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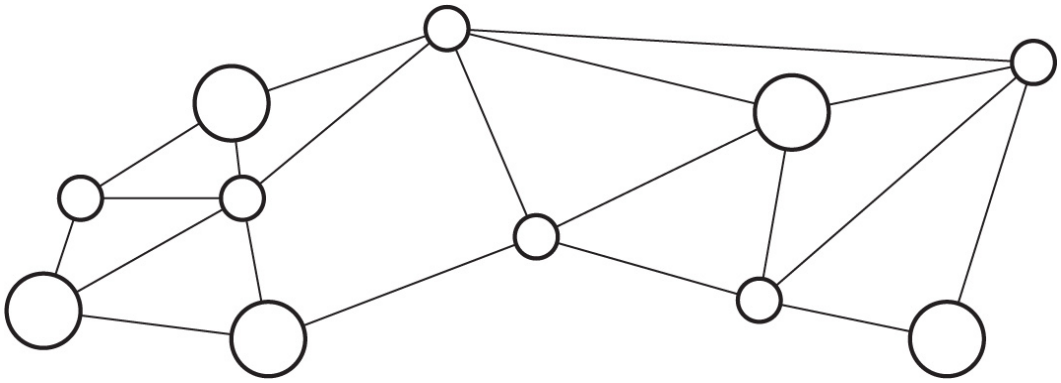
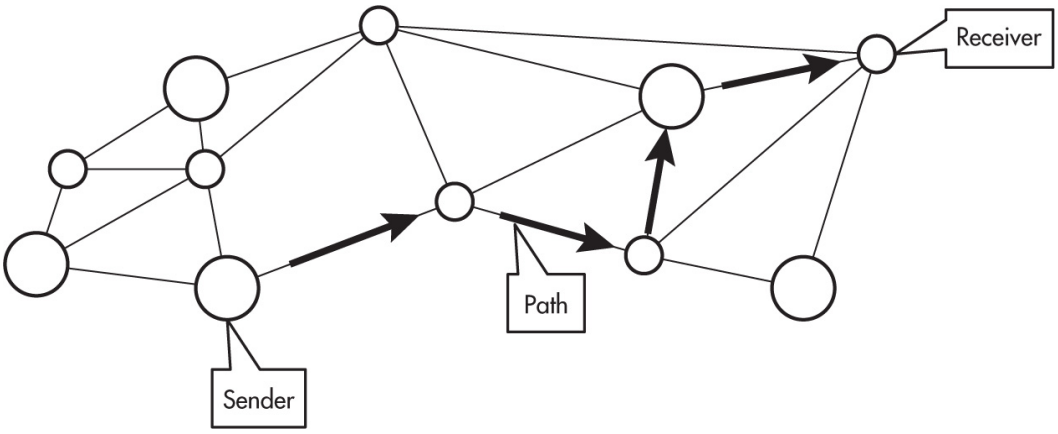
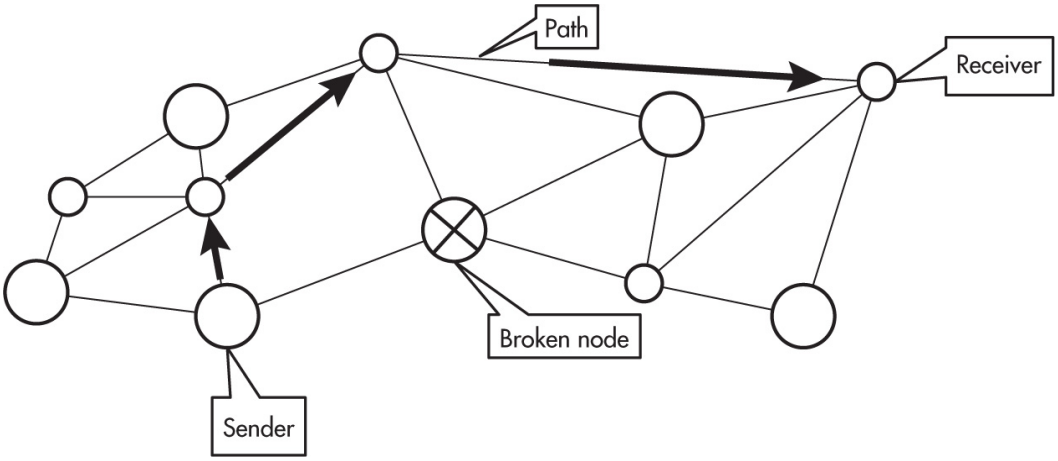
AUTONOMOUS SYSTEMS OF THE INTERNET



Each circle in the diagram above represents a computer system that is connected to another computer system, forming a computer network. The larger circles represent systems that have a higher bandwidth capacity measured in bits per second. The bandwidth of a computer network is the maximum amount of data that can be sent in a fixed amount of time.



A path between two computing devices on a computer network (a sender and receiver) is a sequence of directly connected computing devices that begins at the sender and ends at the receiver. Routing is the process of finding a path from sender to receiver.



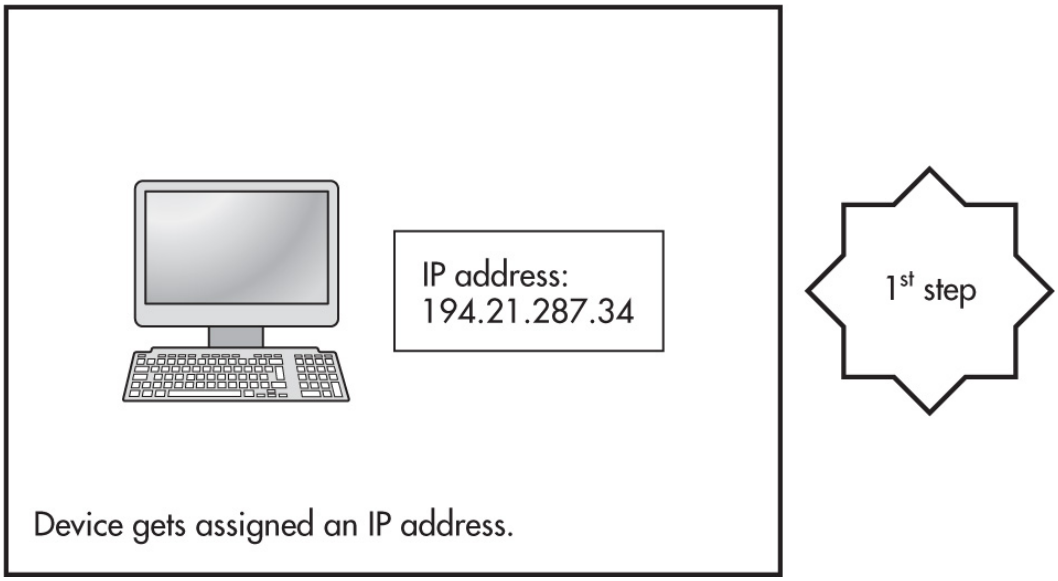
If the path from sender to receiver is broken, the path will be rerouted. This fault-tolerant nature of the internet makes connections between computing devices more reliable.

The internet connects devices and networks from all over the world. The internet is a physical network of fiber optics, radio transmitters, and cabling. Devices and networks that make up the internet are connected and communicate using standardized, open communication protocols. A protocol is an agreed-upon set of rules that specify the behavior of a system. These internet protocols, including those for addresses and names, have evolved to allow for the internet to be scalable. The scalability of a system is the capacity for the system to change in size and scale to meet new demands.

Internet Protocol

Internet protocol (IP) is responsible for addressing and routing your online requests. For a device to connect to the internet, it is first assigned an internet protocol address. When the internet was founded in the 1960s, the creators did not predict the need for billions and billions of IP addresses. Currently, we are switching between the fourth and sixth versions of the internet protocol. The fourth version (IPv4) uses 32 bits to store IP addresses. These 32 bits can hold 2^{32} IP addresses. When multiplied out, 2^{32} is actually 4,294,967,296 unique addresses. The newer version, IPv6, uses 128 bits, which can hold 2^{128} IP addresses. This is equivalent to approximately 34,000,000,000,000,000,000,000,000,000,000,000,000 unique addresses.

Switching from IPv4 to IPv6 is an increase in the capacity by $2^{128} - 2^{32} = 2^{96}$ times.



This IP address is not permanently assigned to a user's device and can change at any time.

Transmission Control Protocol

Transmission control protocol (TCP) is a protocol that defines how computers send packets of data to each other. Data traveling in the internet is broken down

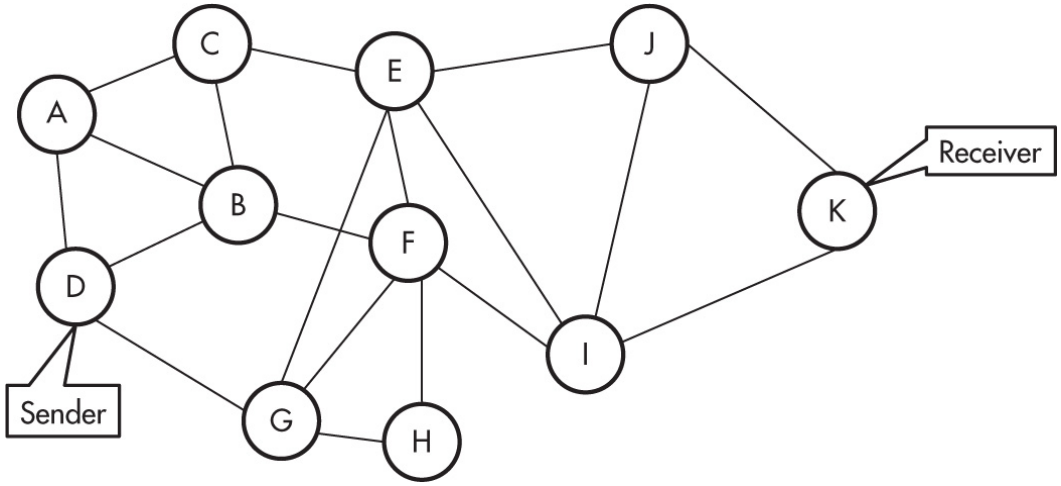
into small chunks of data called packets. TCP protocols guide the rules on how data are subdivided into packets before transmission.

Trailer End of packet	**Data**	**Header:** Sender's IP address Receiver's IP address Packet #

User Datagram Protocol

User datagram protocol (UDP) is a protocol that allows computer applications to send messages without checking for missing packets to save on time needed to retransmit missing packets. UDP is not as reliable as TCP, which does resend packets lost when transmitting.

FAULT TOLERANCE



The internet has been engineered to be fault tolerant. If a system fails, a different path can be chosen between the sending computer and the receiving computer. Redundancy is the inclusion of extra paths that can mitigate the failure of a system if other components fail.

When a system can support failures and continue to function, it is called *fault tolerant*. This is important because elements can fail at any time, and fault

tolerance allows users to continue to use the network.

In the diagram above, the paths various packets travel from computer D to computer K will not be the same. Because packets can travel different paths, they will likely arrive at the target computer out of order. The paths packets take are physically guided by routers.

If a packet is not received, the TCP protocol will request the sender to resend the missing packet. The IP addresses of both the sender and receiver are found in the header of the packet. When all packets are received, the packets are put together using the packet numbers found in the header to form the original binary message.

The process from computer D to computer K in the diagram above is called *end-to-end architecture*. This process involves the breaking down and assembling of the packets at each end. What happens to the packets in the middle is hidden from the user in an abstraction.

Difference Between Internet and World Wide Web

The internet refers to the hardware. It is made up of the computers, cables, routers, and many more components that make up the entire network. It is a global decentralized network connecting millions of computers. The World Wide Web, in contrast, refers to the software used on the internet. HTTP is a protocol used by the World Wide Web to transmit data. The internet allows access to the World Wide Web, which is a system of linked pages, programs, and files.