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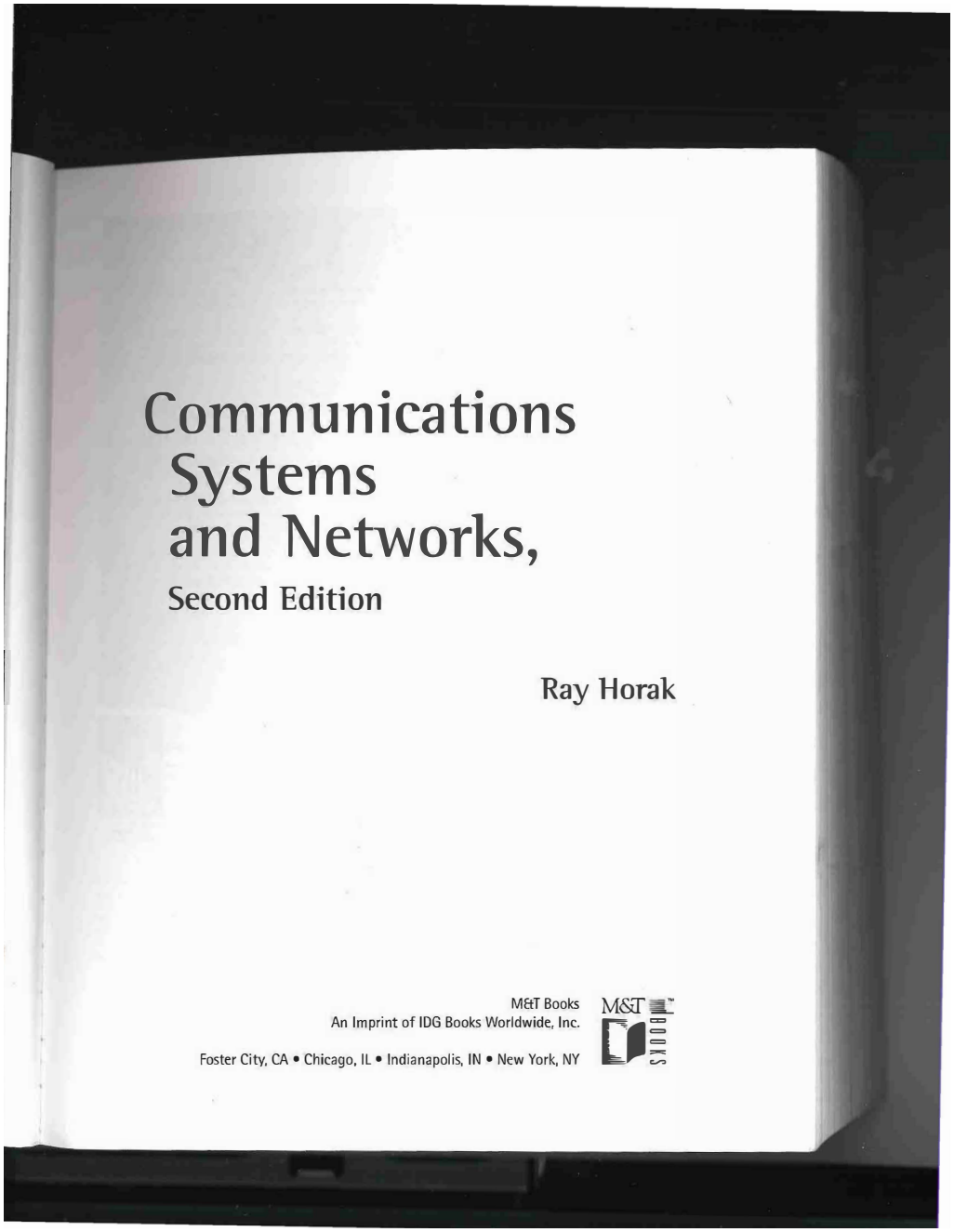

Communications Systems and Networks,

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Ray Horak

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the level of voice quality is yet to be determined, especially under heavy load. Yet, these networks are inherently more efficient than the traditional voice networks; therefore, costs to the consumer are likely to be much less.

Local exchange competition, voice over the Internet, Voice over Frame Relay, and Voice over IP all threaten the concept of universal service, which has been a cornerstone of the PSTN since the formation of the FCC in 1934. In order to ensure the universal availability of voice service at affordable cost to the subscriber, a complex structure of *settlements* (cross-subsidies) developed between incumbent IXCs and LECs. Thereby, a subscriber in a high-cost area such as Hackberry, Arizona could gain affordable network access, as could a subscriber in New York, New York, despite the obvious cost differences in the carriers' service. Unless the integrity of the universal service fund is maintained, with all carriers contributing, the concept of universal service may be relegated to a historical footnote.

Carrier Domains and Network Topology

Some years ago, and certainly prior to AT&T's divestiture of the Bell Operating Companies in 1984, the network was relatively simple in terms of its ownership and topology. Each operating telephone company provided service in its franchised serving areas, and gained access to the AT&T long distance network on a fairly straightforward basis. Beginning in the late 1920s, the network organized on a layered basis, with five levels of hierarchy, known as classes [5-3].

Class 5 offices are the *local exchange offices*, or Central Offices (COs), which serve end users through local loop connections. The approximately 19,000 Class 5 offices in the United States are geographically positioned to address a *Carrier Serving Area* (CSA), as illustrated in Figure 5-1. The CSA has a radius of approximately 18,000 feet, which is the typical maximum length of a local loop without special conditioning provided by either amplifiers (analog signal boosters) or repeaters (digital signal regenerators). The carrier can extend the radius of the CSA through the deployment of either intelligent remote COs, or unintelligent remote line shelves. The remotes are connected to the centralized CO through high-capacity circuits. Should significant volumes of traffic be exchanged directly between COs, they may be directly interconnected. More commonly, they are interconnected through tandem switches.

Class 4 offices are *tandem toll centers*, which serve to interconnect Class 5 offices not connected directly. As the lowest class of toll center, these also serve as the first point of entry to the long distance, or toll, network. Class 4 offices are interconnected within a relatively local toll network and provide access to higher-order toll centers. In many instances, a Class 4 office also serves as a Class 5 office; in other words, a hybrid switch serving as both a Central Office and a tandem toll office, with the separate functions provided through logical and physical partitioning within the switch. Approximately 1,500 tandem toll centers existed in North America prior to AT&T's divestiture of the BOCs.

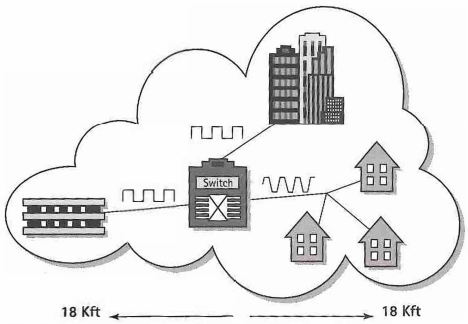

Figure 5-1 Class 5 office with Carrier Serving Area (CSA)

Class 3 offices, or *primary toll centers*, are higher-order toll centers, generally serving to connect Class 4 offices for intrastate toll calling. Class 4 offices typically serve to interconnect independent telcos and BOCs. Approximately 200 such offices existed prior to divestiture.

Class 2 offices, or *sectional toll centers*, serve to interconnect primary toll centers, largely for interstate calling within a geographic region such as the Northeast or the Southwest. Approximately 67 sectional toll centers existed in the AT&T network prior to divestiture.

Class 1 offices, or *regional toll centers*, serve to interconnect sectional toll centers in support of interregional calling. There were 10 regional toll centers in place in the United States prior to divestiture; seven currently exist in the United States, and two in Canada.

As illustrated in Figure 5-2, the offices traditionally were interconnected on a hierarchical basis, with end offices residing at the bottom of the network food chain. As a user places a long distance call, the Class 5 switch examines and analyzes the destination telephone number in the context of the geographic area it serves. Based on that information and relying on program logic, the CO processes and routes the call. Local long distance calls (e.g., within the San Francisco Bay Area) either are handled by directly connected Class 5 offices, or through a Class 4 tandem toll office which interconnects multiple Class 5 offices. A coast-to-coast call, on the other hand, might involve all 5 classes of the hierarchy. For instance, a call from Turlock, California to New York, New York originates in the Class 5 switch of Evans Telephone Company, an independent telco, and is handed to a nearby AT&T tandem toll center. The call then works its way up the hierarchy until it reaches the Class 1 regional toll center in San Francisco. High-capacity, coast-to-

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