Telecommunications Essentials

The Complete Global Source for Communications Fundamentals, Data Networking and the Internet, and Next-Generation Networks

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certain position and are switched to a different position. The position to which bits are switched is determined by a combination of one or more of three dimensions: space (that is, the interface or port number), time, and wavelength. Packet switching is based on labels; addressing information in the packet headers, or labels, helps to determine how to switch or forward a packet through the network node.

Circuit Switching

Circuit switching has been the basis of voice networks worldwide for many years. You can apply three terms to the nature of a circuit-switched call to help remember what this is: continuous, exclusive, and temporary. One of the key attributes of a circuit-switched connection is that it is a reserved network resource that is yours and only yours for the full duration of a conversation. But when that conversation is over, the connection is released. A circuit-switched environment requires that an end-to-end circuit be set up before a call can begin. A fixed share of network resources is reserved for the call, and no other call can use those resources until the original connection is closed. A call request signal must travel to the destination and be acknowledged before any transmission can actually begin. As Figure 4.1 illustrates, you can trace the path from one end of the call to the other end; that path would not vary for the full duration of the call, and the capacity provisioned on that path would be yours and yours alone.

Advantages and Disadvantages of Circuit Switching Circuit switching uses many lines to economize on switching and routing computation. When a call is set up, a line is dedicated to it, so no further routing calculations are needed.

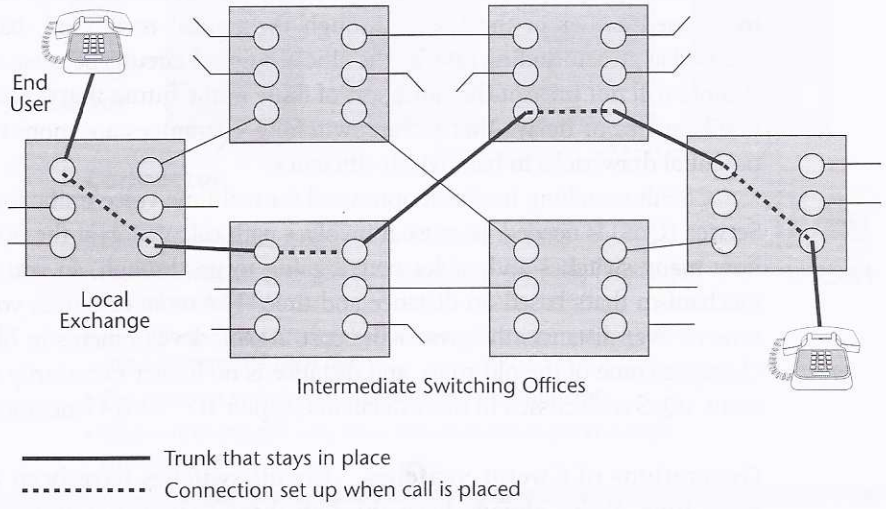

Figure 4.1 A circuit-switched call

Since they were introduced in the mid-1980s, digital cross-connect systems (DCSs) have greatly eased the process of reconfiguring circuit-switched networks and responding to conditions such as congestion and failure. DCSs create predefined circuit capacity, and then voice switches are used to route calls over circuits that are set up by these DCSs. DCSs are analogous to the old patch panels. You may have seen a main distribution frame (MDF) on which twisted-pair wiring is terminated. The MDF is a manual patch panel, and before DCSs were introduced, when it was necessary to reconfigure a network based on outage, congestion, or customer demand as a result of shifting traffic patterns, technicians had to spend days or even weeks, manually making changes at the MDF. The DCS is a software patch panel, and within the software are databases that define alternate routes—alternate connections that can be activated in the event that the network encounters a condition that requires some form of manipulation. DACSs are one of the elements of the PSTN that contribute to its reliability: When network conditions change, in a matter of minutes, a DCS can reconfigure the network around those changes. With such tools, the PSTN is able to offer five 9s reliability—in other words, 99.999% guaranteed uptime. (DCSs are discussed in more detail in Chapter 5.)

Circuit switching offers the benefits of low latency and minimal delays because the routing calculation on the path is made only once, at the beginning of the call, and there are no more delays incurred subsequently in calculating the next hop that should be taken. Traditionally, this was sometimes seen as a disadvantage because it meant that the circuits might not be used as efficiently as possible. Around half of most voice calls is silence. Most people breathe and occasionally pause in their speech. So, when voice communications are conducted over a circuit that's being continuously held, and half the time nothing is being transmitted, the circuit is not being used very efficiently. But remember that this is an issue that is important when bandwidth is constrained. And as mentioned earlier in the book, through the optical revolution, bandwidth is being released at an astounding rate, so the efficient use of circuits because of bandwidth constraints will not present the same sort of issue in the future that it once did. Hence, the low latencies or delays that circuit switching guarantees are more important than its potential drawbacks in bandwidth efficiency.

Circuit switching has been optimized for real-time voice traffic for which Quality of Service (QoS) is needed. Because it involves path calculation at the front end, you know how many switches and cables you're going to go through, so you can use a pricing mechanism that's based on distance and time. The more resources you use, either over time or over distance, the greater the cost. Again, developments in fiber economics are changing some of the old rules, and distance is no longer necessarily an added cost element. (QoS is discussed in more detail in Chapter 10, "Next-Generation Networks.")

Generations of Circuit Switches Circuit switches have been around for quite