DIGITAL COMMUNICATION

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Kluwer Academic Publishers
Boston/Dordrecht/London

DISTRIBUTORS

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for the UK and Ireland:

Kluwer Academic Publishers Group, Distribution Centre, P.O. Box 322, 3300 AH Dordrecht, The Netherlands

Robert Gallager, Consulting Editor

Library of Congress Cataloging-in-Publication Data

Lee, Edward A., 1957-
Digital communication.

Includes bibliographies and index.
1. Digital communications. I. Messerschmitt, David G. II. Title.
TK5103.7.L44 1988 621.38'0413 88-9335
ISBN 0-89838-274-2

PRINTED IN THE UNITED STATES

to the nodes. Time-slots can be *pre-assigned*, implying that changes are infrequent and only as a result of rearrangements, or *demand-assigned*, meaning that frequent reassignments are made to match the ebb and flow of traffic demands.

The reference burst is composed of three parts. A deterministic *carrier and bit-timing* sequence of approximately 30 to 300 symbols enables each node to do accurate carrier recovery and timing recovery for detection of the subsequent information bits. This is followed by a *unique word* with good autocorrelation properties, enabling each node to establish an accurate time-reference within the reference burst. The unique word is entirely analogous to the added framing bits in a TDM frame. Finally, there is the *control and delay channel*, which is a set of information bits used for control of the nodes. It enables the central control to assign time-slots, and can even be used to control the phase of a node's traffic burst within a time-slot, thereby reducing the size of the guard time. The traffic burst preamble has a very similar structure. The control algorithms can get fairly complicated, and the reader is referred to [3] for a more detailed discussion.

Early satellite systems utilized multiple access by FDM, to be described later, but the current trend is to use TDMA.

Example 16-10.

The INTELSAT system uses TDMA for high-volume international traffic. The basic bit rate is 120.832 Mb/s using four-phase PSK so that the baud rate is 60.416 MHz. The basic frame is 2 ms in length, this being 16 times the frame period of both of the standard primary multiplex standards in the world (example 16-5 and example 16-6). Each time-slot is assigned to one of these primary bit streams. For a G.732 bit stream (example 16-5), the traffic burst will contain 2 ms · 2.048 kb/s = 4096 information bits. At a bit rate of 120.832 Mb/s, the information portion of the traffic burst consumes 33.9 μsec. Forgetting the reference burst, guard times, and traffic burst preambles, the frame has room for 59 of these G.732 bit streams. □

16.2.3. Time-Compression Multiplexing

Two methods of providing full-duplex transmission will be described in this chapter; *time-compression multiplexing (TCM)* [5] is described in this subsection and *frequency-division multiplexing (FDM)* is described in section 16.3. A full-duplex channel is a broadcast channel, in the sense that during a near-end transmission, both receivers, the near-end and the far-end, can listen. TDMA is therefore applicable to full-duplex transmission, and TCM is in fact just a simple application of TDMA. We divide a basic frame into two time-slots, using one for transmission in each direction. The "time-compression" refers to the fact that a bit-stream in one direction is divided into traffic bursts and transmitted at a speed at least twice as high as its average bit rate. Of course, "time-compression" in this sense is a feature of all time-division multiplexing schemes, and is not unique to full-duplex transmission.

TCM is illustrated in figure 16-7. The switches close to connect a local transmitter to remote receiver, alternating in direction. The "west" transmitter transmits a traffic burst at regular intervals (to insure the fixed bit rate) and at a rate somewhat higher than twice the average data rate in one direction. The west transmitter is the master for the system, defining the basic TDMA frame. It does not transmit a reference burst