

United States Patent [19]

Wolfe et al.

[11] Patent Number: 4,763,325

[45] Date of Patent: Aug. 9, 1988

[54] DEMAND ASSIGNED REFORMATTING WITH AN OVERFLOW AREA FOR TIME DIVISION MULTIPLE ACCESS COMMUNICATION

4,322,845 3/1982 Fennel, Jr. et al. 370/104
4,504,946 3/1985 Raychaudhuri 370/104
4,513,416 4/1985 Fujiwara 370/104
4,599,720 7/1986 Kunzinger 370/104

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[57] ABSTRACT

[21] Appl. No.: 772,536

A time division multiple access communication system in which the repetitive frame is divided into fixed portions preallocated to separate stations and an overflow portion. Each station retains control of its own preallocated portion. Whenever one of the stations needs space that is not available in its preallocated portion, it requests a reference station for part of the overflow portion, which is relinquished as soon as the requirement stops.

[22] Filed: Sep. 4, 1985

[51] Int. Cl.⁴ H04J 3/16

[52] U.S. Cl. 370/104; 370/95

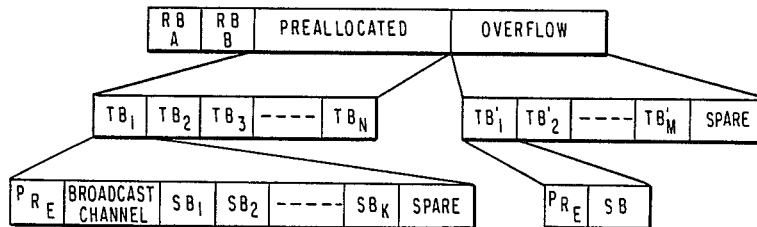
[58] Field of Search 370/99, 104, 79, 95; 455/12

[56] References Cited

U.S. PATENT DOCUMENTS

4,204,093 5/1980 Yeh 370/104

5 Claims, 3 Drawing Sheets



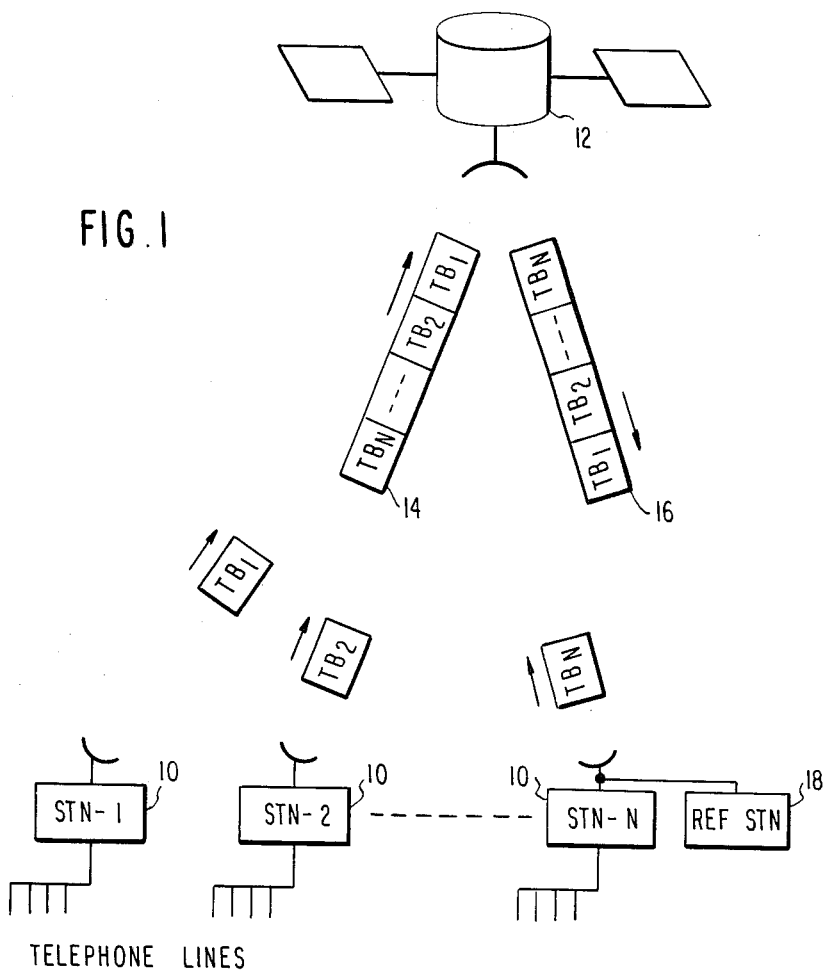


FIG. 2

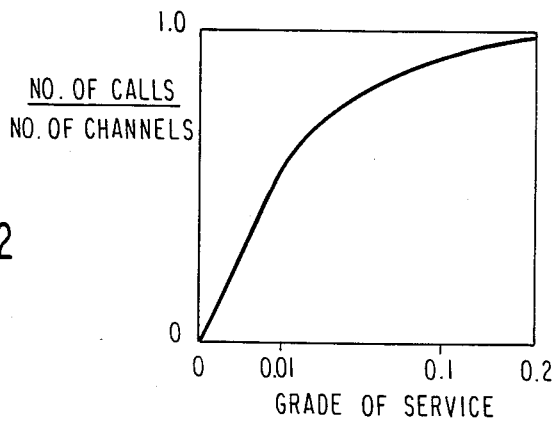


FIG. 3

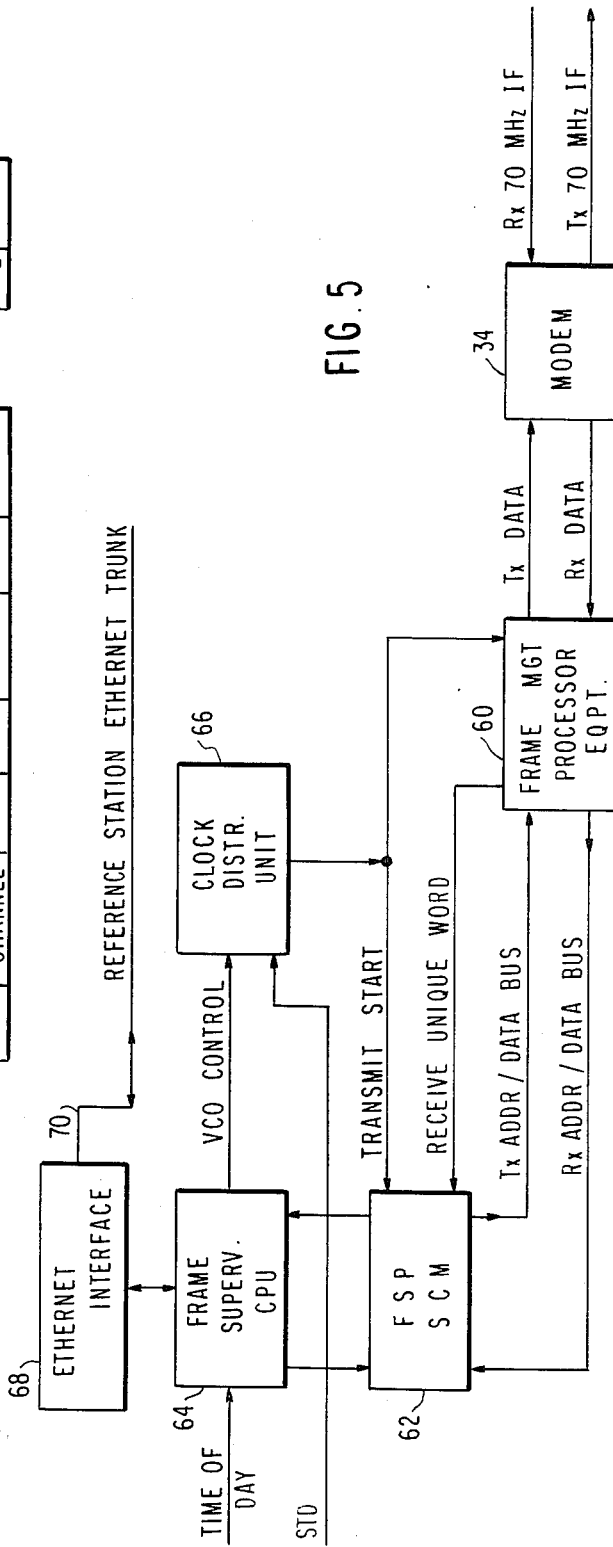
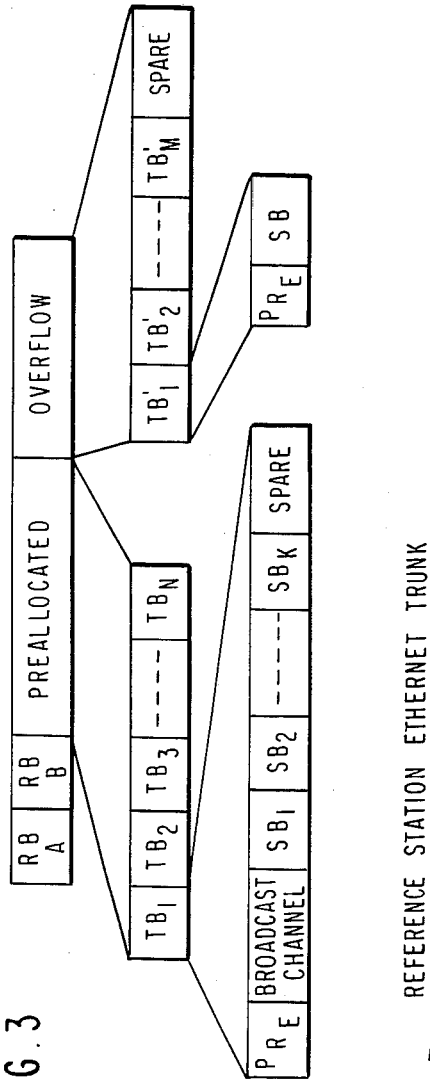


FIG. 5

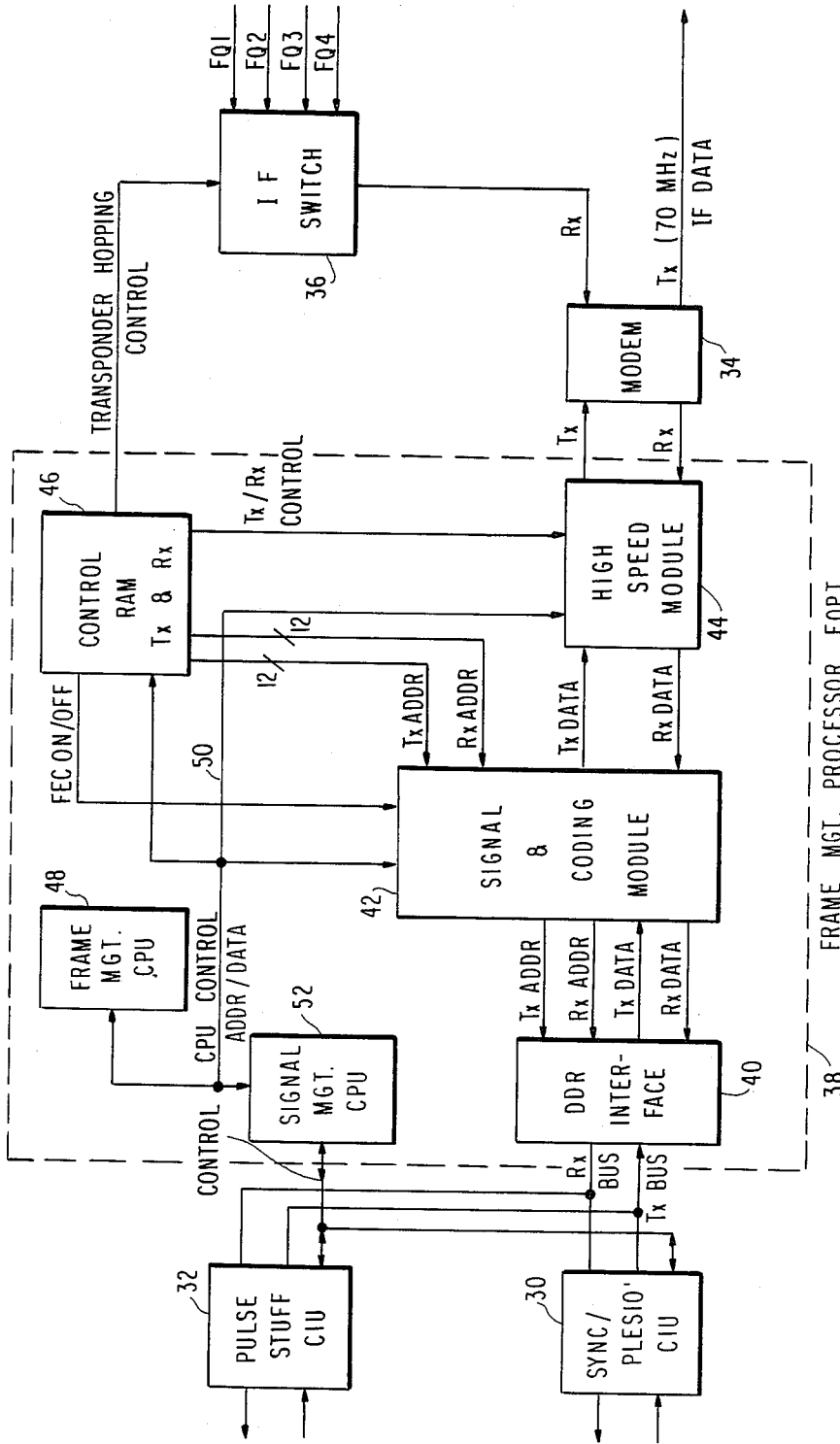


FIG. 4

CEPT-32 TRUNKS

**DEMAND ASSIGNED REFORMATTING WITH AN
OVERFLOW AREA FOR TIME DIVISION
MULTIPLE ACCESS COMMUNICATION**

BACKGROUND

The invention relates generally to communication systems. In particular, the invention relates to the dynamic reformatting of a time division multiple access frame dependent upon the demand of the attached stations.

Many modern, large-scale communication systems rely upon geosynchronous satellites acting as transponders between the transmitting and receiving stations. Although originally used for point-to-point communication between two ground stations, more recent satellite communication systems link together a substantial number of ground stations, offering selective communication between any pair of the ground stations. Such a system is schematically illustrated in FIG. 1 for N ground stations 10 linked together by a communication satellite 12 in geosynchronous orbit. The illustrated system is designed for telephone communications with each station 10 being associated with a telephone regional office. Whenever a telephone connection is desired between two telephone lines connected to different regional offices, the call is routed through the associated ground station 10 and is transmitted from there, through the satellite 12, to the appropriate receiving ground station 10.

Older satellite communication systems relied upon frequency allocation between the transmitting ground stations 10. However, more recent multi-point systems, particularly those designed to support telephone/data communications, have adopted a TDMA (time division multiple access) approach. Such a system is disclosed by Maillet in U.S. Pat. No. 3,649,764. In a TDMA system, data is not transmitted continuously but is time multiplexed. The transmission is divided into time frames 14 and 16 with each frame being further subdivided, according to a predetermined format, into traffic bursts TB. Both data and voice signals are transmitted in digital form. The frames repeat often enough that a telephone conversation can be made to appear continuous and instantaneous. In the illustrated example, each ground station 10 is assigned one traffic burst. The transmission of the traffic bursts from the individual ground stations 10 are synchronized so that they arrive at the satellite 12 in the proper time sequence to form the up-link frame 14. The communication satellite 12 receives the up-link frame 14 and retransmits the frame as the down-link frame 16. Although the satellite 12 amplifies and frequency shifts the up-link frame 14 into the downlink frame 16 and perhaps uses part of the frame for housekeeping purposes, the satellite 12 can be viewed as a passive transponder with the up-link frame 14 being identical to the down-link frame 16. It is of course to be appreciated that the frames 14 and 16 illustrated in FIG. 1 are only one pair of a nearly continuous series of up-link frames and down-link frames, the frames in each series being separated by the minimum necessary time.

The entire down-link frame 16 is received by each of the N stations 10 so that each station 10 is receiving the transmissions of every other station 10. The individual traffic burst TB must contain additional information

indicating for which of the ground stations 10 the transmission is intended.

In a TDMA system, a reference station 18 is usually present to provide some degree of coordination between the ground stations 10. At a minimum, the reference station 18 must synchronize the ground stations 10 so that the frames 14 and 16 are synchronized between the stations 10 and furthermore it synchronizes the traffic bursts TB within the frame.

One of the difficulties of a telephone-based communication system is the fluctuation in the loads of the various ground stations 10. These fluctuations may be either statistical or predictable. A statistical fluctuation arises because the ground stations 10 has no control on the number of requests for a telephone connection and this number statistically varies with time. A predictable fluctuation would arise from different times of day for ground stations 10 located in different time zones. Nonetheless, for a consumer-based telephone/data system, there must be a high probability that, when a connection is demanded, channel capacity is available. If the frame format is fixed, this requirement for availability means that there must be a large amount of excess capacity within each of the traffic bursts TB. This in turn implies a relatively high bandwidth system.

Bandwidth is both scarce and, in the case of the satellite 12, expensive to support because of the correspondingly increased power level. Alternatively, for a fixed bandwidth, the excess capacity required for a high availability with a fixed format implies a decreased number of reliably available channels.

In view of the problems of a fixed allocation between the multiple ground stations 10, demand assigned multiple access (DAMA) has been developed. By DAMA is meant that the allocation of time or bandwidth between the ground stations 10 is dynamically allocated according to a real-time demand for channel capacity demanded by the individual ground stations 10. Demand assigned multiple access has been traditionally used in single channel per carrier satellite communication systems, that is, frequency division rather than the time division illustrated in FIG. 1. Examples of these systems include the SPADE system, which has been implemented in the INTELSAT network. In the SPADE system, each earth station 10 communicates with all other stations 10 via a wide band common signalling channel. All call requests are communicated via this channel among all the stations 10 in the network. The different carrier channels, corresponding to different frequencies, are allocated to the different ground stations 10, according to these requests. Each station 10 maintains a data base that represents the frequency assignments for all carrier frequencies in the transponder of a satellite 12. The SPADE system represents a decentralized approach to channel allocation.

Other satellite systems have been designed for centralized control of single channel per carrier satellite communication networks. For example, a master control computer located in a reference station 18 polls each of the earth stations 10 in the network for call requests and thereafter assigns satellite frequencies as required to set up the desired calls. Both of the described DAMA systems have been used with frequency division rather than time division communication. However, demand assignment for a TDMA system is described by Edstrom in U.S. Pat. No. 3,848,093. It is not felt that either the centralized or the decentralized approaches are totally appropriate for a TDMA system.

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