applications. A “session” is like a longer-running conversation or exchange.
- Session establishment and teardown.
- Ensures both sides agree on when to start/stop sending data in complex interactions.
- Many modern protocols integrate session handling with layers above or below, so the pure “Session Layer” is less visible in real stacks.

Figure. PDU at this layer

Layer 4 Transport:

- Ensures end-to-end data transfer.
- Segments, transfers, and reassembles data into a data stream.
- Provides flow control, error checking, and (optionally) reliability.
- Port addressing to differentiate multiple applications running on the same host.
- TCP (Transmission Control Protocol) – connection-oriented, reliable
- UDP (User Datagram Protocol) – connectionless, less overhead, faster but no guaranteed delivery.
- Adds the Source and Destination IP addresses in its header If TCP selected

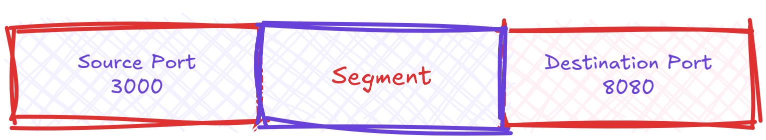

Figure. PDU at this layer

Layer 3 Network:

- Handles routing of data across intermediate networks.
- Addresses data packets with logical (IP) addressing.
- Logical addressing (IP addresses).
- Path determination and routing decisions.
- Packet creation, fragmentation, and reassembly (if needed).
- IP (Internet Protocol), ICMP (Internet Control Message Protocol), IPSec (for secure IP).
- Adds the Source and Destination IP addresses in its header

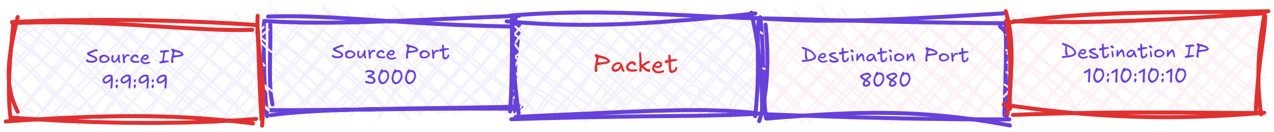

Figure. PDU at this layer

Layer 2 Data link:

- Provides node-to-node data transfer. Ensures data frames are transmitted between physically connected nodes without errors.
- Responsible for MAC (Media Access Control) addressing and controlling how devices share a common medium.
- Ethernet, Wi-Fi (802.11), Point-to-Point Protocol (PPP), HDLC.
- Adds the Source and Destination MAC addresses in its frame header

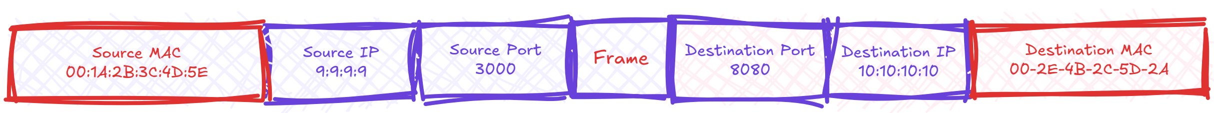

Figure. PDU at this layer

Layer 1 Physical:

- Concerned with the physical transmission of raw bits over a communication medium.
- Defines electrical or optical signals, modulation, wiring standards, pin layouts, etc.
- Physical connectors: RJ-45, coaxial cable ends, fiber connectors.
- Ethernet physical signaling, USB (for data transfer), DSL, Bluetooth radio waves.

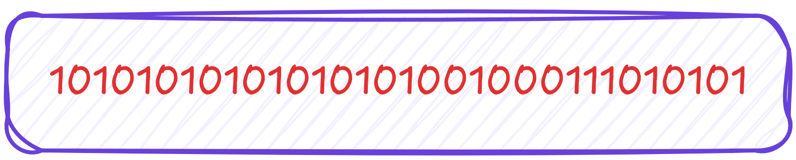

Figure. PDU at this layer

Summary and key takeaways

- The OSI Model is a 7-layer reference that breaks down network communication from physical signals (Layer 1) to application interfaces (Layer 7).
- It was created to standardize and guide how networks should be designed, ensuring compatibility across different systems.
- Though real-world networking typically references the TCP/IP Model, the OSI Model remains vital for teaching, troubleshooting, and conceptual clarity.
- Each layer builds on the services of the layer below it and provides services to the layer above it, forming a modular stack.

TCP/IP Model

TCP/IP (Transmission Control Protocol/Internet Protocol) is the de facto standard suite of protocols that governs how data moves across the Internet.

It was developed by DARPA (U.S. Defense Advanced Research Projects Agency) in the 1970s and officially adopted by the ARPANET on January 1, 1983 (“Flag Day”).

There are typically four layer.

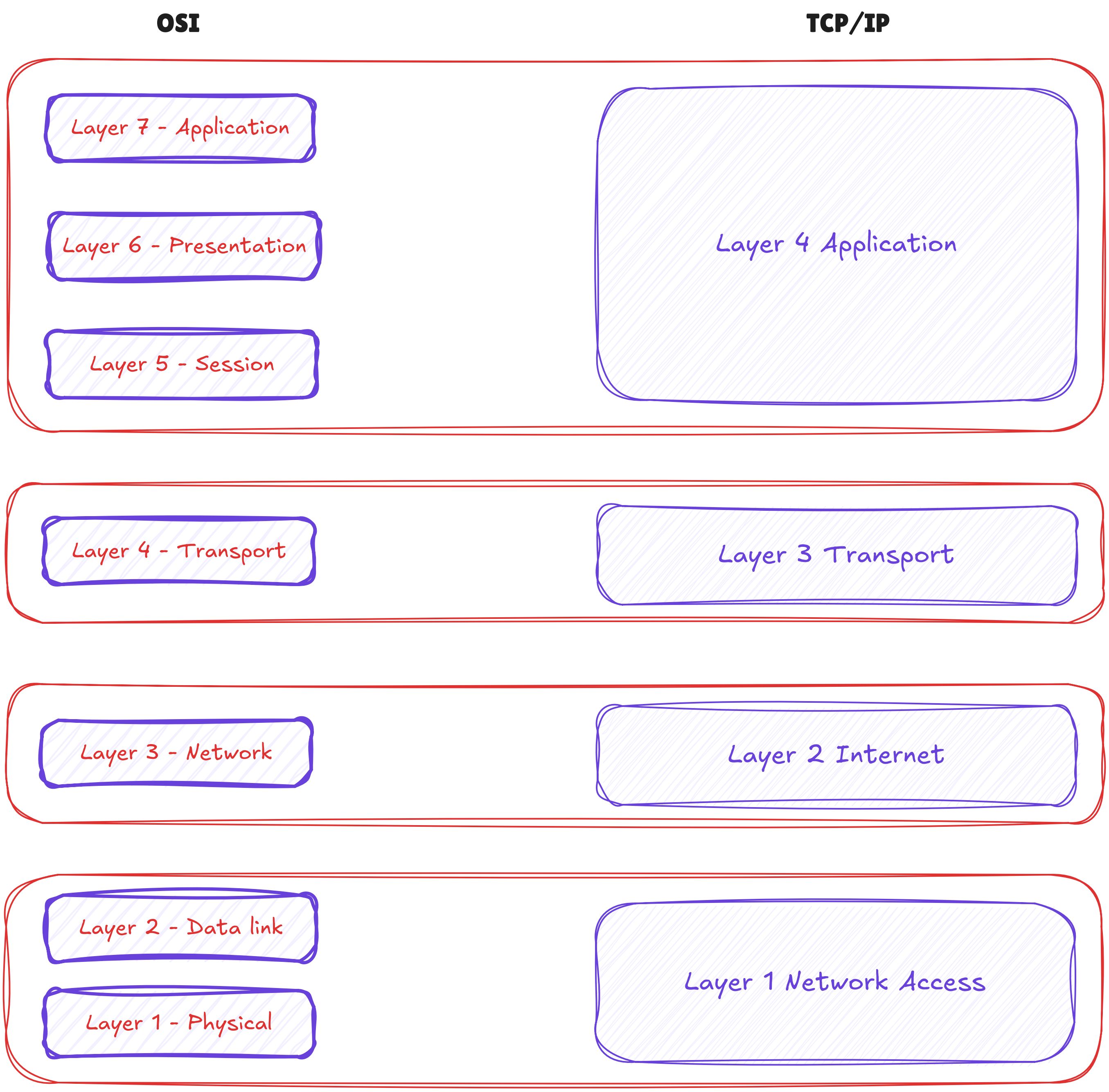

Figure. TCP/IP Diagram