Multiplexing on Wireline Telephone Systems

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ABSTRACT- This Paper Outlines a research multiplexing in the telephone system. Multiplexing [1] is a form of data transmission in which one communication channel carries several transmissions at the same time. The telephone lines that carry our daily conversations can carry thousands or even more of conversations at a time using multiplexing concept. The exact number of simultaneous transmission depends on the type of communication channel and the data transmission[2]. Thus the method of dividing a single channel into many channels so that a number of independent signals may be transmitted on it is known as Multiplexing. We address the Multiplexing schemes divided into two basic categories : Frequency Division Multiplexing FDM [3] ,Time Division Multiplexing TDM[4] .Consequently, telephone companies have developed elaborate schemes for multiplexing many conversations over a single physical trunk[5].

Index Terms- multiplexing, data transmission, FDM, TDM, physical trunk

I. INTRODUCTION

Communication is a vital part of our lives . Multiplexing is the name given to techniques, which allow more than one message to be transferred via the same communication channel. The channel in this context could be a transmission line, *e.g.* a twist pair or co-axial cable, a radio system or a fibre optic system *etc*. A channel will offer a specified bandwidth, which is available for a time *t*, where *t* may $\rightarrow \infty$. Thus, with reference to the channel.there are 2 'degrees of freedom', *i.e.* bandwidth or frequency and time. Multiplexing is one the common tools used today in just about every form of communications. A wide range of telephony services, including online applications, are able to function with such a high degree of efficiency because of the current technological advances this process has made possible. Optical networks also rely heavily on multiplexing to carry voice and video transmissions along concurrent but separate wavelengths from a point of origin to various points of determination. With an increasing range of communication functions taking place across the Internet, it has become an effective tool that aids in everything from videoconference and web conferences to large data transmissions to even making a simple point-to-point telephone call. The purpose of multiplexing is to enable signals to be transmitted more efficiently over a given communication channel, thereby decreasing transmission costs. Today, multiplexing is widely used in many telecommunications applications, including telephony, Internet communications ,digital broadcasting and wireless telephony.

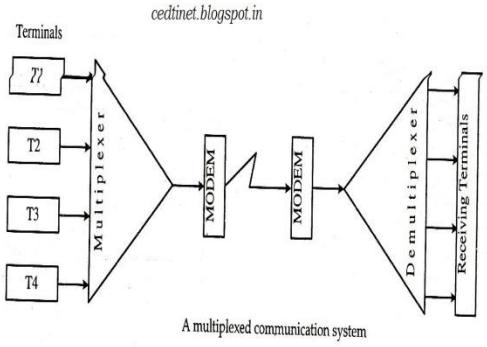

Fig 1 . multiplexed communication system

II. MULTIPLEXING TECHNIQUES

the communication channel is shared in such a way as to maximum the utilization of the channel capacity. Thus the method of dividing a single channel into many channels so that a number of independent signals may be transmitted on it is

known as Multiplexing. Multiplexing schemes can be divided into two basic categories:

- Frequency Division Multiplexing FDM
- Time Division Multiplexing TDM

A. FREQUENCY DIVISION MULTIPLEXING (FDM)

Frequency division multiplexing (FDM) is the technique used to divide the bandwidth available in a physical medium into a number of smaller independent logical channels with each channel having a small bandwidth. The method of using a number of carrier frequencies each of which is modulated by an independent When many channels are multiplexed together, 400Hz is allocated to each channel to keep them well separated. First the voice channels are raised in frequency, each by a different

speech signal is in fact frequency division multiplexing. The following figure depict how three voice-grade telephone channels are multiplexing using FDM. 2. amount. Then they can be combined, because no two channels how occupy the same portion of the spectrum. Notice that even though there are gaps(guard bands) between the channels, there is some overlap between adjacent channels, because the filters do not have sharp edges. This overlap means that a strong spike at the edge of one channel will be felt in the adjacent one as non-thermal noise. Frequency-division multiplexing works best with low-speed devices. The frequency division multiplexing schemes used around the world are to some degree standardized. A wide spread standard is 12 400-Hz each voice channels (300Hz for user, plus two guard bands of 500Hz each) multiplexed into the 60 to 108 KHz band. Many carriers offer a 48 to 56 kbps leased line service to customers, based on the group. Other standards upto 230000 voice channels also exist. Example:

The allocated spectrum is about IMHz, roughly 500 to 1500 KHz. Different (stations, each operating in a portion of the spectrum. With the interchannel separation great enough to prevent interference. This system is an example of frequency division multiplexing. One of FDM's most common applications is the old traditional radio and television broadcasting from terrestrial, mobile or satellite stations, using the natural atmosphere of Earth, or the cable television. Only one cable reaches a customer's residential area, but the service provider can send multiple television channels or signals simultaneously over that cable to all subscribers without interference. Receivers must tune to the appropriate frequency(channel) to access the desired signal.[1]

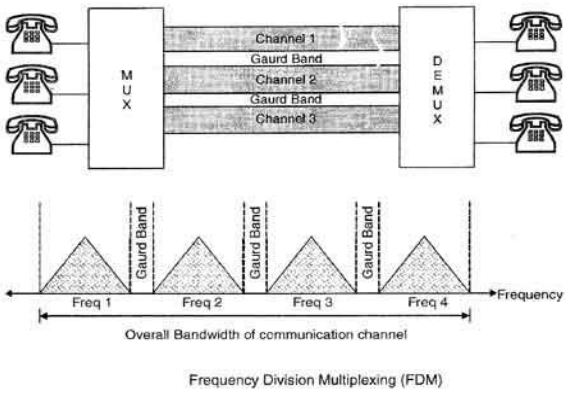

Fig2. Frequency division multiplexing

Advantages of FDM

1. .Here user can be added to the system by simply adding another pair of transmitter modulator and receiver domodulators.
2. FDM system support full duplex information flow which is required by most of application.
3. Noise problem for analog communication has lesser effect.
4.

Disadvantages of FDM

1. In FDM system, the initial cost is high. This may include the cable between the two ends and the associated connectors for the cable.
2. In FDM system, a problem for one user can sometimes affect others.
3. In FDM system, each user requires a precise carrier frequency.

Applications of FDM

1. FDM is used for FM & AM radio broadcasting. Each AM and FM radio station uses a different carrier frequency. In AM broadcasting, these frequencies use a special

band from 530 to 1700 KHz. All these signals/frequencies are multiplexed and are transmitted in air. A receiver receives all these signals but tunes only one which is required. Similarly FM broadcasting uses a bandwidth of 88 to 108 MHz

2 . FDM is used in television broadcasting. .

3 . First generation cellular telephone also uses FDM.

B. TIME DIVISION MULTIPLEXING(TDM)

Time-division multiplexing (TDM) is a digital (or in rare cases, analog) technology which uses time, instead of space or frequency, to separate the different data streams. TDM involves sequencing groups of a few bits or bytes from each individual input stream, one after the other, and in such a way that they can be associated with the appropriate receiver. If done sufficiently quickly, the receiving devices will not detect that some of the circuit time was used to serve another logical communication path. TDM provides a way to merge data from several sources into a single channel for communication over telephone lines, a microwave system or a satellite system. TDM can be implemented in two ways. These are synchronous TDM and asynchronous TDM. Asynchronous TDM is popularly known as Statistical TDM. In synchronous TDM, a single channel is divided into time slots and each transmitting device is assigned at least one of the time slots for *its* transmission

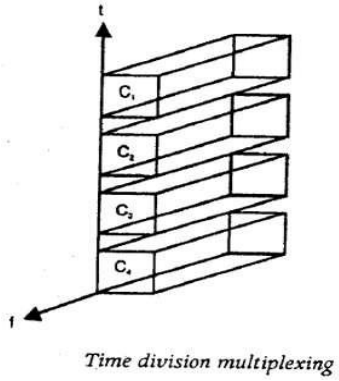

Fig. 3 time slots in TDM

The multiplexer allocates exactly the same time slot to each device at all times, whether or not a device has anything to transmit. Time slot 1, for example, is assigned to device 1 alone and cannot be used by any other device as shown in the figure

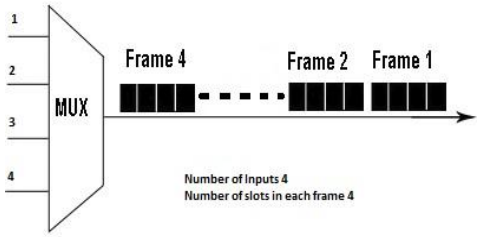

Fig 4. Framework of Synchronous TDM

In asynchronous TDM, each slot in a frame is not dedicated to the fix device. Each slot contains an index of the device to be sent to and **a** message. Thus, the number of slots in a frame is not necessary to be equal to the number of input devices. More than one slot in a frame can be allocated for an input device Asynchronous TDM allows maximization the link. It allows a number of lower speed input lines to be multiplexed to a single higher speed line. As shown in the figure

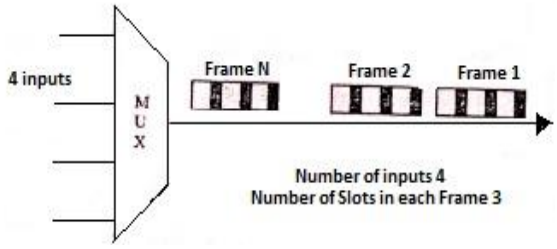

Fig 5. Framework of asynchronous TDM

Advantages of TDM

1. It uses a single links
2. It does not require precise carrier matching at both end of the links.
3. Use of capacity is high.
4. Each to expand the number of users on a system at a low cost.
5. There is no need to include identification of the traffic stream on each packet.

Disadvantages of TDM

I. The sensitivity to other user problem is high
II. Initial cost is high
III. The noise problem for analog communication has greater effect.

IV. IN FIELD OF TELEPHONE SYSTEM

The telephone system includes a conference trunk creating unit that creates a conference trunk as required and has a multiplexing/demultiplexing special number table prestoring a multiplexing special number and demultiplexing special number corresponding to plural group calls. After plural group calls start, if the multiplexing special number is input, a control unit causes the conference trunk creating unit to create a large-conference trunk, switches and connects the voices of plural group calls corresponding to the multiplexing special number to the large-conference trunk and starts the multiplexed group call. If the demultiplexing special number is input, the control unit causes the conference trunk creating unit to create plural small-conference trunks, connects and switches each group call corresponding to the demultiplexing special number to the small-conference trunk and starts the demultiplexed group calls.

The T-1 based digital network has been under development for more than 40 years. During this time, a hierarchy of transmission levels has been implemented through a wide variety of equipment. The primary device is a channel bank which can be arranged to carry many different voice, analog data, or digital data signals. Port cards in the channel bank are used to support the type of inputs into the T-1. The most common are voice (POTS), and digital data (DDS). A T-1 contains 24 signals (or channels). Each channel is represented by 8 bits, for a total of 192 bits within a single frame. A bit is added for management (synchronization, error checking, etc), and the result is a T-1 frame. Because the sampling rate of each channel is 8000 times per second, a T-1 contains 8000 frames, or 1,544,000 bits. In a TDM system, each channel is recognized within each frame at exactly the same point in time. That is – for example – channel one never appears in a channel five time slot. This most common form of multiplexing is used primarily for voice channel services. In fact almost all P.O.T.S. and Special Technical complexity is more

Service communication circuits are multiplexed for transport between Telephone Company Central Offices. Multiplexing (from the telephone company perspective) was developed to obtain efficiency in the use of the available communication cable plant. The telephone companies were able to provide services to more customers without the expensive installation of new communication cables. There were a number of early attempts at providing an efficient multiplexing protocol; for voice based services, but the carriers had to consider the overall quality of the voice communication. Ultimately, the standard for "toll-grade" voice was set as the transmission of frequencies between 0 Hz and 4000 Hz.The voice frequencies are digitized for multiplexing via a process that samples the frequencies at 8000 points in one cycle (Hz) in a period of one second. Each digital sample point is produced as an 8 bit character. Therefore, each voice channel uses 64,000 bits per second. Twenty-four voice channels are combined into a single multiplexed communication channel referred to as a T-1. Because the telephone company needs to monitor and manage the T-1 circuit, it "steals" 8000 bits. A few bits are taken from each sample point, and the caller never notices a reduction in quality. Most data transmission is accomplished using a dial-up modem. The modem converts the data output of a computer (or other device – traffic signal field controller, dynamic message sign, etc.) to a VF (voice frequency) signal. This signal is treated as if it were a P.O.T.S telephone call. The modem dials a telephone number associated with another modem and a connection is made via the switched voice network. The telephone network does not treat the call as if it were something special. In terms of T-1 multiplexing, it is treated as if it were a normal telephone call.

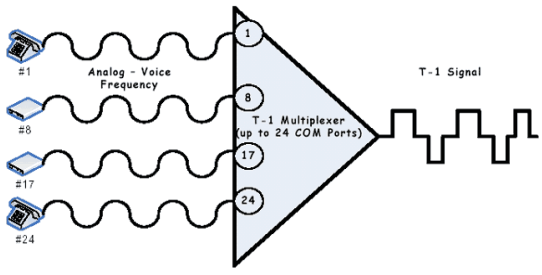

Fig. 6.: Diagram of Analog Inputs to T-1 Mux

V. CONCLUSIONS

The design of telecommunications systems is an iterative process. Each piece of a system is dependent upon the others. A simple example of this dependency can be found in the use of a modem. Basic modems rely on the cables that connect them to

a computer (a serial cable) and the twisted-pair cable that connects them to a telephone network. Each of these elements is dependent upon the other to provide a working system. These types of dependencies can be found in all telecommunications systems. This research was organized to provide basic information about individual elements and their relationships. Recognition of these relationships will help to provide an effective design of a telecommunications network.

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