



CCNA Discovery II Working at a Small-to- Medium Business or ISP



Internet and Its Uses– Chapter 1

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Objectives

After completion of this chapter, you should be able to:

- Describe how the Internet is evolving and the various ways that businesses are using the Internet.
- Describe the importance of standards in the continuing growth of the Internet.
- Describe the purpose of an Internet Service Provider (ISP) and the services that it offers.
- Describe the hierarchical structure of the Internet and the purpose of the Point of Presence (POP) and the Internet Exchange Point (IXP).
- Identify the types of devices used by the ISP to provide services and describe the importance of scalability in the ISP network.
- Describe the various network support teams that work at an ISP and the roles and responsibilities of each one.

The Internet and Its Standards

- The Internet is a worldwide, publicly accessible network of networks. It enables individuals and businesses alike, through interconnected computer networks, to share information, resources, and services.
- In the beginning, the Internet was used strictly for scientific, educational, and military research.
- In 1991, regulations changed to allow businesses and consumers to connect as well. The Internet has grown rapidly, and is now global.

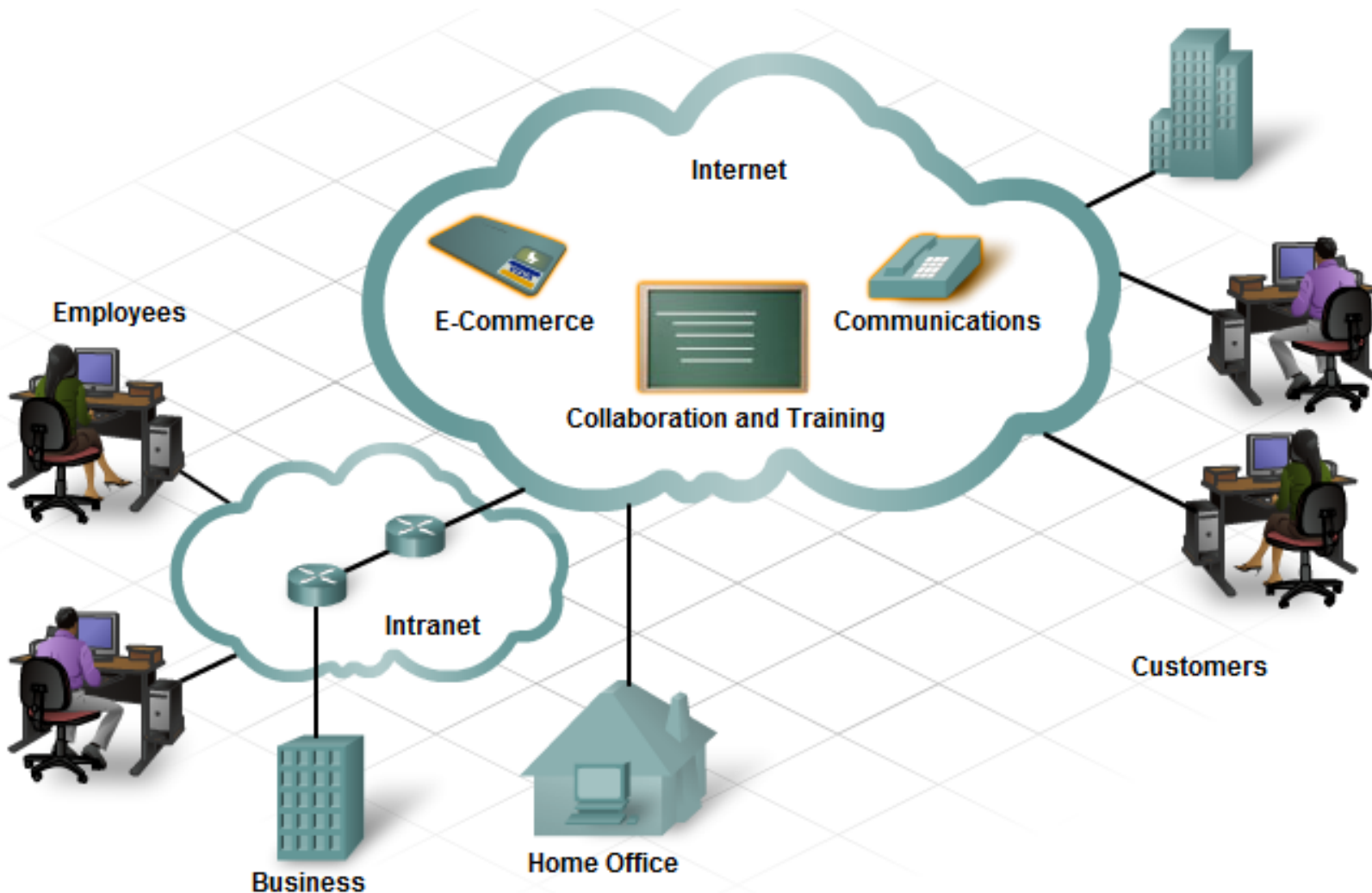
The Internet and Its Standards

- New technologies are continuously being developed that make the Internet easier and more attractive to use. Online applications are available to the Internet user, including email, web browsing, streaming music and video, online gaming, and instant messaging.
- The way people interact, share information, and even do business is changing to keep up with the continuous evolution of this global network.

The Internet and Its Standards

- The Internet is creating a wider audience and consumer base for whatever message, product or service can be delivered. For many businesses, having Internet access has become critical, not only for communication, but also just for day-to-day operation. Some of the business uses of the Internet include:
 - E-Commerce
 - Communications
 - Collaboration and Training

The Internet and Its Standards



The Internet and Its Standards

- With the increasing number of new devices and technologies coming online, how is it possible to manage all the changes and still reliably deliver services such as email? The answer is Internet standards.
- A standard is a set of rules for how something must be done. Networking and Internet standards ensure that all devices connecting to the network use the same set of rules.

The Internet and Its Standards

- By having standards, it is possible for different types of devices to send information to each other over the Internet. For example, the way an email is formatted, forwarded, and received by all devices is done in a standardized manner. If one individual sends an email via a personal computer, another individual can use a mobile phone to receive and read the e-mail as long as the mobile phone uses the same standards.

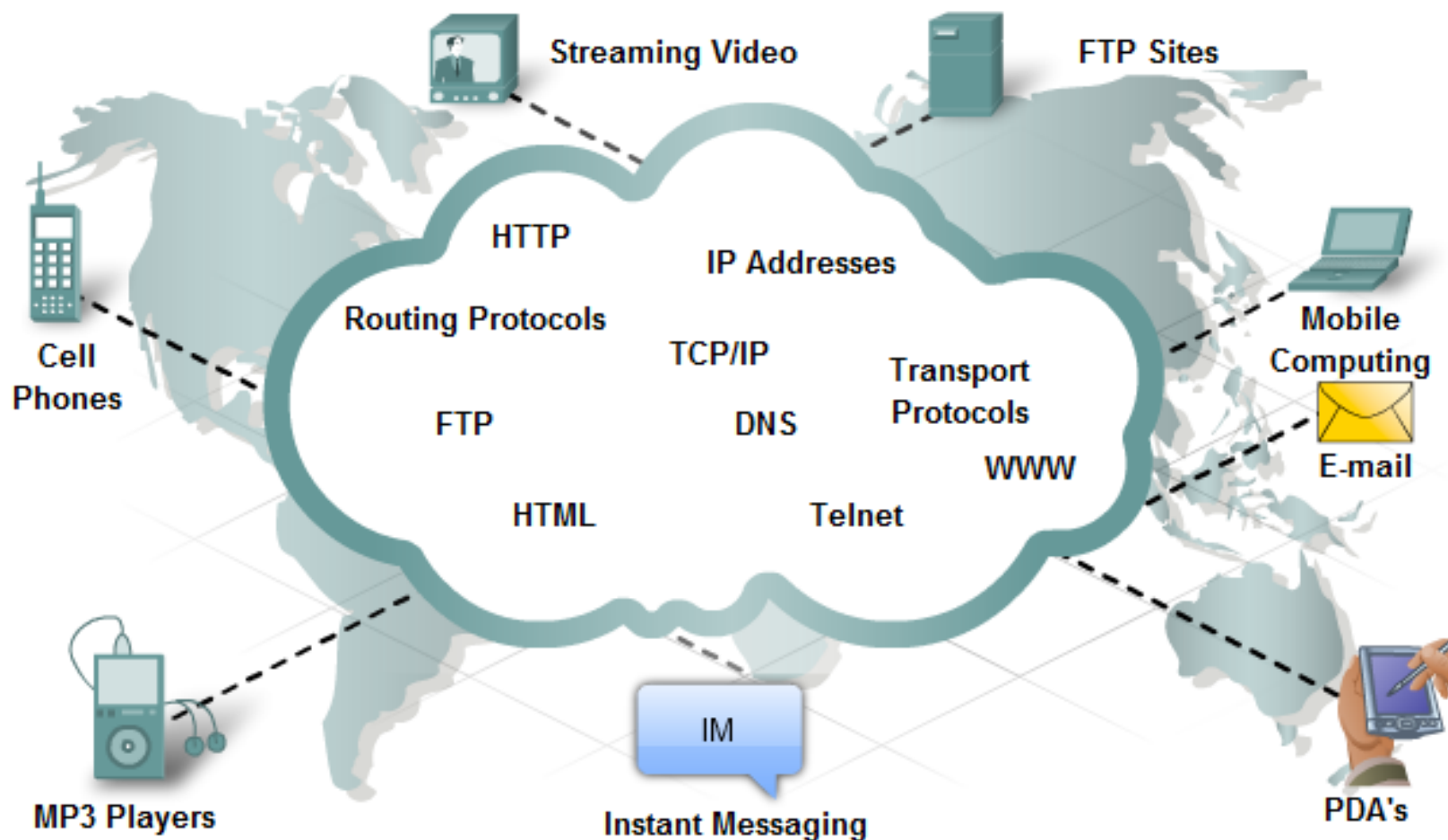
The Internet and Its Standards

- An Internet standard is the end result of a comprehensive cycle of discussion, problem solving, and testing. When a new standard is proposed, each stage of the development and approval process is recorded in a numbered Request for Comments (RFC) document so that the evolution of the standard is tracked.

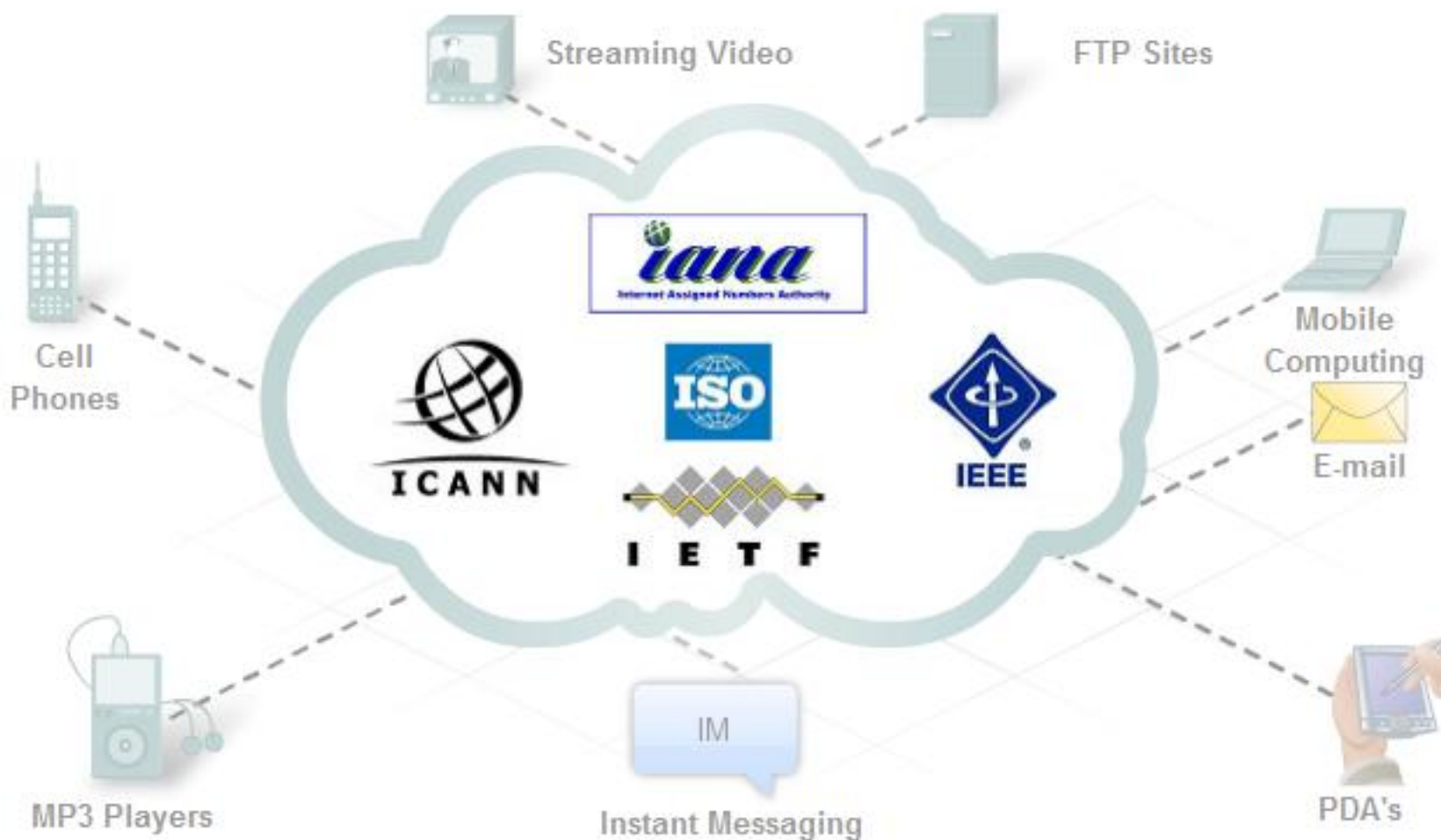
The Internet and Its Standards

- There are thousands of Internet standards that help define the rules for how devices communicate on networks. These different standards are developed, published, and maintained by a variety of different organizations. By these organizations creating and maintaining standards, millions of individuals are able to connect to the Internet using a variety of devices including personal computers, cellular phones, handheld personal digital assistants (PDAs), MP3 players, and even televisions.

The Internet and Its Standards



The Internet and Its Standards



ISP and ISP Services

- Regardless of the type of device that an individual or business uses to connect to the Internet, the device must connect through an Internet service provider (ISP). An ISP is a company or organization through which a subscriber obtains Internet access. A subscriber can be a business, a private consumer, a government body, or even another ISP.

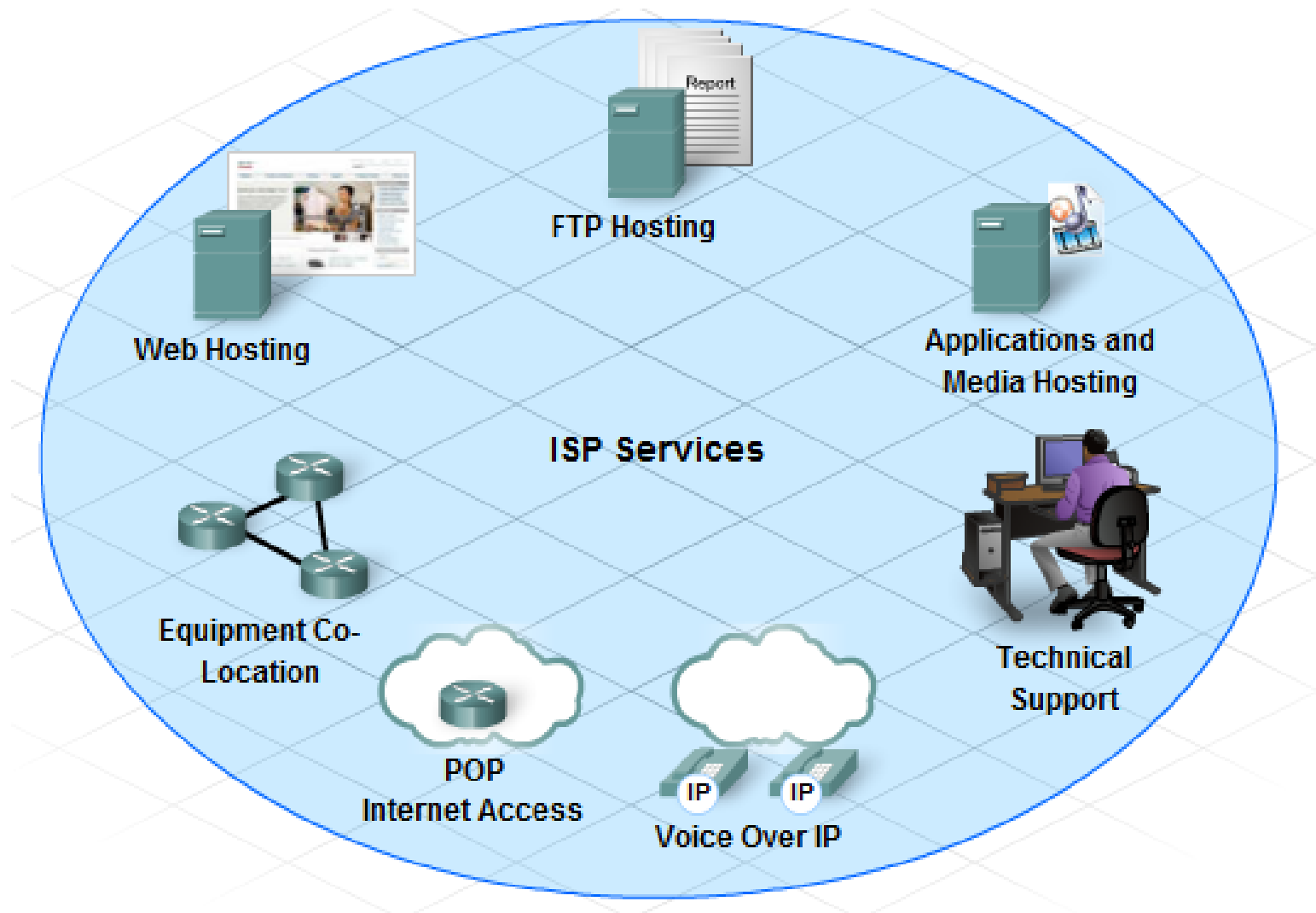
The Internet and Its Standards

- In addition to offering connection to the Internet, an ISP can offer other services to subscribers including:
- Equipment co-location - A business may opt to have some or all internal network equipment physically located on the ISP premises.
- Web hosting - The ISP provides the server and application software for storing web pages and web content for the business website.
- FTP hosting - The ISP provides the server and application software for the FTP site of a business.

The Internet and Its Standards

- Applications and media hosting - The ISP provides the server and software to allow a business to provide streaming media such as music, video or applications, such as online databases.
- Voice over IP - A business can save on long distance telephone charges, especially for internal calls between geographically distant offices, by using Voice over IP (VoIP).
- Technical support - Many businesses do not have the in-house technical expertise to manage large internal networks. Some ISPs provide technical support and consulting services for an additional fee.

The Internet and Its Standards



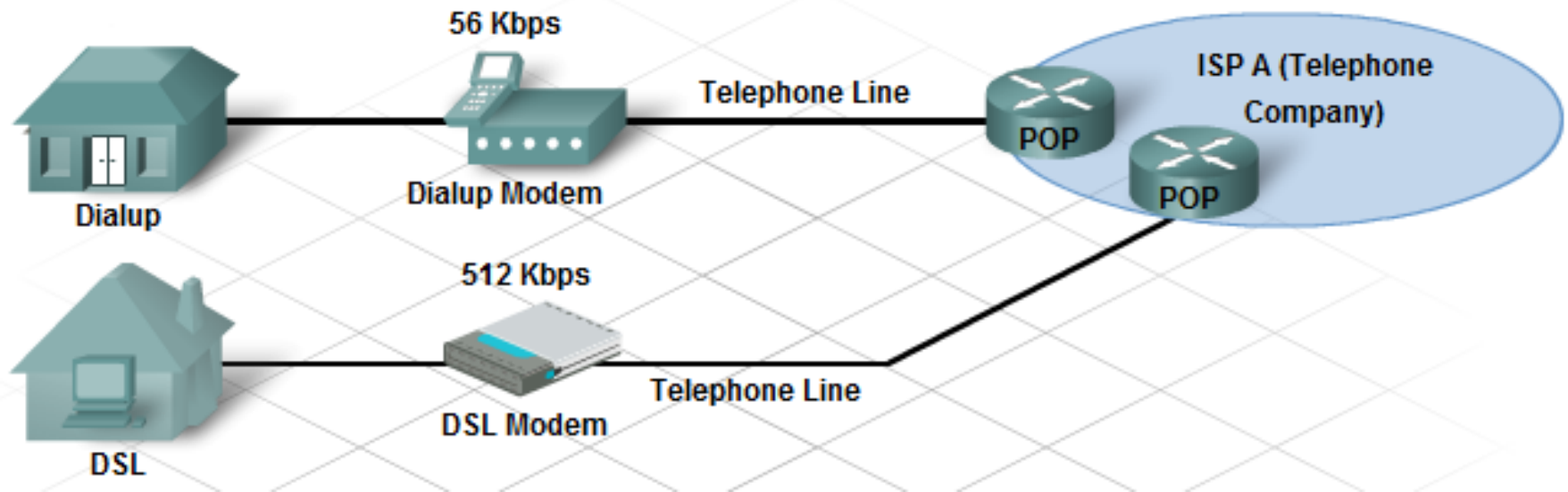
Delivering Internet Services to End Users

- To gain access to the Internet, it is first necessary to have a connection to an ISP. ISPs offer various connection options. The main connection methods used by home and small business users are:
- Dialup access
- Dialup access is an inexpensive option that uses any phone line and a modem. To connect to the ISP, a user calls the ISP access phone number. Dialup is the slowest connection option, and is typically used by mobile workers and in areas where higher speed connection options are not available.

Delivering Internet Services to End Users

- DSL
- DSL is more expensive than dialup, but provides a faster connection. DSL also uses telephone lines, but unlike dialup access, DSL provides a continuous connection to the Internet. This connection option uses a special high-speed modem that separates the DSL signal from the telephone signal and provides an Ethernet connection to a host computer or LAN.

Delivering Internet Services to End Users



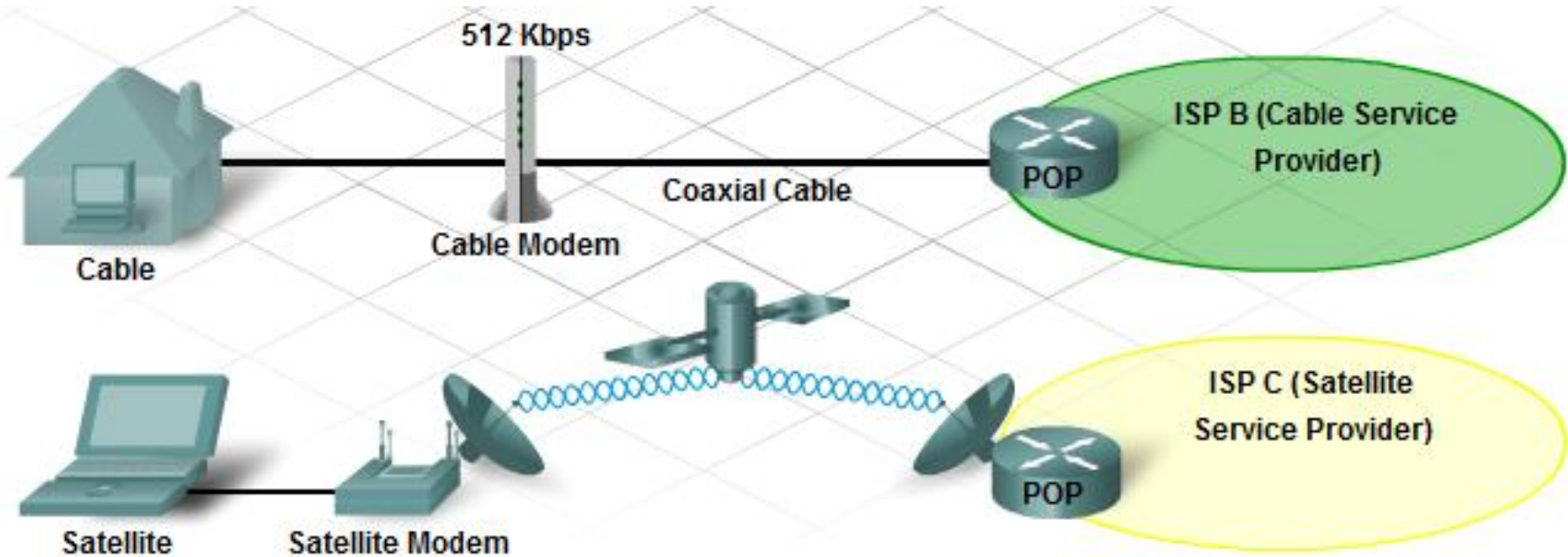
Delivering Internet Services to End Users

- Cable modem
- A cable modem is a connection option offered by cable television service providers. The Internet signal is carried on the same coaxial cable that delivers cable television to homes and businesses. A special cable modem separates the Internet signal from the other signals carried on the cable and provides an Ethernet connection to a host computer or LAN.

Delivering Internet Services to End Users

- Satellite
- Satellite connection is an option offered by satellite service providers. The user's computer connects through Ethernet to a satellite modem that transmits radio signals to the nearest POP within the satellite network.

Delivering Internet Services to End Users



Delivering Internet Services to End Users

- Bandwidth is measured in bits per second (bps). Higher bandwidth speeds are measured in kilobits per second (kbps), megabits per second (Mbps), or gigabits per second (Gbps).

- There are three main types of high bandwidth connection options that are used by businesses:

Delivering Internet Services to End Users

- T1 connections transmit data up to 1.544 Mbps. T1 connections are symmetrical, meaning that the upload bandwidth is the same as the download bandwidth. A medium-sized business may need only one T1 connection. E1 is a European standard that transmits data at 2.048 Mbps.

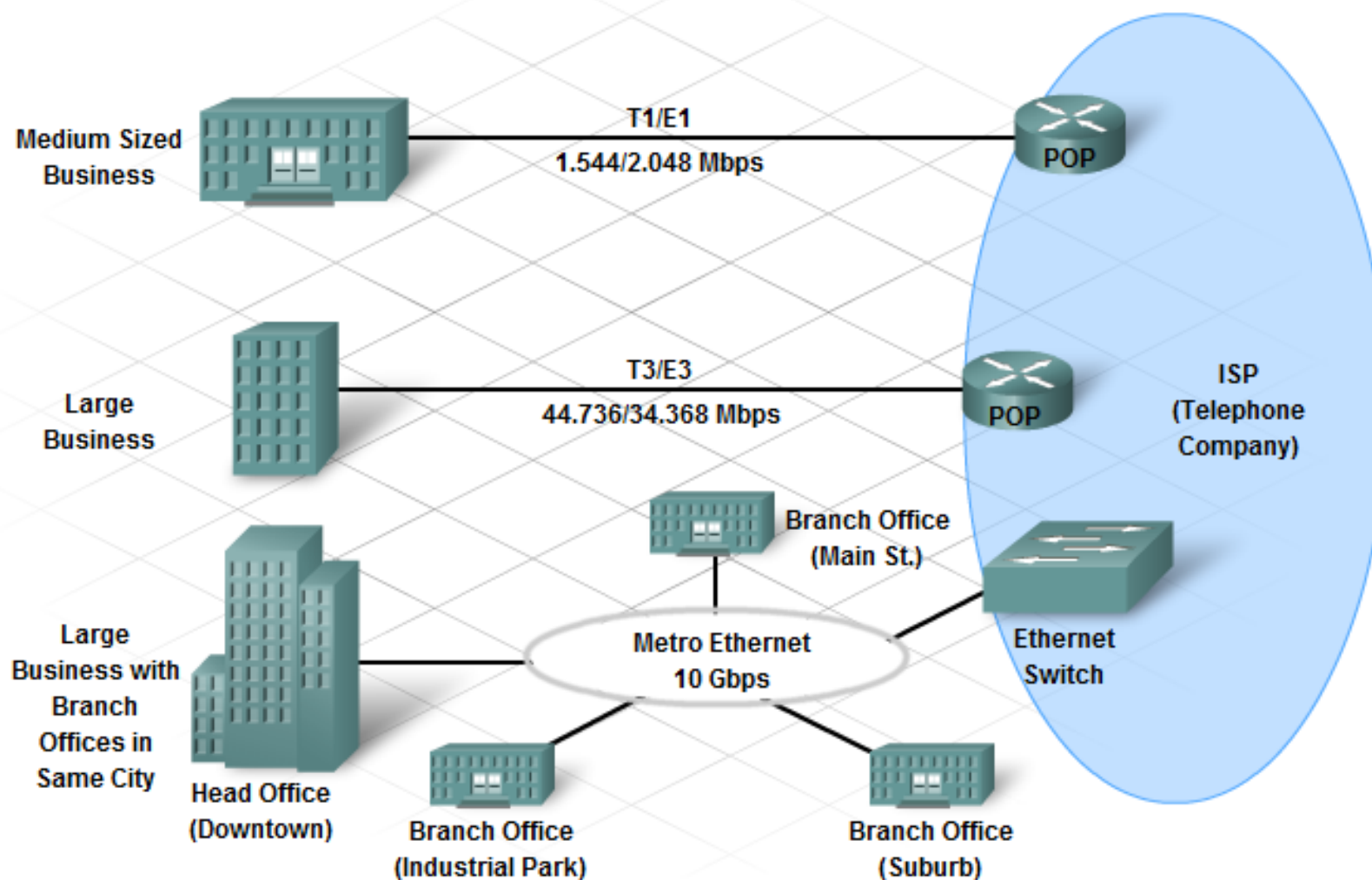
Delivering Internet Services to End Users

- T3 connections transmit data up to 45 Mbps. Although considerably more expensive than a T1 connection, a larger business may need a T3 connection to accommodate the number of employees. Large businesses with multiple locations might use a combination of T1 and T3 lines. E3 is a European standard that transmits data at 34.368 Mbps.

Delivering Internet Services to End Users

- Metro Ethernet offers a wide range of high-bandwidth options, including Gbps links. Large companies with many branches in the same city, such as banks, use Metro Ethernet. Metro Ethernet connects the main office location and all the branches using switched technology. Metro Ethernet allows the transfer of large amounts of data faster and less expensively than other high-bandwidth connection options.

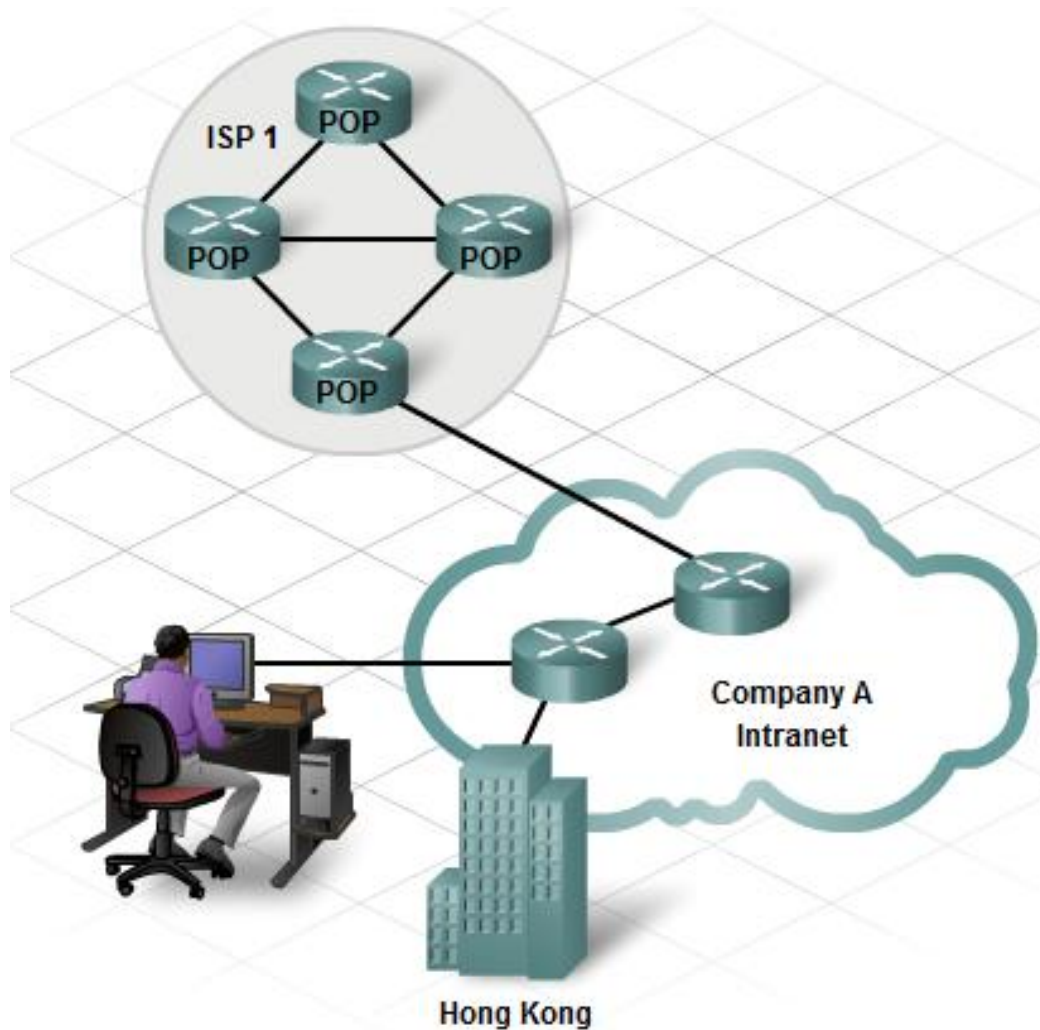
Delivering Internet Services to End Users



Delivering Internet Services to End Users

- After the type of connection is established, it is necessary to connect to the ISP to get access to the Internet. Individual computers and business networks connect to the ISP at a POP. POPs are located at the edge of the ISP's network and serve a particular geographical region. They provide a local point of connection and authentication (password control) for multiple end users. An ISP may have many POPs, depending on the size of the POP and the area that it services.

Delivering Internet Services to End Users



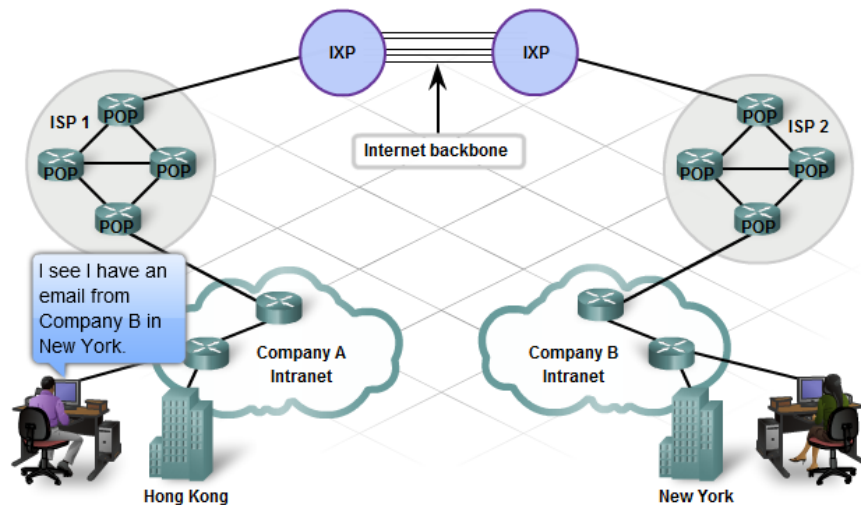
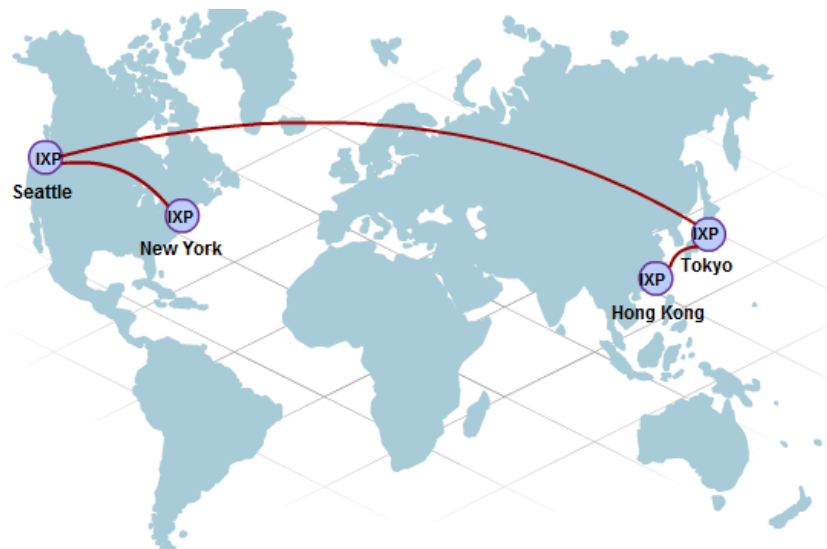
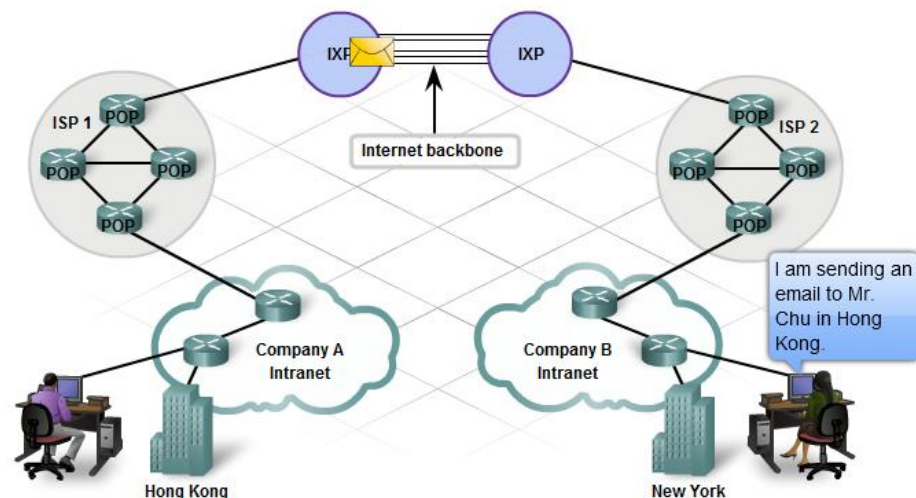
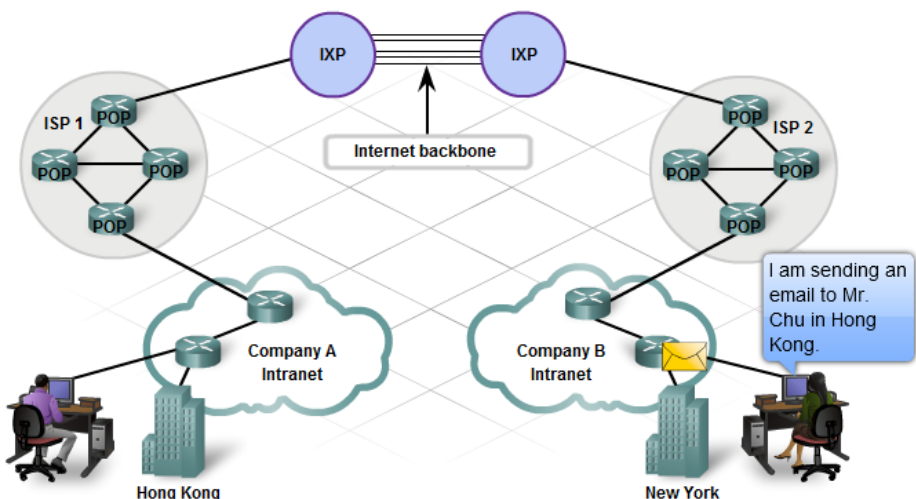
Delivering Internet Services to End Users

- The Internet has a hierarchical structure. At the top of this hierarchy are the ISP organizations. The ISP POPs connect to an Internet Exchange Point (IXP). In some countries, this is called a Network Access Point (NAP). An IXP or NAP is where multiple ISPs join together to gain access to each other's networks and exchange information. There are currently over 100 major exchange points located worldwide.

Delivering Internet Services to End Users

- The Internet backbone consists of this group of networks owned by various organizations and interconnected through IXPs and private peering connections.
- The Internet backbone is like an information super highway that provides high-speed data links to interconnect the POPs and IXPs in major metropolitan areas around the world. The primary medium that connects the Internet backbone is fiber-optic cable. This cable is typically installed underground to connect cities within continents. Fiber-optic cables also run under the sea to connect cities between continents.

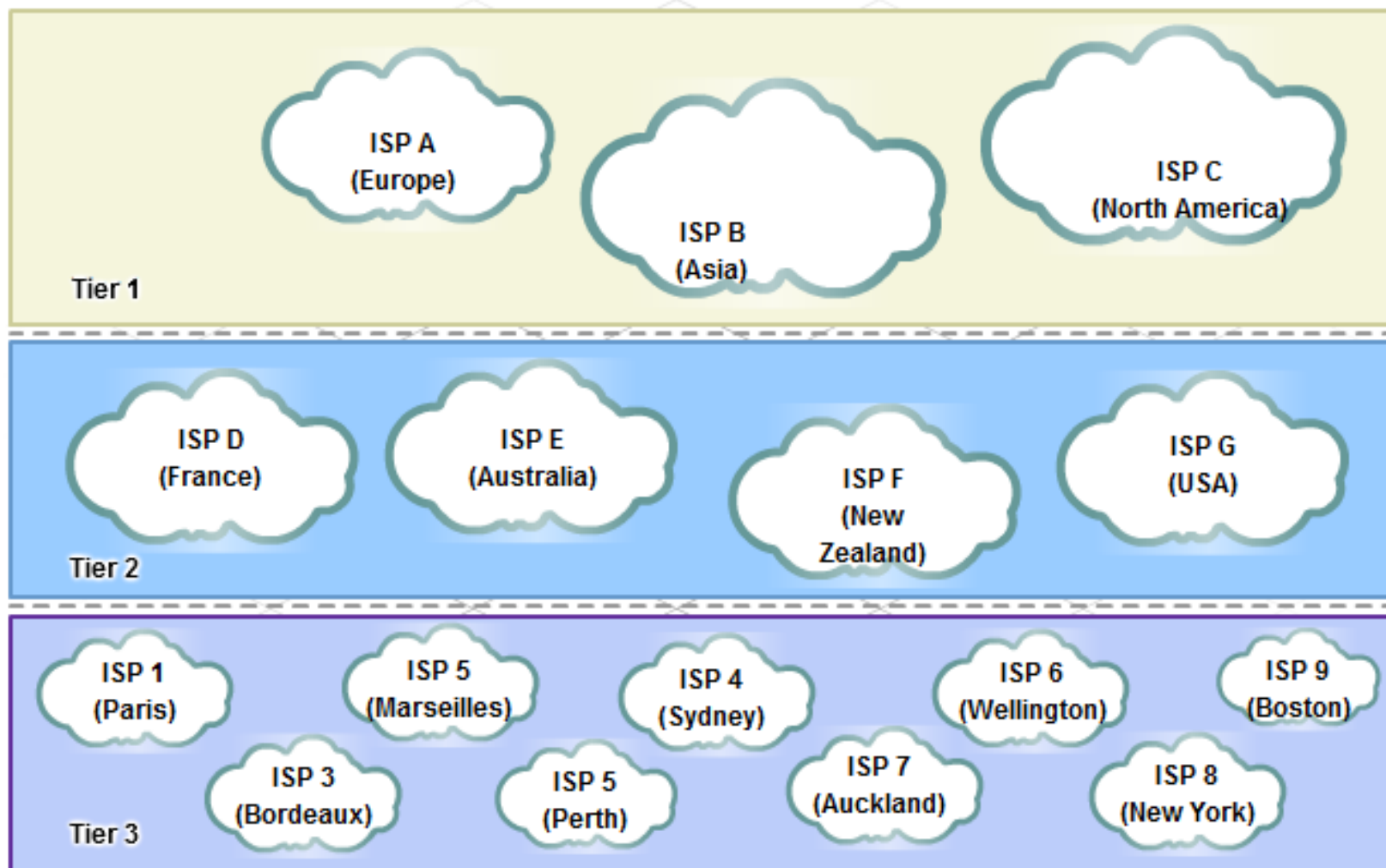
Delivering Internet Services to End Users



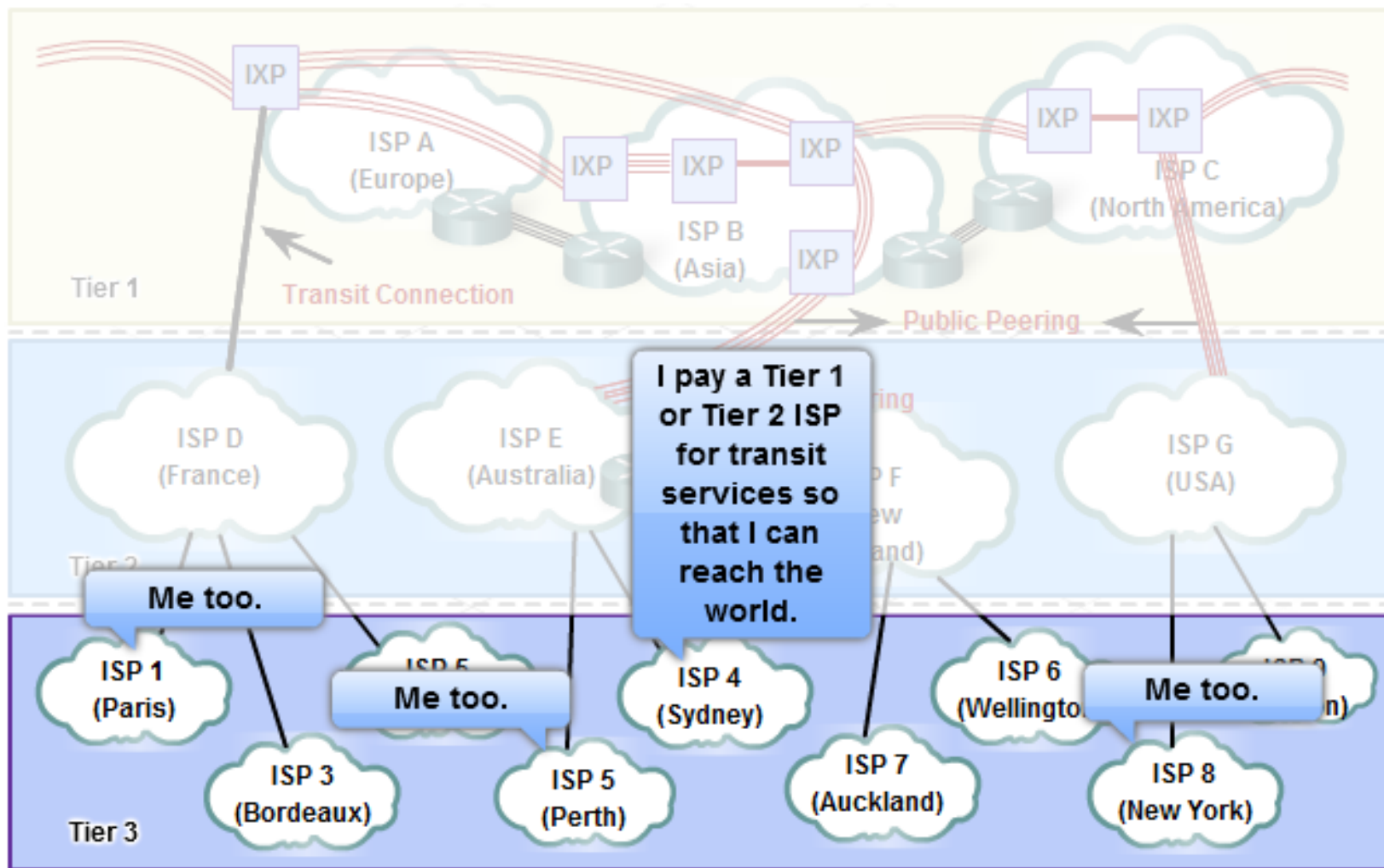
Internet Hierarchy

- ISPs are classified into different tiers according to how they access the Internet backbone:
- Tier 1 ISPs are the top of the hierarchy. Tier 1 ISPs are huge organizations that connect directly with each other through private peering, physically joining their individual network backbones together to create the global Internet backbone. Within their own networks, the Tier 1 ISPs own the routers, high-speed data links, and other pieces of equipment that join them to other Tier 1 ISP networks. This includes the undersea cables that connect the continents.

Internet Hierarchy



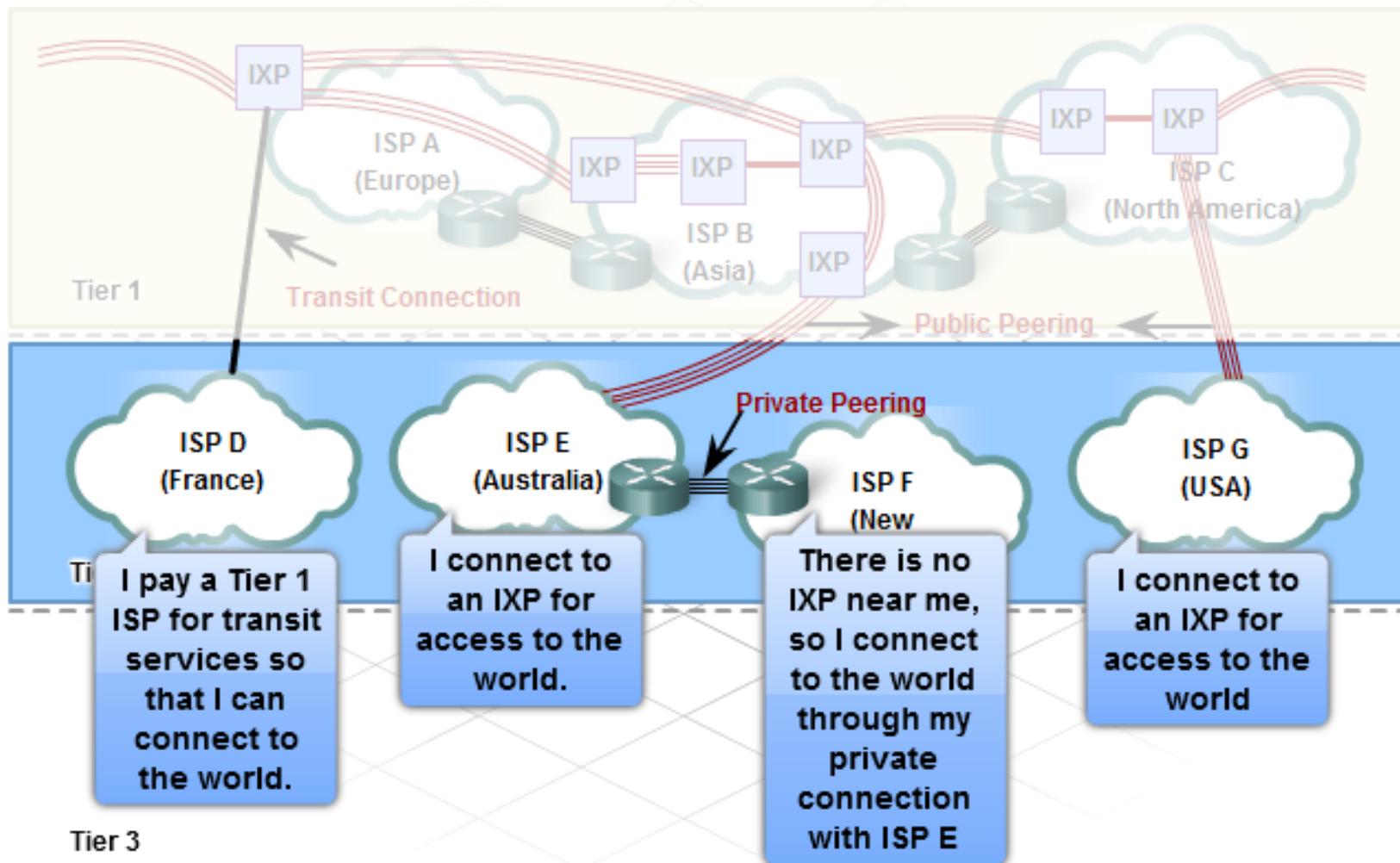
Internet Hierarchy



Internet Hierarchy

- Tier 2 ISPs are the next tier in terms of backbone access. Tier 2 ISPs can also be very large, even extending across several countries, but very few have networks that span entire continents or between continents. To provide their customers with global Internet access, some Tier 2 ISPs pay Tier 1 ISPs to carry their traffic to other parts of the world. Some Tier 2 ISPs exchange global traffic with other ISPs less expensively through public peering at IXPs.

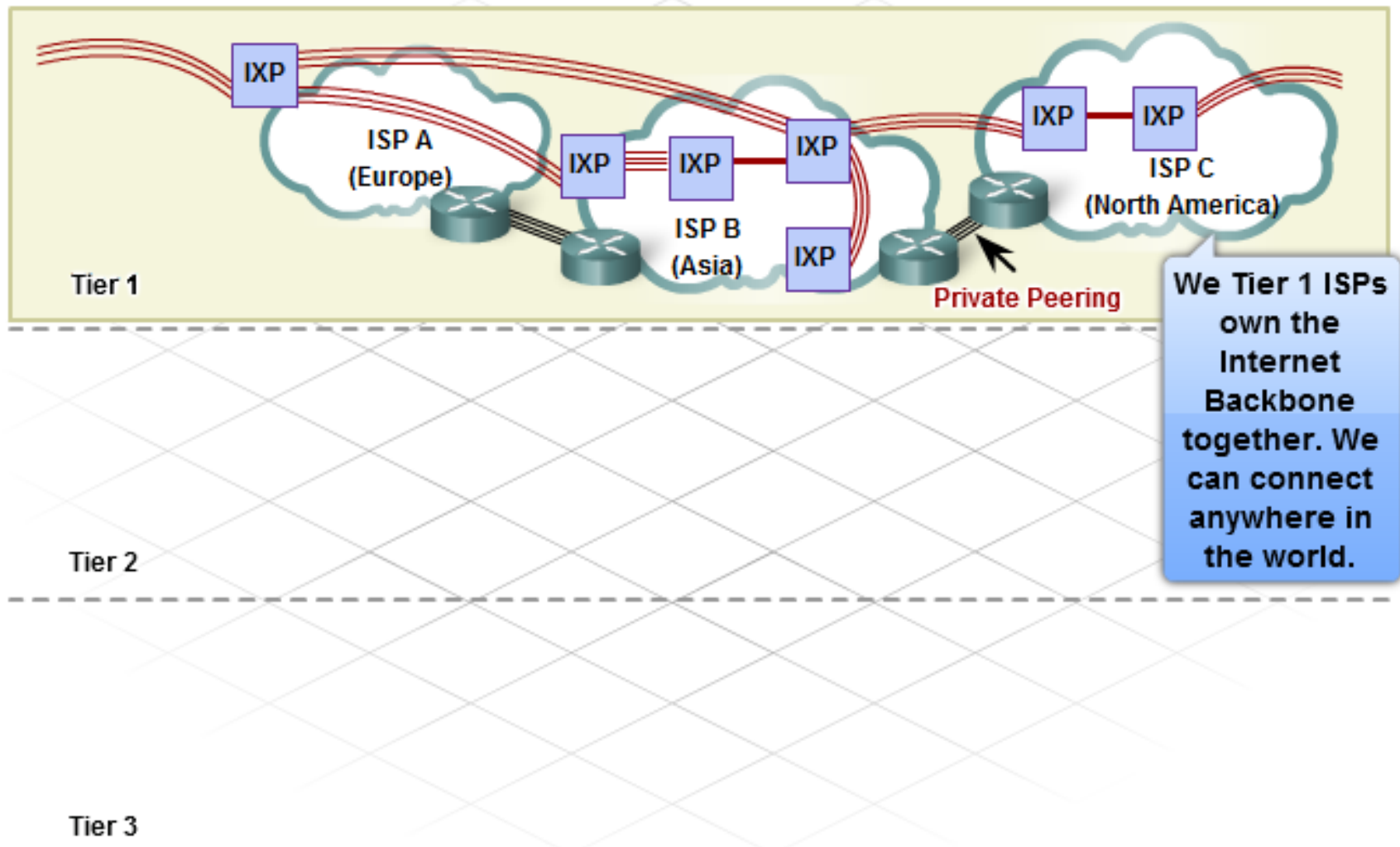
Internet Hierarchy



Internet Hierarchy

- A large IXP may bring together hundreds of ISPs in a central physical location for access to multiple networks over a shared connection.
- Tier 3 ISPs are the farthest away from the backbone. Tier 3 ISPs are generally found in major cities and provide customers local access to the Internet. Tier 3 ISPs pay Tier 1 and 2 ISPs for access to the global Internet and Internet services.

Internet Hierarchy



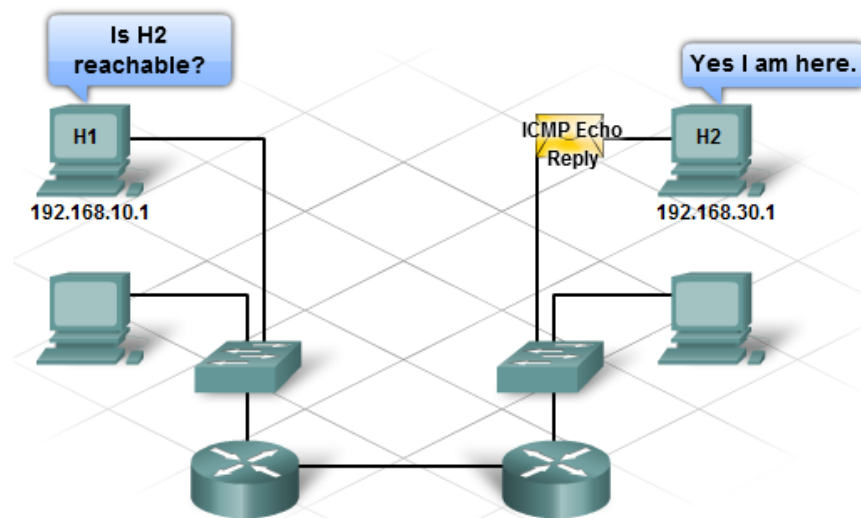
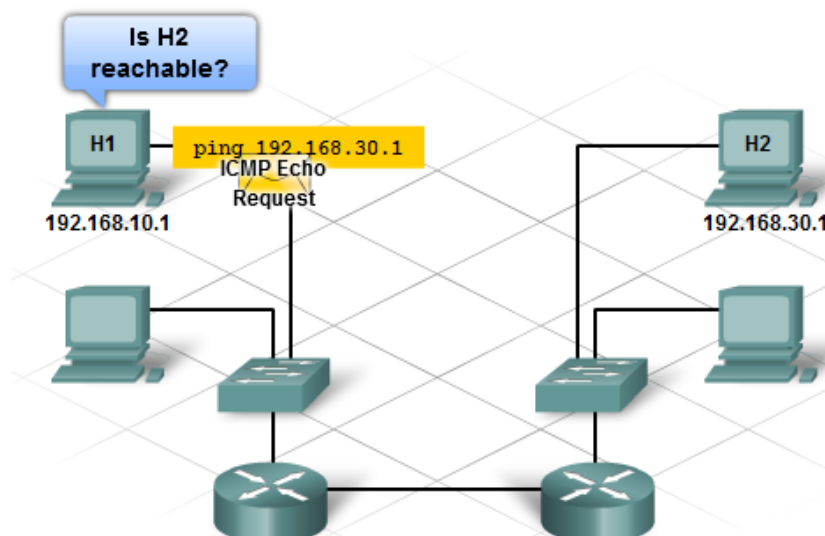
Identifying the structure of the Internet

- Network utilities create a map of the various interconnections to visualize how ISP networks interconnect. These utilities also illustrate the speed at which each connecting point can be reached.
- The ping command tests the accessibility of a specific IP address. The ping command sends an echo request packet to the destination address and then waits for an echo reply packet to return from that host.

Identifying the structure of the Internet

- It measures the time that elapses between when the request packet is sent and the response packet is received. The ping command output indicates whether the reply was received successfully and displays the round-trip time for the transmissions.
- To use the ping command, enter the following command at the Cisco command line interface (CLI) router prompt or at the Windows command prompt:
- `ping <ip address>`
- where `<ip address>` is the IP address of the destination device.

Identifying the structure of the Internet



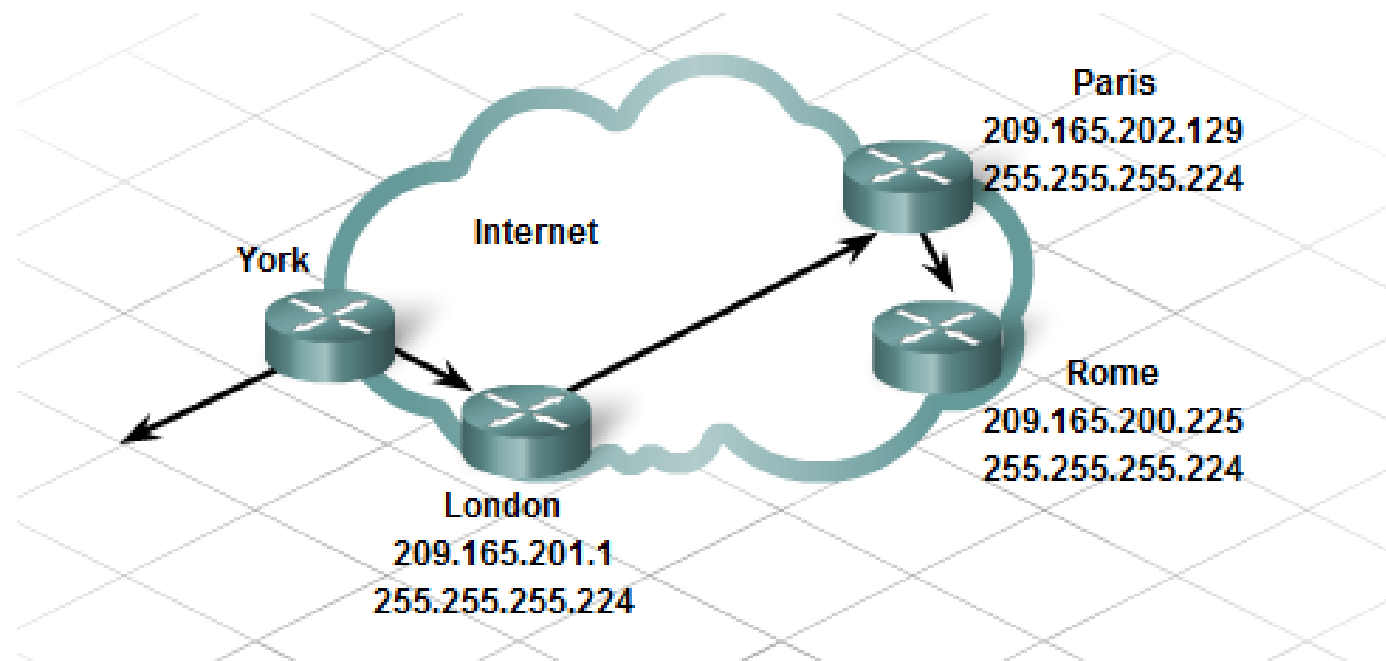
Identifying the structure of the Internet

- If a packet does not reach the destination, or if delays are encountered along the way, how is it determined where the problem is located or through which routers the packet has passed?
- The traceroute utility displays the path that a packet takes from the source to the destination host. Each router that the packet passes through is called a hop. Traceroute displays each hop along the way. It also calculates the time between when the packet is sent and when a reply is received from the router at each hop.

Identifying the structure of the Internet

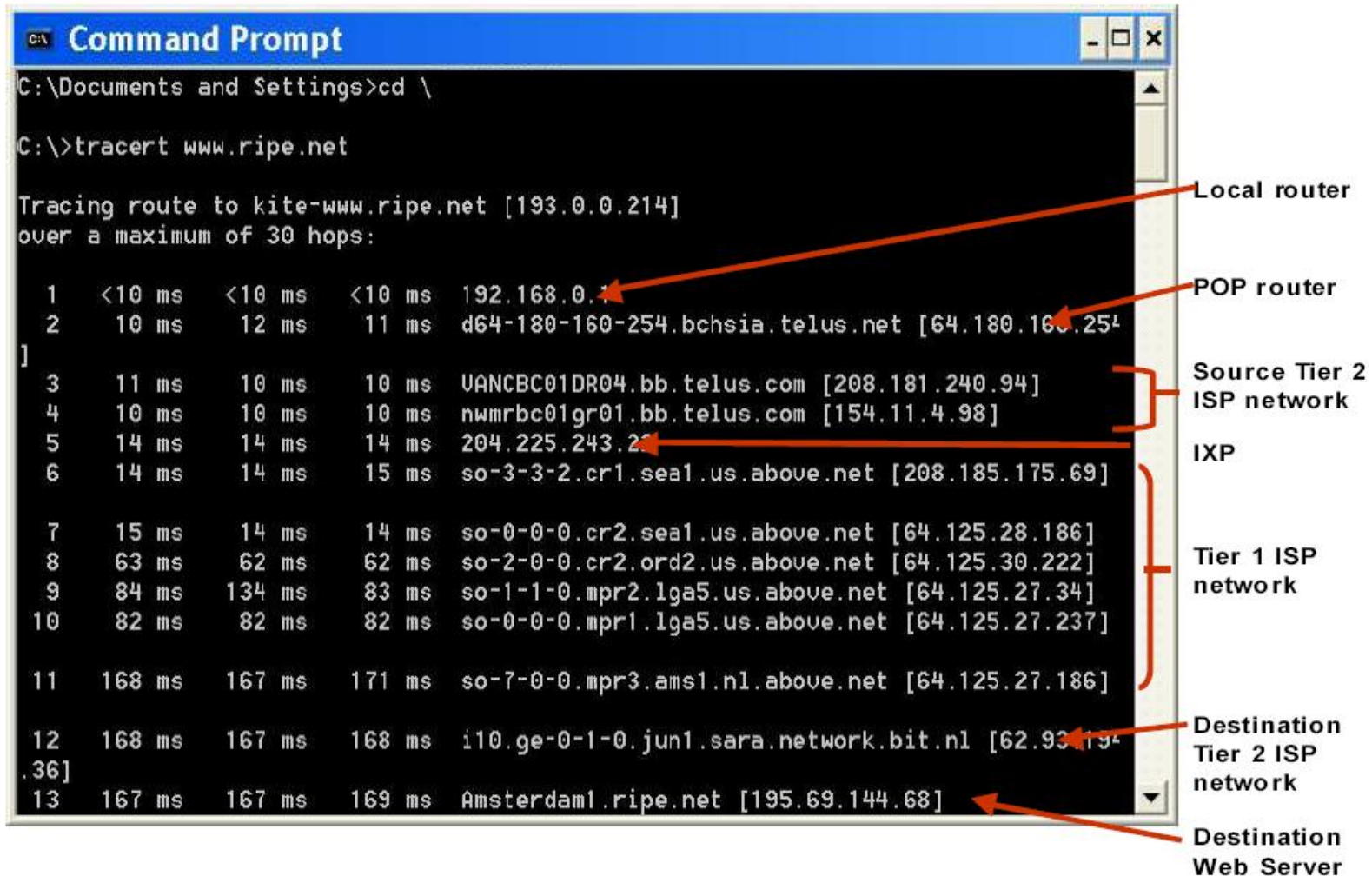
- If a problem occurs, use the output of the traceroute command to help determine where a packet was lost or delayed. The output also shows the various ISP organizations that the packet must pass through during its journey from source to destination.
- The Windows tracert utility works the same way. There are also a number of visual traceroute programs that provide a graphical display of the route that a packet takes.

Identifying the structure of the Internet



```
York#traceroute ROME
Type escape to abort.
Tracing the route to ROME(209.165.200.225)
 1. LONDON (209.165.201.1)  8 msec  8 msec  4 msec
 2. PARIS (209.165.202.129)  8 msec  8 msec  8 msec
 3. ROME (209.165.200.225)  8 msec  8 msec  4 msec
```

Identifying the structure of the Internet



Command Prompt

```
C:\Documents and Settings>cd \
C:\>tracert www.ripe.net

Tracing route to kite-www.ripe.net [193.0.0.214]
over a maximum of 30 hops:

  1  <10 ms  <10 ms  <10 ms  192.168.0.1
  2   10 ms   12 ms   11 ms  d64-180-160-254.bchsia.telus.net [64.180.160.254]
  3   11 ms   10 ms   10 ms  VANCBC01DR04.bb.telus.com [208.181.240.94]
  4   10 ms   10 ms   10 ms  nwmrbc01gr01.bb.telus.com [154.11.4.98]
  5   14 ms   14 ms   14 ms  204.225.243.22
  6   14 ms   14 ms   15 ms  so-3-3-2.cr1.sea1.us.above.net [208.185.175.69]
  7   15 ms   14 ms   14 ms  so-0-0-0.cr2.sea1.us.above.net [64.125.28.186]
  8   63 ms   62 ms   62 ms  so-2-0-0.cr2.ord2.us.above.net [64.125.30.222]
  9   84 ms  134 ms   83 ms  so-1-1-0.mpr2.lga5.us.above.net [64.125.27.34]
 10   82 ms   82 ms   82 ms  so-0-0-0.mpr1.lga5.us.above.net [64.125.27.237]
 11  168 ms  167 ms  171 ms  so-7-0-0.mpr3.ams1.nl.above.net [64.125.27.186]
 12  168 ms  167 ms  168 ms  i10.ge-0-1-0.jun1.sara.network.bit.nl [62.93.194.36]
 13  167 ms  167 ms  169 ms  Amsterdam1.ripe.net [195.69.144.68]
```

Annotations:

- Local router:** Hop 1 (192.168.0.1)
- POP router:** Hop 2 (d64-180-160-254.bchsia.telus.net)
- Source Tier 2 ISP network:** Hops 3 and 4 (bb.telus.com)
- IXP:** Hop 5 (204.225.243.22)
- Tier 1 ISP network:** Hops 6 through 11 (above.net)
- Destination Tier 2 ISP network:** Hop 12 (sara.network.bit.nl)
- Destination Web Server:** Hop 13 (Amsterdam1.ripe.net)

ISP Requirements

- An ISP requires a variety of devices to accept input from end users and provide services. To participate in a transport network, the ISP must be able to connect to other ISPs. An ISP must also be able to handle large volumes of traffic.

- Some of the devices required to provide services include:

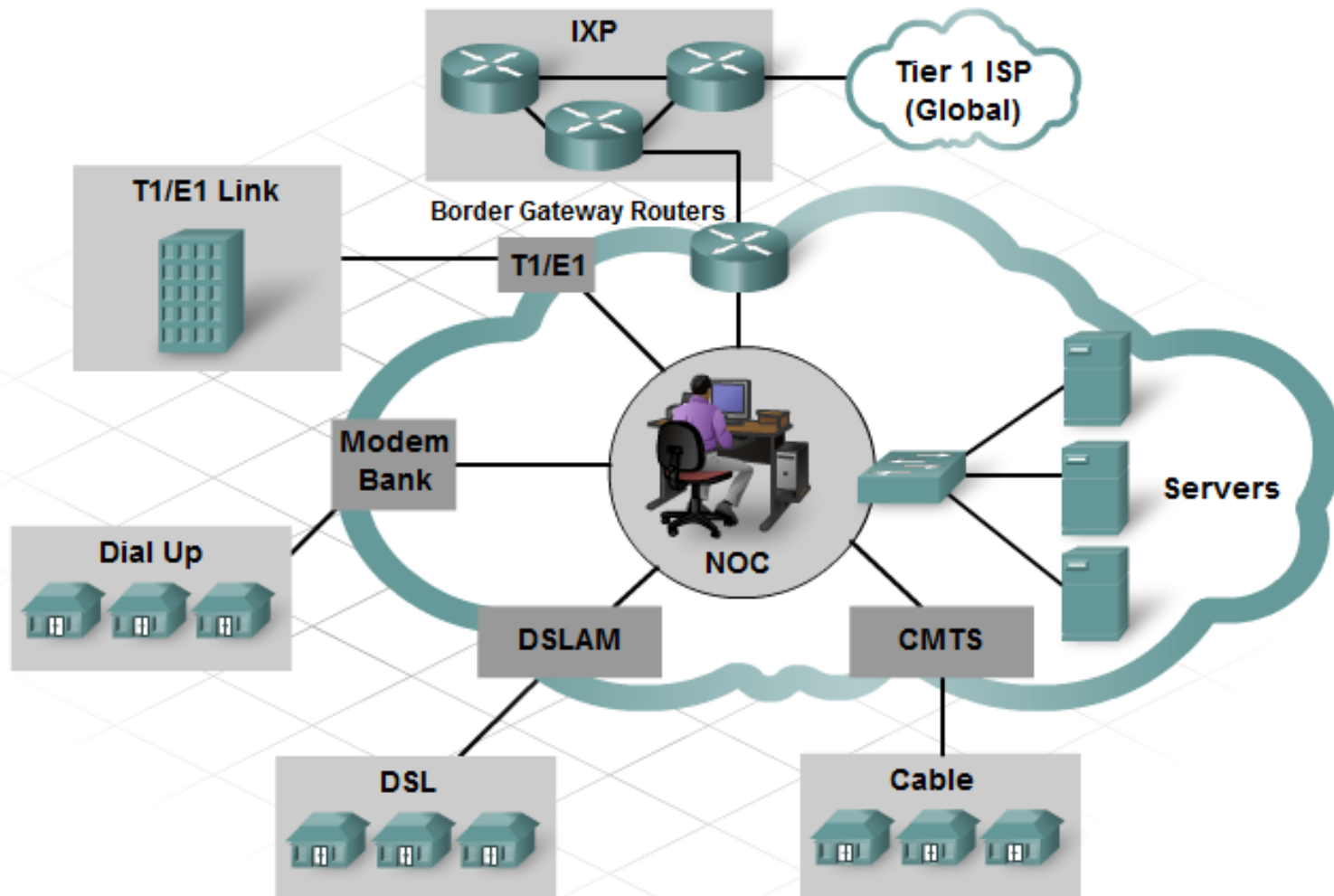
ISP Requirements

- Access devices that enable end users to connect to the ISP, such as a DSL Access Multiplexer (DSLAM) for DSL connections, a Cable Modem Termination System (CMTS) for cable connections, modems for dialup connections, or wireless bridging equipment for wireless access.
- Border gateway routers to enable the ISP to connect and transfer data to other ISPs, IXPs, or large business enterprise customers.

ISP Requirements

- Servers for such things as e-mail, network address assignment, web space, FTP hosting, and multimedia hosting.
- Power conditioning equipment with substantial battery backup to maintain continuity if the main power grid fails.
- High capacity air conditioning units to maintain controlled temperatures.

ISP Requirements



ISP Requirements

- ISPs, like other businesses, want to expand so that they can increase their income. The ability to expand their business depends on gaining new subscribers and selling more services. However, as the number of subscribers grows, the traffic on the ISP's network also grows.

ISP Requirements

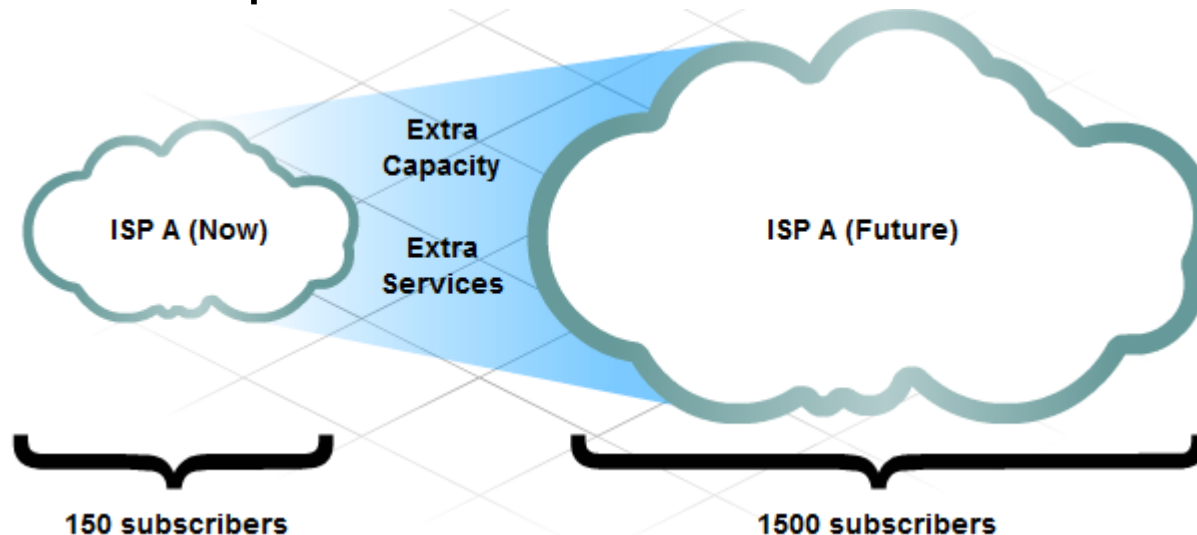
- Eventually, the increased traffic may overload the network, causing router errors, lost packets, and excessive delays. In an overloaded network, subscribers can wait for minutes for a web page to load, or may even lose network connection. These customers may choose to switch to a competing ISP to get better performance.

ISP Requirements

- Loss of customers directly translates to loss of income for an ISP. For this reason, it is important that the ISP provide a reliable and scalable network.
- Scalability is the ability to allow for future change and growth. A scalable network can expand quickly to support new users and applications without impacting the performance of the service being delivered to existing users.

ISP Requirements

- The most scalable devices are those that are modular and provide expansion slots for adding modules. Different modules can have different numbers of ports. In the case of a chassis router, some modules also offer different interface options, allowing for different connection options on the same chassis.



Roles and Responsibilities within an ISP

- ISP organizations consist of many teams and departments who are responsible for ensuring that the network operates smoothly and that the services that the ISP offers are available.
- Network support services are involved in all aspects of network management, including planning and provisioning of new equipment and circuits, adding new subscribers, network repair and maintenance, as well as customer service for network connectivity issues.

Roles and Responsibilities within an ISP



On-site Installation Team



Planning and Provisioning Team



NOC Team



Customer Service Order Entry



Help Desk Technical Support

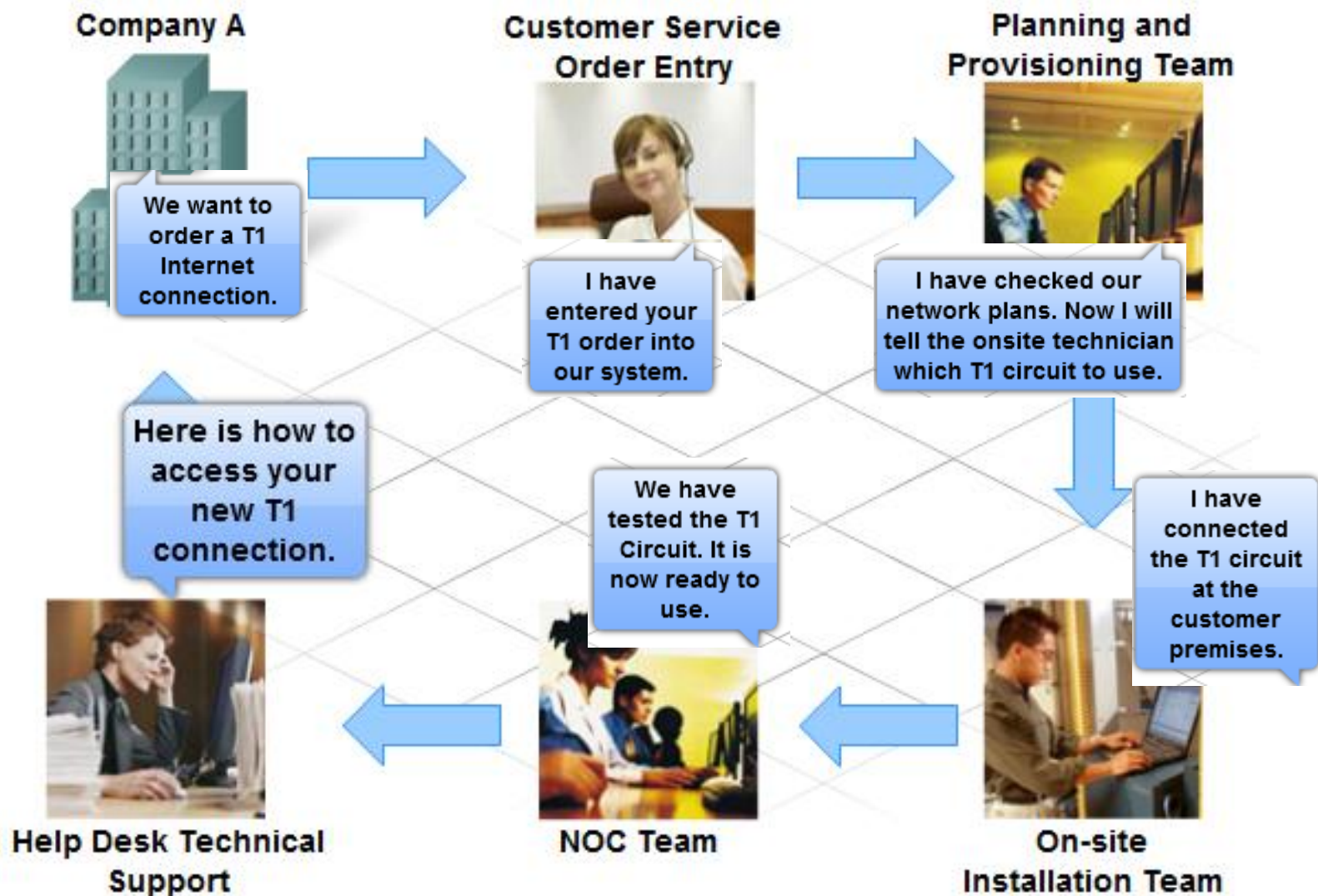
Roles and Responsibilities within an ISP

- Each of the network support service teams have their own roles and responsibilities:
- Customer Service receives the order from the customer and ensures that the customer's specified requirements are accurately entered into the order tracking database.
- Planning and Provisioning determines whether the new customer has existing network hardware and circuits or whether new circuits need to be installed.

Roles and Responsibilities within an ISP

- The On-site Installation is advised of which circuits and equipment to use and then installs them at the customer site.
- The Network Operations Center (NOC) monitors and tests the new connection and ensures that it is performing properly.
- The Help Desk is notified by the NOC when the circuit is ready for operation and then contacts the customer to guide them through the process of setting up passwords and other necessary account information.

Roles and Responsibilities within an ISP



Summary

- Many businesses use the Internet for E-Commerce, communications, collaboration and training.
- Networking and Internet standards ensure that all devices connecting to the network use the same set of rules. By having standards, it is possible for different types of devices to send information to each other over the Internet.
- Regardless of the type of device that an individual or business wants to use to connect to the Internet, the device must connect through an Internet service provider (ISP).
- In addition to offering connection to the Internet, an ISP can offer services such as: equipment co-location, Web hosting, FTP hosting, technical support, Voice over IP, applications and media hosting.

Summary

- Larger businesses typically require more bandwidth and higher-speed connections such as: T1/E1, T3/E3, and MetroEthernet.
- The ISP POPs connect to an Internet Exchange Point (IXP), a point where multiple ISPs join together to gain access to each other's networks and exchange information.
- The Internet backbone is made up of a group of networks owned by various organizations and interconnected through IXPs and private peering connections.
- ISPs are classified as Tier 1, Tier 2, or Tier 3, according to how they access the Internet backbone.

Summary

- An ISP requires a number of devices to accept input from end users and provide services, including: access devices, border gateway routers, high end air conditioning units, and power conditioning equipment.
- The ISP provides a reliable and scalable network.
- A scalable network can expand quickly to support new users and applications without impacting current performance.
- ISP organizations are made up of many teams and departments that have the responsibility of ensuring the smooth operation of the network.
- ISP network support teams can include: a customer service team, a NOC team, an on-site installation team, a planning and provisioning team, and the help desk team.