Coding ([Subtlies of Coding (Page 299)](#_bookmark453)), exceeded the Source Coding Theorem's upper bound.

Internally, communication networks do have point-to-point communication links between network **nodes** well described by the Fundamental Model of Communications. However, many messages share the communications channel between nodes using what we call **time-domain multiplexing**: Rather than the continuous communications mode implied in the Model as presented, message sequences are sent, sharing in time the channel's capacity. At a grander viewpoint, the network must **route** messages decide what nodes and links to use based on destination information the **address** that is usually separate from the message information. Routing in networks is necessarily dynamic: The complete route taken by messages is formed as the network handles the message, with nodes relaying the message having some notion of the best possible path at the time of transmission.

Note that no omnipotent router views the network as a whole and pre-determines every message's route. Certainly in the case of the postal system dynamic routing occurs, and can consider issues like inoperative and overly busy links. In the telephone system, routing takes place when you place the call; the route is fxed once the phone starts ringing. Modern communication networks strive to achieve the most efcient (timely) and most reliable information delivery system possible.

### Message Routing

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Focusing on electrical networks, most analog ones make inefcient use of communication links because truly dynamic routing is difcult, if not impossible, to obtain. In radio networks, such as commercial television, each station has a dedicated portion of the electromagnetic spectrum, and this spectrum cannot be shared with other stations or used in any other than the regulated way. The telephone network is more dynamic, but once it establishes a call the path through the network is fxed. The users of that path control its use, and may not make efcient use of it (long pauses while one person thinks, for example). Telephone network customers would be quite upset if the telephone company momentarily disconnected the path so that someone else could use it. This kind of connection through a network fxed for the duration of the communication session is known as a **circuit-switched** connection.

During the 1960s, it was becoming clear that not only was digital communication technically superior, but also that the wide variety of communication modes computer login, fle transfer, and electronic mail needed a diferent approach than point-to- point. The notion of computer networks was born then, and what was then called the ARPANET, now called the Internet, was born. Computer networks elaborate the basic network model by subdividing messages into smaller chunks called **packets** ([Figure](#_bookmark476) [6.26](#_bookmark476)). The rationale for the network enforcing smaller transmissions was that large fle transfers would consume network resources all along the route, and, because of the long transmission time, a communication failure might require retransmission of the entire fle. By creating packets, each of which has its own address and is routed independently of others, the network can better manage congestion. The analogy is