How Computer Networks Send Data Across the Internet

When you send information across the Internet, the **Transmission Control Protocol/ Internet Protocol (TCP/IP)** the language computers use when communicating over the Internet first breaks the information up into *packets*, smaller blocks of information that also contain a variety of data that helps the packets travel across the Internet.

The packets travel through many of networks, computers, and communications lines before they reach their final destinations. A variety of hardware processes those packets and routes them to their proper destinations.

Five of the most important pieces of hardware are hubs, bridges, repeaters, and routers.

Hubs/ Switches are important because they link groups of computers to one another and let computers communicate with each other.

Bridges link local area networks (LANs) with one another. They enable data destined for another LAN to be sent there, while keeping local data inside its own network.

When data travels across the Internet, it often crosses great distances, which can be a problem because the signal sending the data can weaken over the distance. To solve the problem ,**repeaters** amplify the data at intervals so the signal doesn't weaken.

Routers play a key role in managing Internet traffic. Their job is to ensure the packets always arrive at the proper destination. If data is being transferred among computers that are on the same LAN, routers often aren't necessary because the network itself can handle its internal traffic. Routers come into play when the data is sent between two different networks. Routers examine packets to determine their destinations. They take into account the volume of activity on the Internet, and they send the packet to another router that is closer to the packet's final destination.

All this hardware connects the many networks that make up the Internet. Corporate LANs are at the most *local* level of networks. Mid level networks hook together these LANs using high-speed telephone lines, Ethernet, and microwave links. A *regional* network is a mid level network in a geographic area. A wide area network (WAN) is another type of midlevel network. A WAN consists of an organization with many networked sites linked together.

When a packet travels from a computer on a LAN in a midlevel network to a computer somewhere else on the midlevel network, a router (or a series of routers) sends the packet to its proper destination. However, if the destination lies outside the midlevel network, the packet is sent to a network access point (NAP), where it is sent across the country or the world on a backbone. High-speed backbones such as the vBNS (very high-speed Backbone Network Services) can transmit data at an exceedingly high rate155 megabits (millions of bits) per second (Mbps) or higher. Even faster backbones are being built that will transmit data at an astonishing 9.6 billion bits per second.

How Networks Talk with Each Other

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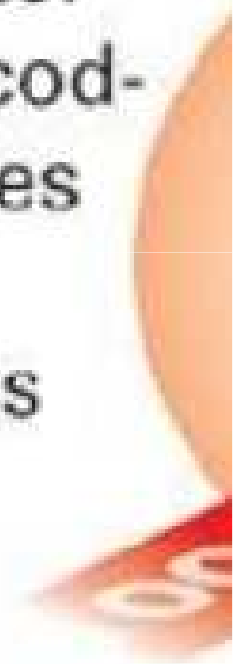
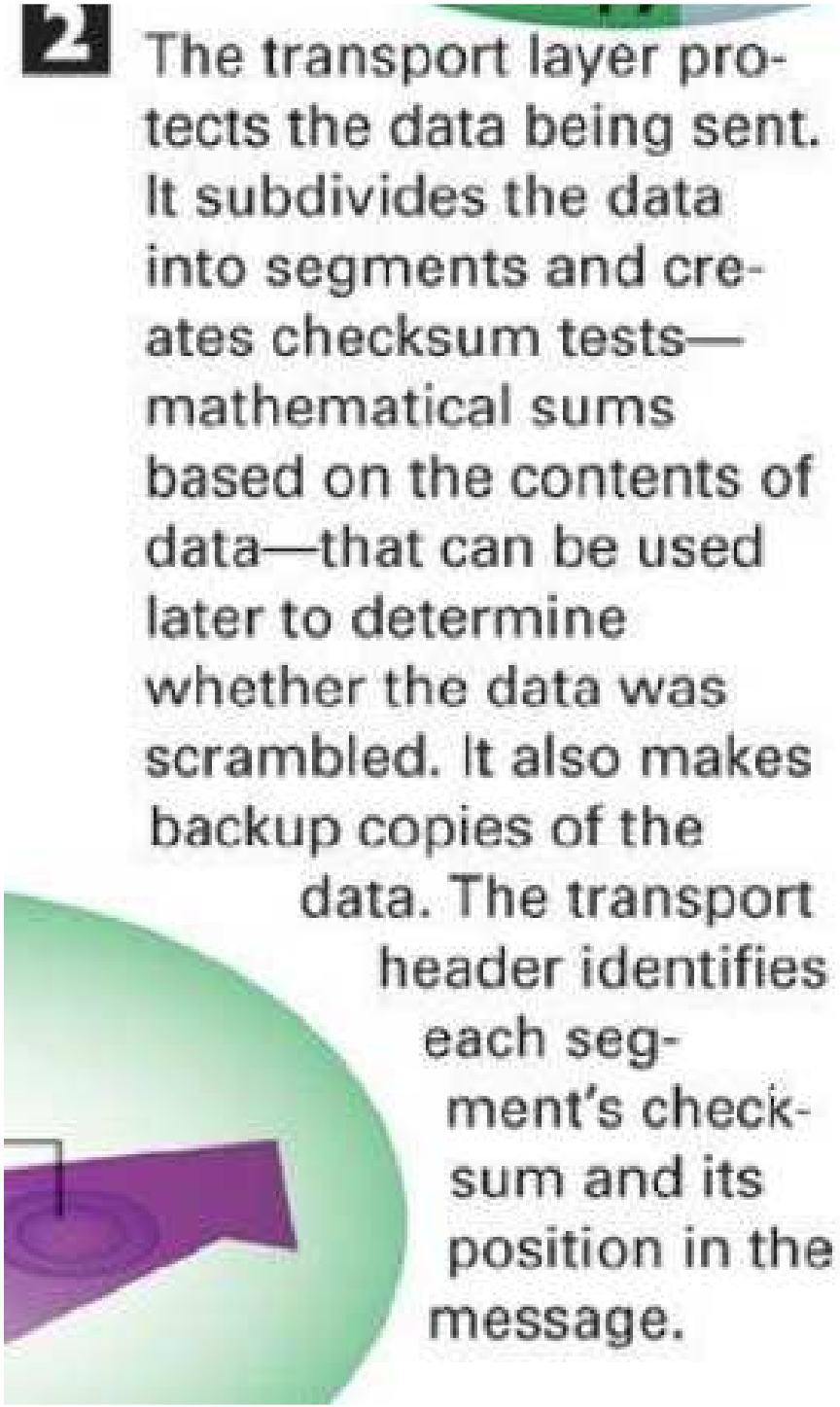
For a message, file, or any other data to travel through a network, it must pass through several layers, all designed to make sure the data gets through intact and accurate. The first layer, the application layer, is the only part of the process a user sees, and even then the user doesn't see most of the work the application does to prepare a message for sending over a network. The layer converts a message's data into bits and attaches a header identifying the sending and receiving computers.

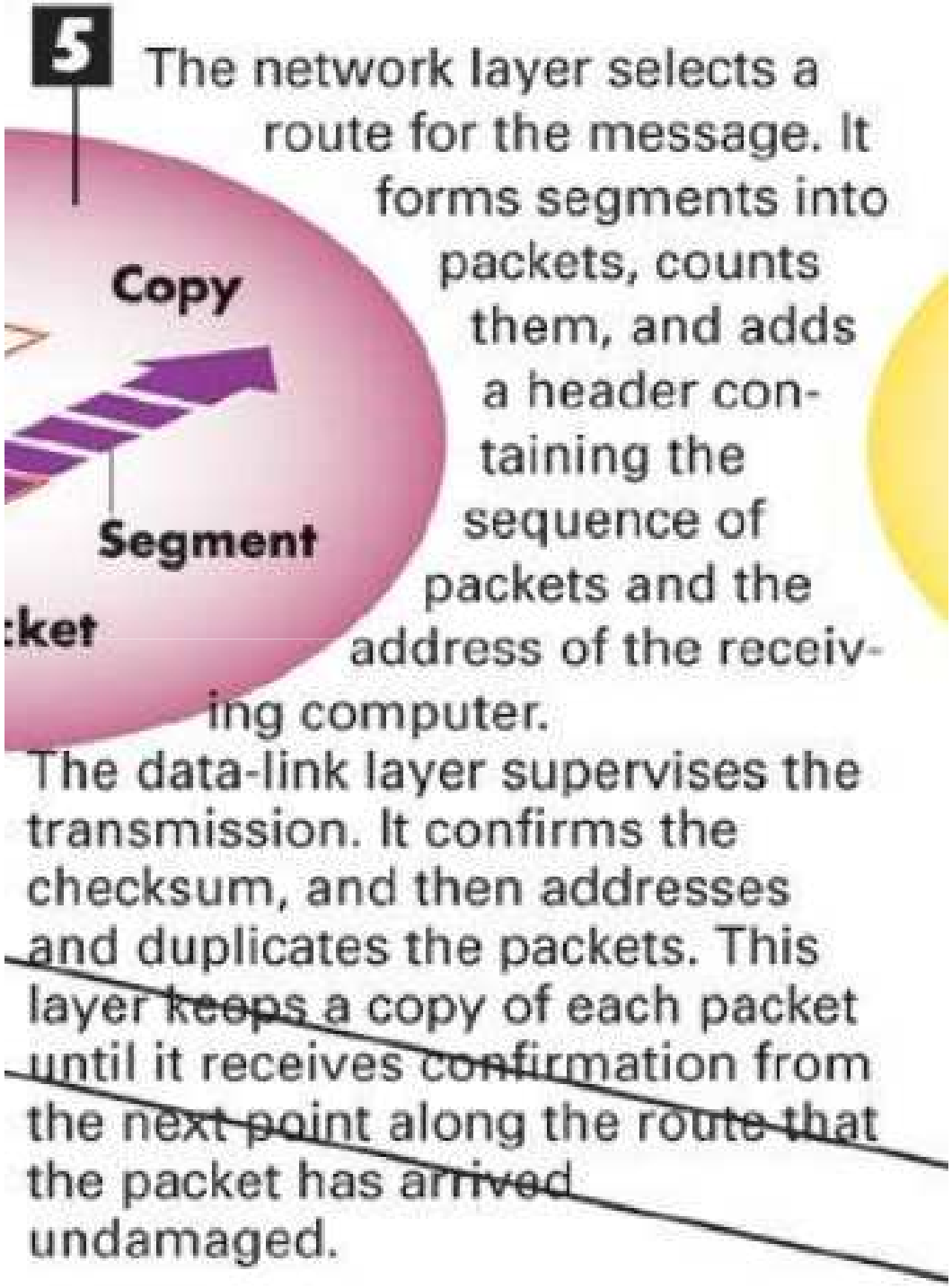
The presentation layer translates the message into a language that the receiving computer can understand (often ASCII, a way of encoding text as bits). This layer also compresses and perhaps encrypts the data. It adds another header specifying the language as well as the compression and encryption schemes.



The session layer opens communications. It sets boundaries (called brackets) for the beginning and end of the message and establishes whether the message will be sent half duplex, with each computer taking turns sending and receiving, or full duplex, with both computers sending and receiving at the same time. The details of these decisions are placed into a session header.



The transport layer protects the data being sent. It subdivides the data into segments and creates checksum tests—mathematical sums based on the contents of data—that can be used later to determine whether the data was scrambled. It also makes backup copies of the data. The transport header identifies each segment's checksum and its position in the message.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The network layer selects a route for the message. It forms segments into packets, counts them, and adds a header containing the sequence of packets and the address of the receiving computer.
Copy
Segment
ket
The data-link layer supervises the transmission. It confirms the checksum, and then addresses and duplicates the packets. This layer keeps a copy of each packet until it receives confirmation from the next point along the route that the packet has arrived undamaged.

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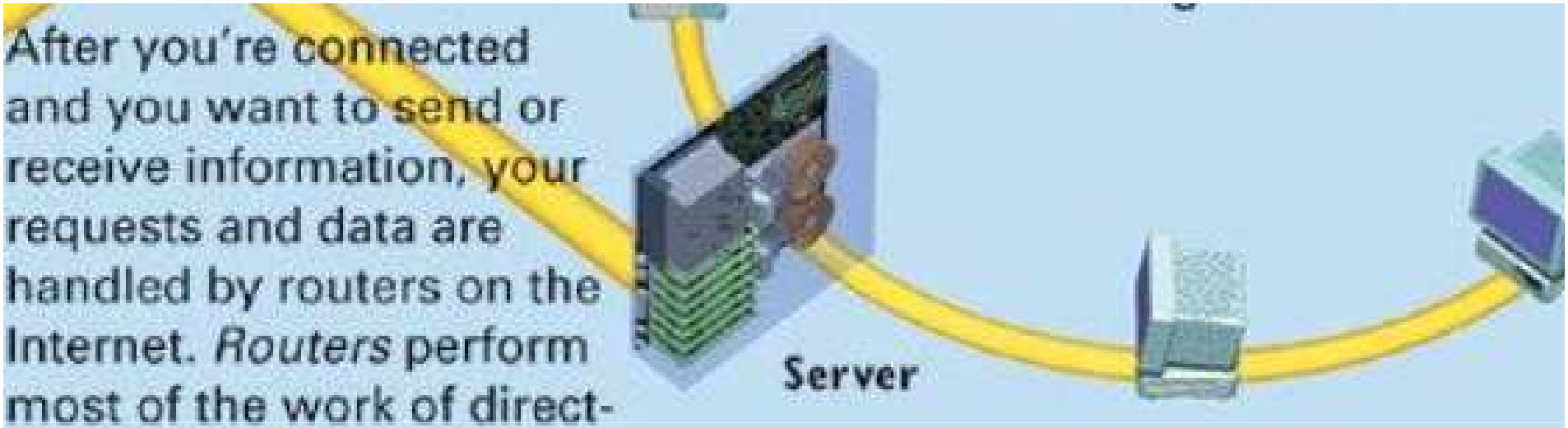
The physical layer encodes the packets into the medium that will carry them—such as an analog signal, if the message is going across a telephone line—and sends the packets along that medium.

At the receiving node, the layered process that sent the message on its way is reversed. The physical layer reconverts the message into bits. The data-link layer recalculates the checksum, confirms arrival, and logs in the packets. The network layer recounts incoming packets for security. The transport layer recalculates the checksum and reassembles the message segments. The session layer holds the parts of the message until it is complete and sends it to the next layer. The presentation layer decrypts, expands, and translates the message. The application layer identifies the recipient, converts the bits into readable characters, and directs the data to the correct application.

An intermediate node calculates and verifies the checksum for each packet. A router might also reroute the message to avoid congestion on the network.

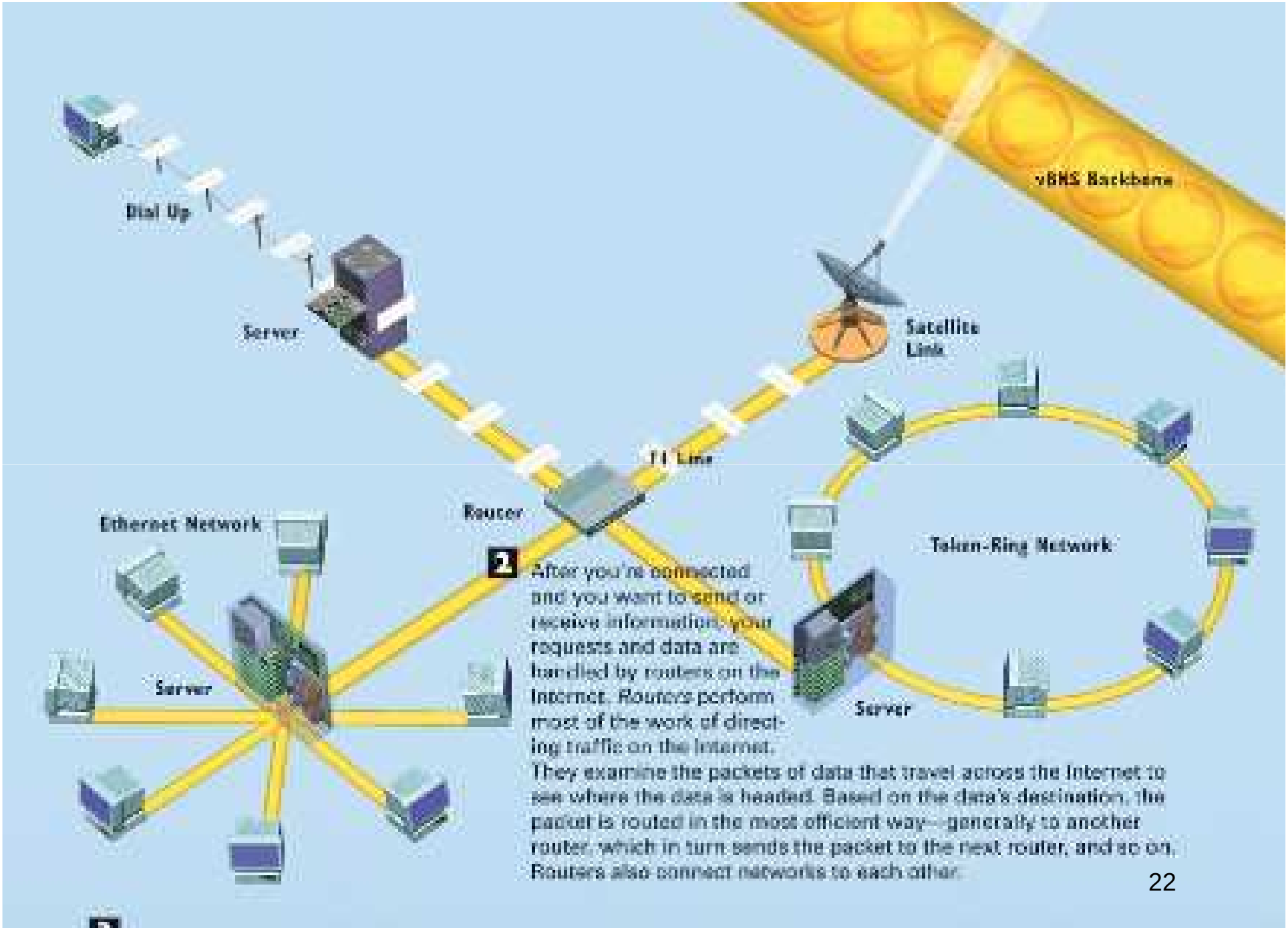
How Networks Link to the Internet

- Whether at work or at home, you get onto the Internet via a variety of ways. You may connect to a LAN at your place of business via Ethernet networks and token-ring networks. Token-ring networks pass data in tokens from computer to computer in a ring or star configuration. In Ethernet networks, the data goes from a server to a computer on the network. At home, you can dial into a large computer connected to the Internet via an online service or a dial-in Internet service provider (ISP), or you can use another type of Internet service, such as a cable modem, Digital Subscriber Line (DSL) modem, or a satellite connection.



After you're connected and you want to send or receive information, your requests and data are handled by routers on the Internet. *Routers* perform most of the work of directing traffic on the Internet. They examine the packets of data that travel across the Internet to see where the data is headed. Based on the data's destination, the packet is routed in the most efficient way—generally to another router, which in turn sends the packet to the next router, and so on. Routers also connect networks to each other.

The data can be transferred between networks in a number of ways. Dedicated telephone lines can transmit data at 56Kbps (kilobits per second). An increasing number of T1 leased telephone lines carry data between networks. A T1 link can carry data at 1.544Mbps. Higher-speed T3 links, which can carry data at 44.746Mbps, are being used as well. If you dial into an ISP from home, you might connect at a lower speed than at your office, where you might have higher-speed connections such as a T1 line. However, a variety of high-speed options are available for connecting to the Internet at home, such as cable modems or DSL connections.


Dial Up
Server
vBNS Backbone
Satellite Link
T1 Line
Router
Ethernet Network
Token-Ring Network
Server
Server
2
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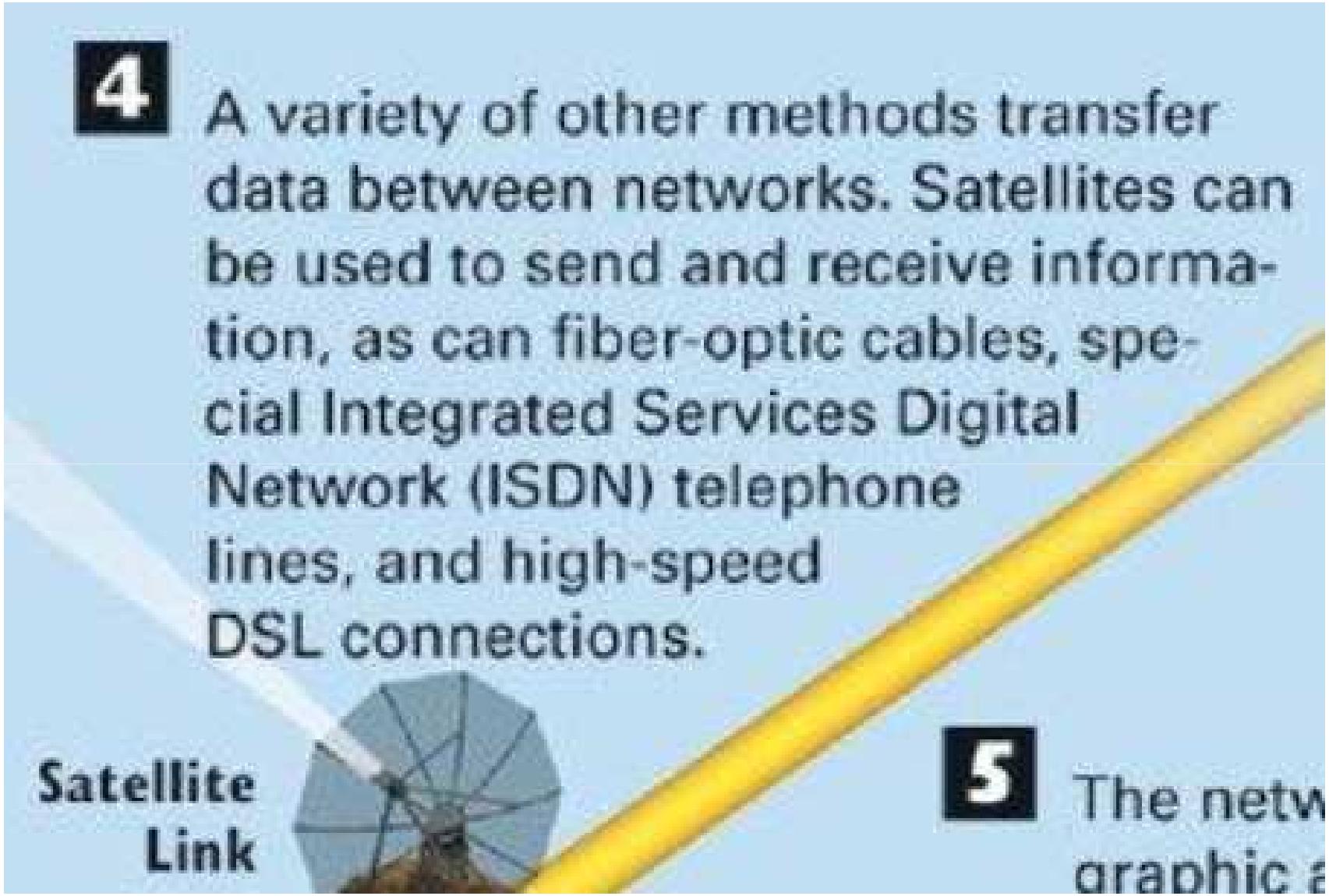
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A variety of other methods transfer data between networks. Satellites can be used to send and receive information, as can fiber-optic cables, special Integrated Services Digital Network (ISDN) telephone lines, and high-speed DSL connections.
Satellite Link
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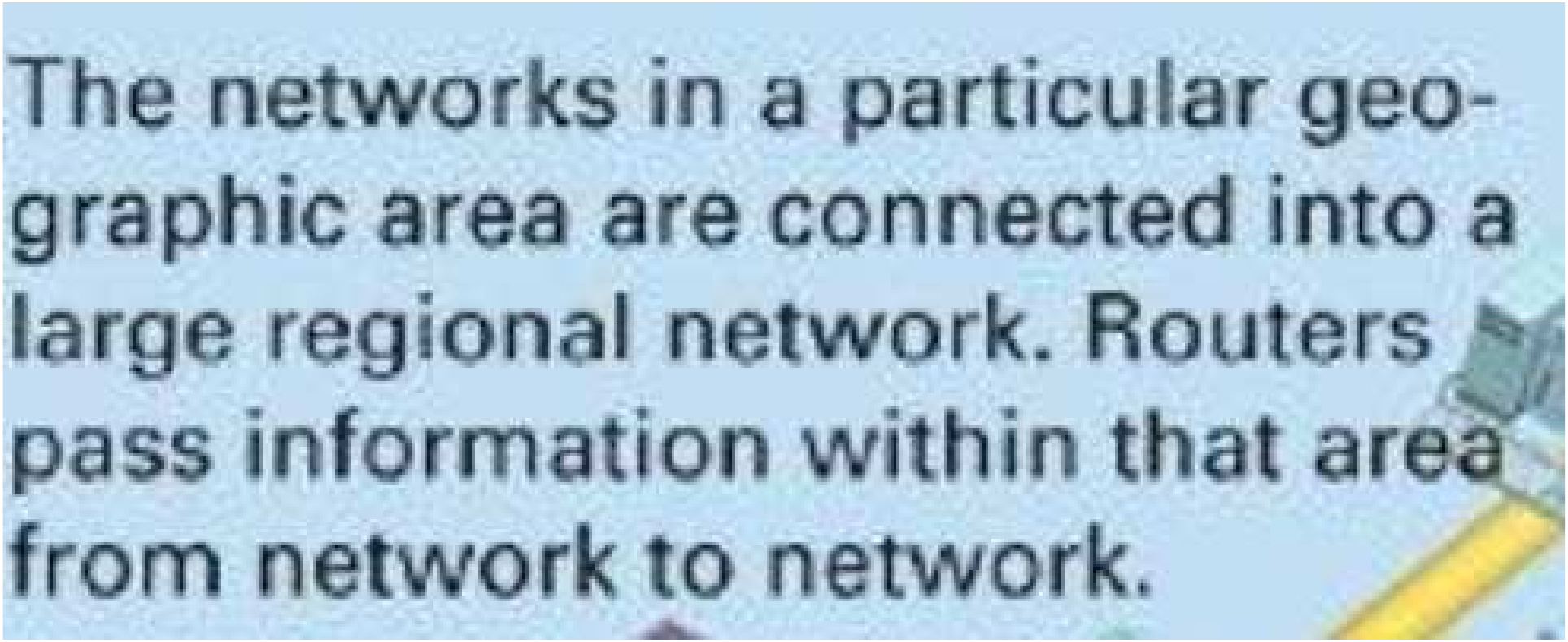
The netw
graphic a


The networks in a particular geo-
graphic area are connected into a
large regional network. Routers
pass information within that area
from network to network.

Regional networks are connected to one another via high-speed backbones—connections that can send data at extremely high speeds. When data is sent from one regional network to another, it is first sent to a network access point (NAP). The NAP then routes the data to high-speed backbones, such as vBNS, which can transmit data at 155Mbps or higher. The data is then sent along the backbone to another regional network. Finally, it is passed to a specific network and computer within that regional network.

- **TCP/IP (Transmission Control Protocol/Internet Protocol)**

  The communications protocols that underlie the Internet.

  packet

  A piece of data broken down into pieces for transmitting over the Internet or another network.

vBNS (very high-speed Backbone Network Services) can transmit data at an exceedingly high rate many Gbps.