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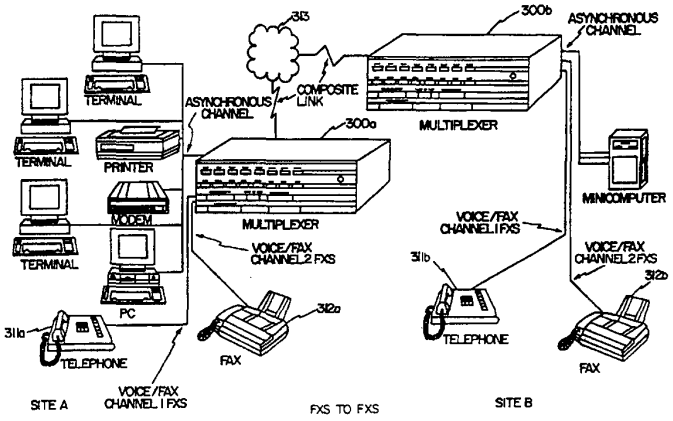
(54) Title: DATA/VOICE/FAX ADVANCED PRIORITY STATISTICAL MULTIPLEXER



(57) Abstract

A data multiplexing network is described which multiplexes a plurality of asynchronous data channels with an asynchronous data stream representing compressed voice signals and/or facsimile signals onto a single synchronous data packet stream. The single synchronous data packet stream is then transmitted by a high speed statistical multiplexer over a composite link to a second site using a modified high-level synchronous data link control protocol with an overlay of an advanced priority statistical multiplexing algorithm. The asynchronous data channels and the compressed voice channel and/or facsimile signals are demultiplexed and reconstructed for sending to other asynchronous computer terminals and to a standard telephone or facsimile analog port at the second site, respectively. PBX trunk interfaces are also provided to allow PBX's to share the composite link between sites. Communication between the first site by voice or facsimile and the second site is transparent to the users. The multiplexer efficiently allocates the bandwidth of the composite link by detecting silence periods in the voice signals and suppressing the sending of the voice information to preserve bandwidth. An advanced priority statistical multiplexer is also described which dynamically allocates composite link bandwidth to both time-sensitive and non-time-sensitive data to maximize data throughout efficiency and quality while simultaneously reducing multiplexer processing overhead.

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DATA/VOICE/FAX ADVANCED PRIORITY STATISTICAL MULTIPLEXER

Field of the Invention

The present invention relates to data communication multiplexers and in particular to automatic data bandwidth allocation in communication multiplexers which multiplex data, facsimile and compressed voice over a single composite link.

Background of the Invention

Data multiplexers in the telecommunications field are used to combine several asynchronous and synchronous data communication signals from individual data terminal equipment (DTE) sources such as computer terminals or personal computers (PC's) onto a single composite link. The individual asynchronous and synchronous signals from the PC's are connected to the multiplexer channel inputs and converted into a single signal called the composite signal which is then sent over a single analog or digital link called the composite link. Of course, the composite link may be a dedicated telephone line, a leased line, or a single private wire.

The data multiplexer combines the channel signals from individual PC's into a composite signal by using one of a variety of techniques such as frequency division multiplexing, time division multiplexing and statistical time division multiplexing. Frequency division multiplexers assign separate frequencies to each signal and combine the frequencies onto the single composite link. Time division multiplexers assign a time slice of a single carrier to each of the channels being combined. Statistical time division multiplexers are an adaptation of time division multiplexers in which only those channels actually sending data get a slice of time. This results in a more efficient use of the composite link.

Typically, a data multiplexer is used as an efficient alternative to traditional data communications in which a single channel uses a single telephone line link. By combining a plurality of asynchronous channels into a composite link, fewer telephone lines or leased lines and less equipment is used to transfer the data. This is especially cost effective when a four wire

"leased" line is used to connect a pair of synchronous modems. This type of private line offers a degree of security that public dial-up telephone lines cannot match. In addition, the superior error correction of a synchronous multiplexer network is preferred over the single telephone line asynchronous connections. Better yet, the use of a digital line with a DSU (Digital Service Unit) connection is more reliable and error free than analog.

Figure 1 shows a typical arrangement for a prior art connection of a plurality of PC's at building A 101 and a computer system at building B 102. The computer system at building B may be personal computers (PC's) 103 such as those shown in building A or any variety of computer equipment devices. Traditional dial-up telephone links 105a, 105b, 105c through 105n are used between the plurality of PC's in building A 101 and the plurality of data terminal equipment (DTE) devices of building B such as a VAX computer 106. Each asynchronous link, therefore, requires its own dial-up link 105a, 105b, 105c through 105n , which is in many cases not cost effective. The connections may be between two sites, or multiple sites may be connected.

Figure 2 shows a prior art data multiplexer scheme in which a plurality of PC's 203 at building "A" 201 are multiplexed using a data multiplexer and synchronous modem 207 to transmit the information over a single telephone link 205 to building "B" 202. The signals are then demultiplexed by a similar multiplexor/modem 208 and transmitted to the DTE of building "B" 202, which for illustrative purposes is shown as a VAX computer 206.

In general, Figure 2 describes a data multiplexer 207 and, in particular, a device manufactured by the assignee of the present invention called the MultiMux (model 900, 1600 or 3200) product from Multi-Tech Systems, Inc. of Mounds View, Minnesota. The product allows for up to n-RS232 connections to local PC's 203, dumb terminals, host computers such as a DEC VAX 206, or other devices which communicate via asynchronous connection. In one product environment, n equals eight where eight PC's or other asynchronous devices can be attached to eight RS232 ports. The

composite link is typically handled through an proprietary protocol with data rates up to 64 kilobytes per second. Not shown is a command port for menu driven control of the operational settings of the data multiplexer.

Connections from one site to another site over a composite link using a dedicated line is an efficient use of the line resources, however additional line connections are still typically needed between the two sites or more sites for traditional telephone voice or facsimile connections between the sites. There is a need in the art, therefore, to combine compressed voice grade telephone signals with data signals and facsimile signals and transmit all over a composite link to further increase the efficient use of a single telephone line connection. There is yet a further need in the art to combine voice grade telephone signals with both synchronous and asynchronous data signals for transmission over a composite link for enhanced efficiency of a single telephone line connection.

Summary of the Invention

The present invention solves the aforementioned deficiencies of the prior art and solves other problems that will be understood and appreciated by those skilled in the art upon reading and understanding the present specification. The present invention describes a data multiplexing network which combines a plurality of asynchronous and synchronous data channels with an asynchronous data stream representing compressed voice signals and/or facsimile signals onto a single synchronous data packet stream. The single synchronous data packet stream is then transmitted by a high speed statistical multiplexer over a composite link to a second site using a modified high-level synchronous data link control protocol with an overlay of an advanced priority statistical multiplexing algorithm. The asynchronous/ synchronous data channels and the compressed voice channel and/or facsimile signals are demultiplexed and reconstructed at the second site for sending to other asynchronous and synchronous data terminal equipment and to a standard telephone or facsimile analog port or PBX interface, respectively.

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