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Review of Multiplexing Techniques in Advance Communication Systems

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Abstract: In this paper, we present an overview of different multiplexing techniques. The goal of transmission of signal which communication system is to have faithful reproduction of the same original signal at the receiver end without error. The aim of data communication and networking is to facilitate the exchange of data such as data,audio, text, video, etc. between any point in the world. Insurance rise enterprise free and lossless original signal transmission and reception.Modulation is the key operation performance on the signal. The orthogonal frequency division multiplexing is a multi-carrier transmission Technology. It aims to achieve higher data rate in the multi-path fading involvement of communication system. The purpose of applying multiplexing techniques to reduce frequency selective fading and burst error generated by wide band fading channel in wireless communication.

Keywords: FDM, TDM, MUX, DEMUX, WDM.

I. INTRODUCTION

The multiplexer receives a large number of different input signals. Multiplexer has only one output which is connected to the single communication channel. At the receiving end of communication link, a de-multiplexer is used to sort out the signals into their original form.The multiplexing technique can be broadly classified into two categories, namely analog and digital. Analog multiplexing can be either FDM or WDM and digital multiplexing is TDM. Here shown the classification of multiplexers [3].As shown in Fig.1.

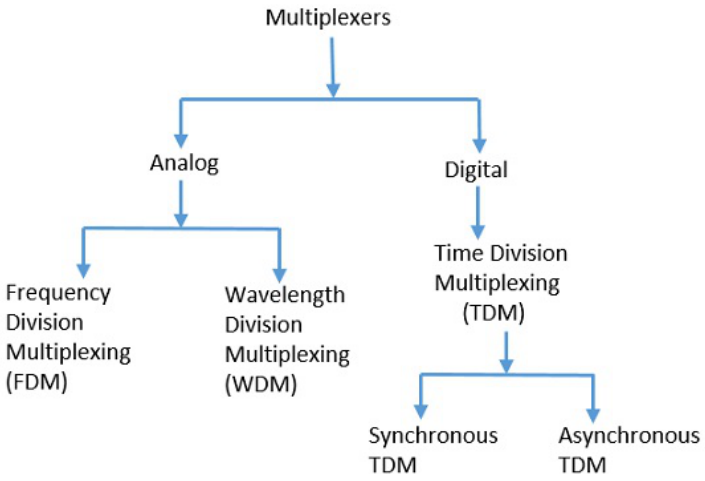

Fig. 1 Multiplexer Techniques

Generally, the FDM and WDM systems are used to deal with the analog information, where the TDM systems are used to handle the Digital information. The guard time is made use of frequency division multiplexing, so that ISI can be reduced. Many signals are transmitted simultaneously where is signal occupies a different frequencies slot within a common bandwidth.TDM and FDM depends on the choice of modulation scheme to maximize spectral efficiency. To achieve a higher throughput in the same bandwidth, must be use higher order modulation scheme.TDM techniques, the signals are transmitted at different time slots.Due to multiplexing, it is possible to increase the number of communication channels so that more information can be transmitted [4]. The typical applications of multiplexing are in telemetry and telephone or in the satellite communication. As shown in Fig.2

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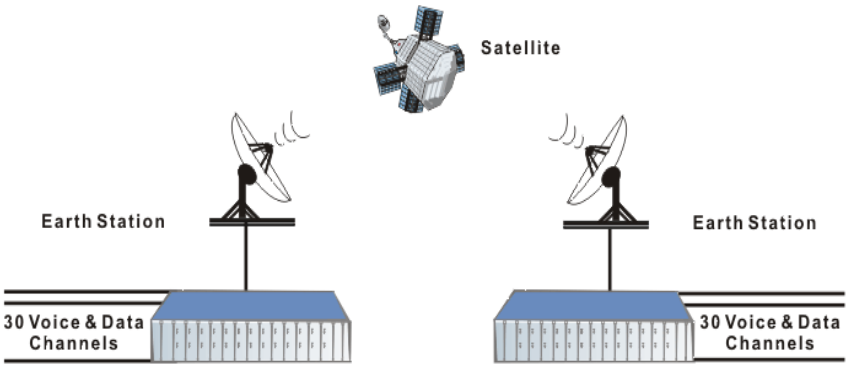

Fig. 2 Multiplexing application of Satellite communication

In TDM, the multiplexer is a single pole rotating switch or commutator. Which can be mechanical switch or an electronic switch and it rotates at very high speed. As a switch on rotates, it is going to make contact with the position 1 2 3 up to n channels for short time. The switch will connect these and input signals one by one to the communication channels. The Rotary switch samples each message during each of its rotation.TDM and FDM depends on the choice of modulation scheme to maximize spectral efficiency.

II MODULATION TECHNIQUES

In the modulation process to signal are used namely the modulating signal and carrier signal. The modulation signal is nothing but the base band signal or information signal while carrier is high frequency sinusoidal signal. In the modulation process some parameter of the carrier wave such as amplitude, frequency or phase is varied in according with the modulating signal [2]. The base band signal or modulating signal is a low frequency signal and it is not possible to multiplexing without modulation. Main advantage of modulation is reduction of the height of antenna, avoids mixing of signals, increase the range of communication, multiplexing is possible, improve quality of signal so these are the basic advantage of modulation techniques. Three different techniques are used for analog modulation; amplitude modulation, frequency modulation and phase modulation. These techniques can be used to generate analog signal and translate the individual frequencies to different frequency bands by using different carrier frequencies [7]. Basically, the modulation is of following two types as shown in fig.3.

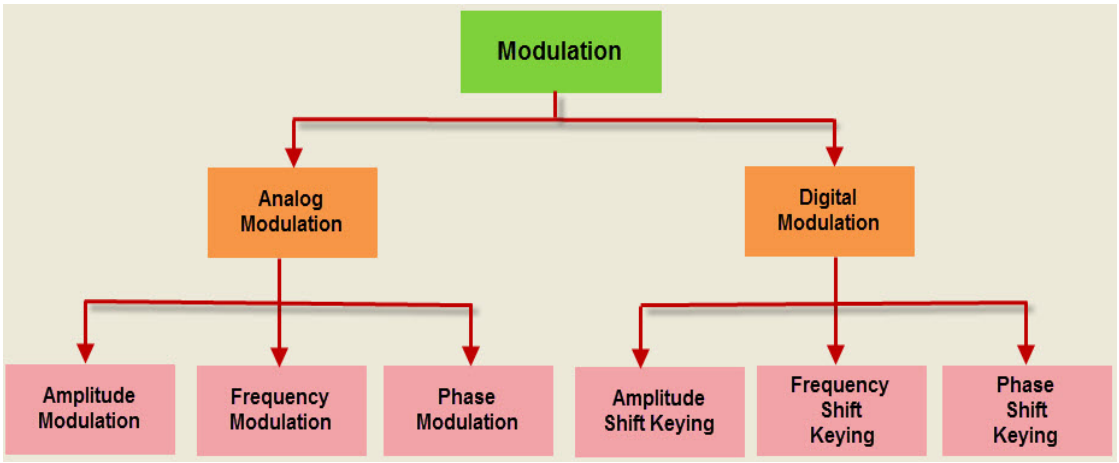

Fig. 3 Modulation Techniques

So, depending on whether data is analog or digital be using, either analog or digital modulation after that doing multiplexing. If transmitting the analog data to digital medium then convert into digital form by using pulse code modulation or Delta modulation. As shown on fig.4 first baseband signal converts higher frequency signal by modulation techniques after that do the multiplexing and send the data through single channel.

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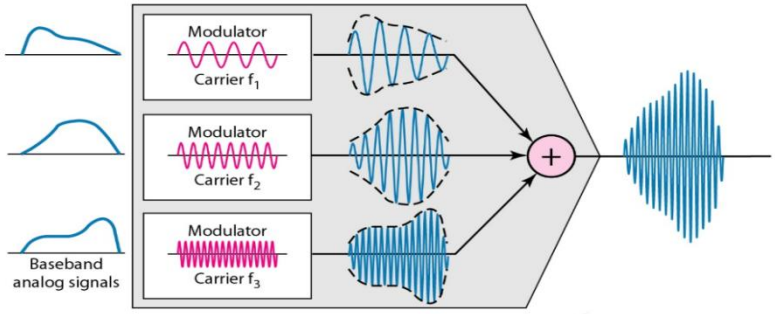

Fig. 4 Modulation Mechanism of analog signal before Multiplexing

III BASIC CONCEPT OF MULTIPLEXING:

To achieve a higher throughput in the same bandwidth, must be use higher order modulation scheme.The communication media usually have much higher bandwidth [1]. Nowadays, use coaxial cable, optical fiber, microwave link, they have data rate several megabits per second andbandwidth hundreds of megabits. A consequence the communication media provides much higher bandwidth. On the other hand, individual users have lesser data to send.If got two users like, user 1 and user 2 and they are linked by a communication channel, may be optical fiber, coaxial cable or wireless, but it may be not able to utilize the link capacity fully. The higher the data rate, the most cost effective is the transmission [1]. If the data rate is small, then the cost per byte or per kilo byte is more, but if the capacity is large say several gigabits, then the cost per byte or power cost per kilobyte is much less. So use a technique known as multiplexing.Multiplexing technique, individual signals to be transmitted through a channel, a medium can be shared by more than one channel or signals by using multiplexing as shown on fig 5.The channel capacity or bandwidth of a particular medium higher so the channel capacity can be shared among a number of communicating stationsand utilize the channel capacity fully [2].

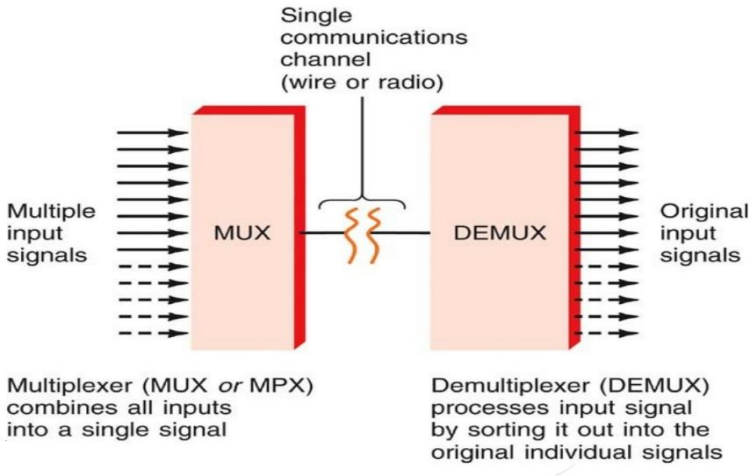

Fig. 5 Concept of Multiplexing

IV FREQUENCY DIVISION MULTIPLEXING:

This is the simplest kind of scheme; whole frequency band frequency is being divided. It is called frequency division multiplexing.The frequency channel is divided into logical channels each user uses a particular frequency on the radio spectrum. The multiplexer is attached to a high-speed communication line, because all these frequency bands from individual users are going to add up to a fact range of frequencies. so, the communication line must be able to handle this whole frequency range or in other words the communication line has to be high speed a corresponding multiplexer and de-multiplexer [4]. As shown in fig. 6.

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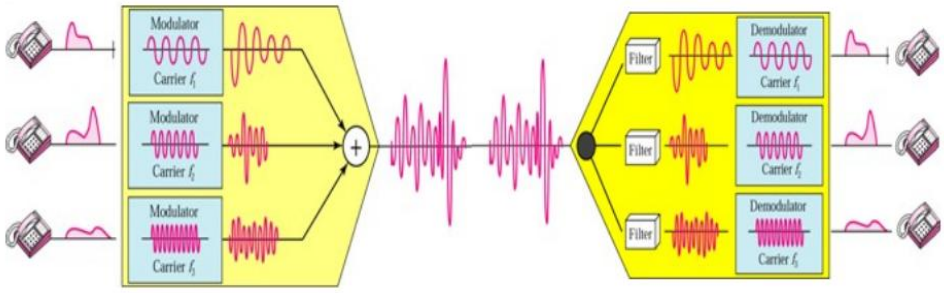

Fig. 6 Frequency division multiplexing

This whole bandwidth of radio frequencies that is divided into small channels and each channel is given to one particular station [3]. For example, on radio communication at receiver side user tune our radio then select one particular frequency and receive from particular station only. Although a number of stations are all transmitting at the same time from radio station, so this is an example of multiplexing.Other example of frequency division multiplexing in the cable TV; the cable TV providers, gives one cable, which is connected to the TV, one coaxial cable apparently is carrying a number of channels maybe hundreds of channels. All the frequencies which can travel through cable, it has number of logical channels and each channel is dedicated to one particular station. So that is carry multiple video channels on a single cable.Broadcasting of radio, cable television and cellular phone systems are used frequency division multiplexing. This technique is the oldest of multiplexing. One application shone as fig. 7. These all telephone signals combined with FDM.

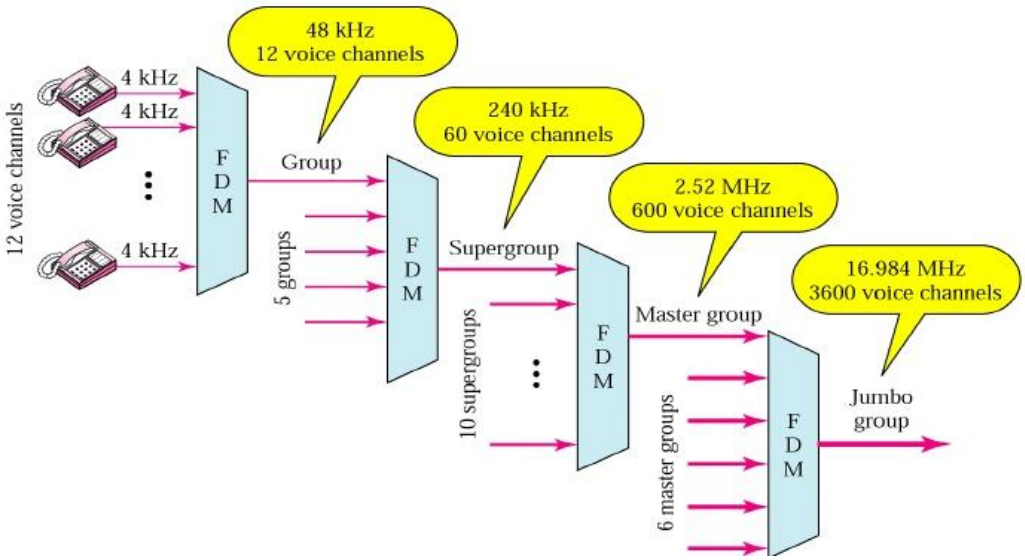

Fig. 7 FDM application in Telephone line

Each signal is modulated onto a different carrier frequency and carrier frequencies are separated by guard bands. This guard bands are important because, one particular channel may be a radio channel or may be a TV channel needthe free range of frequencies between two channelsso thatit will not interference or not overlapping with the others frequencies as shown on fig. 8.These are important otherwise these two frequencies signals are going to interfere with each other, so that using a guard band between two channel or frequency bands. These guard bands usually usedinFDM.

Fig. 8 Guard band in FDM

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The drawback of FDM is that cannot utilize the full capacity of the channel. It is useguard bands between the two channeland other disadvantage is that probability of noise more because dealing the analog signals in FDM [3].

A. WAVELENGTH DIVISION MULTIPLEXING:

Wavelength division multiplexing is the same as the frequency division multiplexing only thing is that here the operating frequencies are much higher range and they are use in the optical fiber communication. Optical fiber communication carries the very large data capacity, with high speed.In Optical fiber light is launched into the fiber, using a light source such as a light emitting diode or laser. it is detected on the other side using a photo detector or photo transistor. It has many advantages over the electrical cable, it has higher bandwidth therefore can operate at higher data rate, distortion is low, better quality of signal, it has no electromagnetic interface, lightweight and used for point to point communication [3].Wavelength division multiplexing is the basic technology of optical networking. This technique is used for fiber to carry many separate and independent optical channels [2]. Multiplexing and de-multiplexing for wavelength division multiplexing is very simple. If take a prism and send the light through between them, it breaks up into all the different colors, because the refractive index of the prism, so this is the basic principle of WDM technique. As shown on fig. 9.

Wavelength-division multiplexing, multiplexes multiple data streams on to a single optical fiber line. These different frequencies have different wavelength. Lambda is used for denoting a wavelength. So different frequencies have different lambdas. Wavelength selective colors are used both multiplexer and to separate the signals in demultiplexers [4].

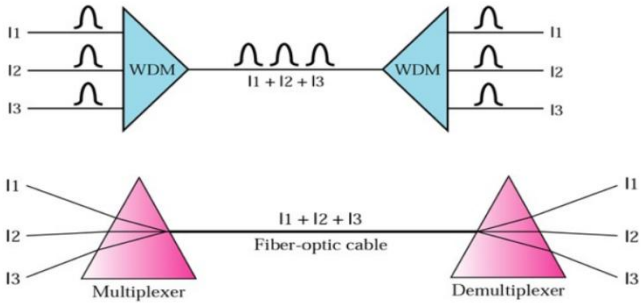
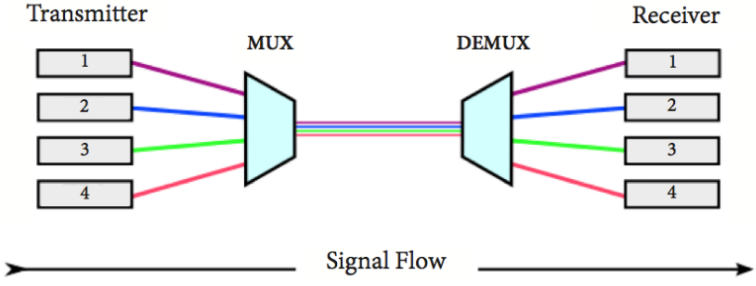


Fig. 9 Prism in Wavelength division multiplexing

The role of WDM is simple to increase the total bit rate. The output of transmitter in optical fiber each operating at its own carrier frequency or different wavelength. The multiplexer multiplex in single fiber and combined it. The multiplex signal is launched into the optical Fiber for transmission. On the other end, where a demultiplexer separate all wavelength on original form and sends to each channel [4]. Shown on fig.10



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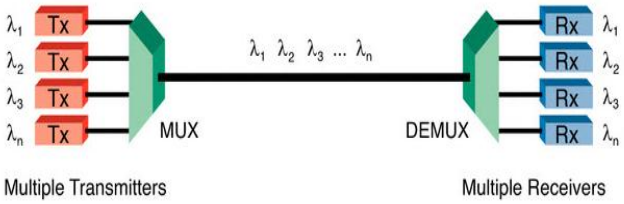

Fig. 10 Wavelength division multiplexing

Optical networks are used to connect a large group of users spread over a geographical area. They can be classified according to the area, they cover Local Area Network (LAN), MAN, WAN. All these types of network can benefit with WDM Technology. They can be designed using the hub, ring or star topology. WDM multiple access networks offer a random bidirectional access to each subscriber. Each user can receive and transmit information to any other user of the same network at all times, telephone networks is the example of WDM network. Another example is provided by the internet used for connecting multiple computers.

V TIME DIVISION MULTIPLEXING

In Time division multiplexing, the signals are sent in such a way that in different time slots [5]. If have n numbers of signals, so first sending signal from channel one, channel two, channel 3 and so on with fixed time delay time period. Each time delay between channel is fixed. In time division multiplexing each user periodically gets the entire bandwidth, that means the entire channel is dedicated to one user but, only for a short period of time, or a small burst of time.Time division multiplexing is very extensively used, on this method sharing of the signal is accomplished in time division multiplexing by dividing the available transmission time on a medium amongst users [6]. Time is being divided each user and gets a small burst of time the entire channel and the entire bandwidth.This way maybe in a round robin fashion after some time, it will come back to the original user. It is usually use digital signaling in time division multiplexing.Time division multiplexing comes in two basic forms, one is synchronous time division multiplexing, the other is statistical or asynchronous time division multiplexing [6].

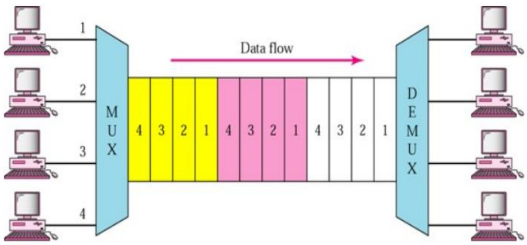

Fig. 11 Time division multiplexing

A. SYNCHRONOUS TIME DIVISION MULTIPLEXING:

In the synchronous digital multiplexer, master clock governs all the sources. Therefore, all the sources will operate at the same bit rate. As the bit rate variation are completely eliminated, the synchronous multiplexing system attend a very high throughput efficiency. But they need elaborate provisions to distribute the master clock signal, to all the sources.Synchronous time division multiplexing clock has to be synchronized [8].The multiplexer accepts input from attached devices in a round robin fashionand transmit the data in a never-ending patternas shown in fig. 12. T-1 and ISDN telephone lines are common examples of synchronous time division multiplexing. The disadvantage of time division multiplexing is that even if the sender does not have to send anything but that time slot will go empty [6], as shown in fig. 13.

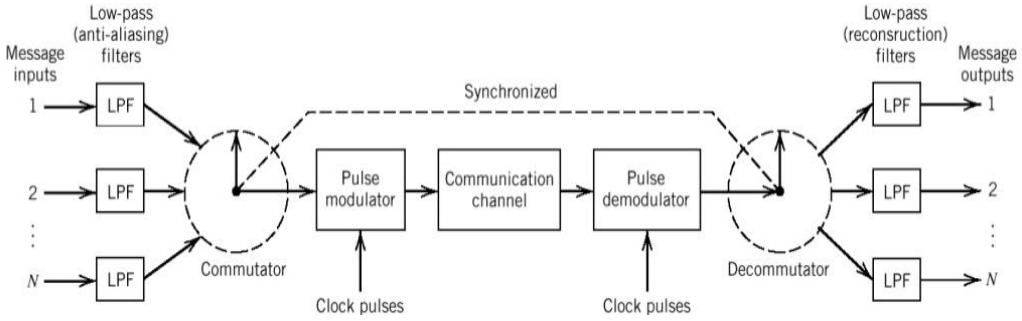

Fig. 12 Synchronous TDM Mechanism

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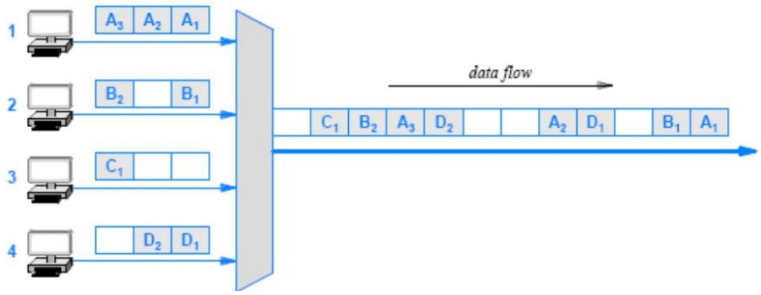

Fig. 13 Synchronous TDM system leaving slots unfilled when a source does not have a data

B. STATISTICAL OR ASYNCHRONOUS MULTIPLEXER:

It is also known as asynchronous time division multiplexing or Statistical time division multiplexing. The asynchronous multiplexer is use for the digital data sources, which operate in the start/stop mode. The sources produced data in the form of bursts of characters with a variable spacing between the bursts. The technique such as buffering and character interleaving, makes it possible to merge these sources into a synchronous multiplexer bit stream.This is time division but on-demand rather than fixed [9]. The disadvantage of synchronous time division multiplexing is that even if the sender does not have to send anything but that time slot now will go empty, this thought to be addressed in statistical time division multiplexing. The packets are sent on demand that means, if somebody has to send the signal and the channel is free it will be sent the signal with other time also & utilizes the channel in a much more efficient manner as shown on fig 14. A statistical multiplexer transmits only the data from active workstations, if a workstation is not active, no space is wasted on the multiplexed stream. The statistical multiplexer accepts the incoming data streams and creates a frame containing only as shown in fig. 14.

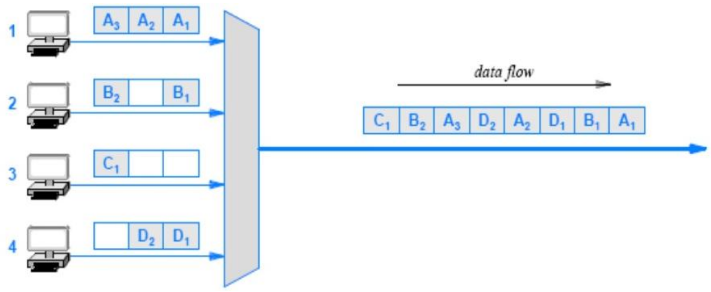

Fig. 14 Asynchronous multiplexer avoids unfilled slots and takes less time to send data

VI CONCLUSION

Multiplexing is the process of simultaneously transmitting two or more individual signals of a single communication channel.Cost savings can be gained by using a single channel to send multiple information. It also increases the number ofcommunications channels so that more information can be transmitted. There are many communication applications that will be proactively expensive or impossible without multiplexing, satellite, cable TV and cell phones are some example of multiplexing.Frequency division multiplexing is generally used for analog information. The individual signals to be transmitted with different frequency within a common channel.At the same time, time-division multiplexing is generally used for digital signal. Multiple signals are transmitted in different time slots on a single channel. In TDM each signal occupies the entire bandwidth of a channel, each signal is transmitted for only a period of time frame.

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