such as the IEEE (Institute for E lectronics and Electrical Engineers) and the ISO (International Standards Organization) define standards such as this. Despite being a standard, it does not constrain protocol implementation so much that innovation and competitive individuality are ruled out.

Segregation of information transmission, manipulation, and interpretation into these categories directly afects how communication systems are organized, and what role(s) software systems fulfl. Although not thought about in this way in earlier times, this organizational structure governs the way communication engineers think about all communication systems, from radio to the Internet.

###### Exercise 6.37.1

How do the various aspects of establishing and maintaining a telephone conversation ft into this layered protocol organization?

We now explicitly state whether we are working in the physical layer (signal set design, for example), the data link layer (source and channel coding), or any other layer. IP abbreviates Internet protocol, and governs gateways (how information is transmitted between networks having diferent internal organizations). TCP (transmission control protocol) governs how packets are transmitted through a wide-area network such as the Internet. Telnet is a protocol that concerns how a person at one computer logs on to another computer across a network. A moderately high level protocol such as telnet, is not concerned with what data links (wireline or wireless) might have been used by the network or how packets are routed. Rather, it establishes connections between computers and directs each byte (presumed to represent a typed character) to the appropriate operation system component at each end. It is **not** concerned with what the characters mean or what programs the person is typing to. That aspect of information transmission is left to protocols at higher layers.

Recently, an important set of protocols created the World Wide Web. These protocols exist independently of the Internet. The Internet insures that messages are transmitted efciently and intact; the Internet is not concerned (to date) with what messages contain. HTTP (hypertext transfer protocol) frame what messages contain and what should be done with the data. The extremely rapid development of the Web on top of an essentially stagnant Internet is but one example of the power of organizing how information transmission occurs without overly constraining the details.

### Information Communication Problems

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**Problem 6.1**: Signals on Transmission Lines

A modulated signal needs to be sent over a transmission line having a characteristic impedance of *Z*0 = 50 (Ω) . So that the signal does not interfere with signals others may be transmitting, it must be bandpass fltered so that its bandwidth is 1 MHz and

centered at 3.5 MHz. The flter's gain should be one in magnitude. An op-amp flter ([Figure 6.31](#_bookmark485)) is proposed.