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Chapter 1 : What is Statistical Time Division Multiplexing (STDM, StatMUX)? - Definition from Techopedia

Time-division multiplexing (TDM) is a method of transmitting and receiving independent signals over a common signal path by means of synchronized switches at each end of the transmission line so that each signal appears on the line only a fraction of time in an alternating pattern.

Multiplexing is the process of combining multiple signals into one signal, over a shared medium. The process is called as analog multiplexing if these signals are analog in nature. If digital signals are multiplexed, it is called as digital multiplexing. Multiplexing was first developed in telephony. A number of signals were combined to send through a single cable. The process of multiplexing divides a communication channel into several number of logical channels, allotting each one for a different message signal or a data stream to be transferred. The device that does multiplexing, can be called as a MUX. The reverse process, i. Their primary use is in the field of communications. Types of Multiplexers There are mainly two types of multiplexers, namely analog and digital. The following figure gives a detailed idea about this classification. There are many types of multiplexing techniques. Of them all, we have the main types with general classification, mentioned in the above figure. Let us take a look at them individually. Analog Multiplexing The analog multiplexing techniques involve signals which are analog in nature. This technique uses various frequencies to combine streams of data, for sending them on a communication medium, as a single signal. Wavelength Division Multiplexing Wavelength Division multiplexing WDM is an analog technique, in which many data streams of different wavelengths are transmitted in the light spectrum. If the wavelength increases, the frequency of the signal decreases. Digital Multiplexing The term digital represents the discrete bits of information. Hence, the available data is in the form of frames or packets, which are discrete. This technique is used to transmit a signal over a single communication channel, by allotting one slot for each message. One slot is allocated for each input line. In this technique, the sampling rate is common for all signals and hence the same clock input is given. The MUX allocates the same slot to each device at all times. If the allotted device, for a time slot transmits nothing and sits idle, then that slot is allotted to another device, unlike synchronous. This type of TDM is used in Asynchronous transfer mode networks. Demultiplexer Demultiplexers are used to connect a single source to multiple destinations. This process is the reverse of multiplexing. As mentioned previously, it is used mostly at the receivers. DEMUX has many applications. It is used in receivers in the communication systems. It is used in arithmetic and logical unit in computers to supply power and to pass on communication, etc. Demultiplexers are used as serial to parallel converters. The serial data is given as input to DEMUX at regular interval and a counter is attached to it to control the output of the demultiplexer. Both the multiplexers and demultiplexers play an important role in communication systems, both at the transmitter and receiver sections.

Chapter 2 : What is OFDM | Orthogonal Frequency Division Multiplexing | theinnatdunvilla.com

The Time Division Multiplexing system can be used to multiplex analog or digital signals but it is mostly preferred for digital signal multiplexing. The TDM Signal is transmitted on the common communication medium in the form of frames.

Incoming signals received divided into an equal length of time slots. They will then reassemble into the original signal after going through the process of de-multiplexing. So what is time division multiplexing? It is basically a process which will prove to be useful for effective transmission of the communication signals to the required destination. This will help us in ensuring that data transmitted to the desired destination without suffering from any kind of loss. Even the targeted user able to effectively understand the data which transmitted to them by means of de-multiplexing. Details about what is TDM In this method instead of sending all the data simultaneously, they divided into small packets. These packets then sent over a particular time slot. It will help in ensuring that data is sent effectively and securely to the targeted destination. The main thing in this is that the packets which prepared should send precisely over the specified time slots only. Receiving end of the signal will collect all the signals sent for reassembling them. This will prove to be useful while assembling them to get back the original data. TDM is basically consisting of two categories. It includes TDM and synchronous time division multiplexing. Mainly it used for the purpose of long-distance communication and also for the purpose of bearing heavy loads. During each time a data packet generated which also consisting of the error correction channel. This repeated till the process channel gets expired and it gets repeated over the next channel. One of the examples of TDM is transmitting the multiple telephonic conversations over a single four-wire cable. It is also possible to have a pulse code modulation over this system which will be used for interchanging the system. Discussion Thus, we can say that communication has become quite effective due to the use of Time Division Multiplexing. It is leading to the sharing of information by dividing them into small packets of data. They assembled together at the final location to retrieve back the original data. It used when there is a need to transmit multiple signals over a single transmission cable. All the data packets will collect at the end and de-multiplexed to obtain the required information.

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Chapter 3 : Time-Division Multiplexing

Time division Multiplexing Explanation and animation Description.

It has also been adopted for other broadcast systems as well including Digital Radio Mondiale used for the long medium and short wave bands. Although OFDM, orthogonal frequency division multiplexing is more complicated than earlier forms of signal format, it provides some distinct advantages in terms of data transmission, especially where high data rates are needed along with relatively wide bandwidths. An OFDM signal consists of a number of closely spaced modulated carriers. When modulation of any form - voice, data, etc. It is necessary for a receiver to be able to receive the whole signal to be able to successfully demodulate the data. As a result when signals are transmitted close to one another they must be spaced so that the receiver can separate them using a filter and there must be a guard band between them. This is not the case with OFDM. Although the sidebands from each carrier overlap, they can still be received without the interference that might be expected because they are orthogonal to each another. This is achieved by having the carrier spacing equal to the reciprocal of the symbol period. Traditional view of receiving signals carrying modulation To see how OFDM works, it is necessary to look at the receiver. This acts as a bank of demodulators, translating each carrier down to DC. The resulting signal is integrated over the symbol period to regenerate the data from that carrier. The same demodulator also demodulates the other carriers. As the carrier spacing equal to the reciprocal of the symbol period means that they will have a whole number of cycles in the symbol period and their contribution will sum to zero - in other words there is no interference contribution. Any non-linearity will cause interference between the carriers as a result of inter-modulation distortion. This will introduce unwanted signals that would cause interference and impair the orthogonality of the transmission. In terms of the equipment to be used the high peak to average ratio of multi-carrier systems such as OFDM requires the RF final amplifier on the output of the transmitter to be able to handle the peaks whilst the average power is much lower and this leads to inefficiency. In some systems the peaks are limited. Although this introduces distortion that results in a higher level of data errors, the system can rely on the error correction to remove them. This reduces the data rate taken by each carrier. The lower data rate has the advantage that interference from reflections is much less critical. This is achieved by adding a guard band time or guard interval into the system. This ensures that the data is only sampled when the signal is stable and no new delayed signals arrive that would alter the timing and phase of the signal. Guard Interval The distribution of the data across a large number of carriers in the OFDM signal has some further advantages. Nulls caused by multi-path effects or interference on a given frequency only affect a small number of the carriers, the remaining ones being received correctly. By using error-coding techniques, which does mean adding further data to the transmitted signal, it enables many or all of the corrupted data to be reconstructed within the receiver. This can be done because the error correction code is transmitted in a different part of the signal. Immunity to selective fading: One of the main advantages of OFDM is that is more resistant to frequency selective fading than single carrier systems because it divides the overall channel into multiple narrowband signals that are affected individually as flat fading sub-channels. Interference appearing on a channel may be bandwidth limited and in this way will not affect all the sub-channels. This means that not all the data is lost. Using close-spaced overlapping sub-carriers, a significant OFDM advantage is that it makes efficient use of the available spectrum. Another advantage of OFDM is that it is very resilient to inter-symbol and inter-frame interference. This results from the low data rate on each of the sub-channels. Resilient to narrow-band effects: Using adequate channel coding and interleaving it is possible to recover symbols lost due to the frequency selectivity of the channel and narrow band interference. Not all the data is lost. One of the issues with CDMA systems was the complexity of the channel equalisation which had to be applied across the whole channel. An advantage of OFDM is that using multiple sub-channels, the channel equalization becomes much simpler. OFDM disadvantages Whilst OFDM has been widely used, there are still a few disadvantages to its use which need to be addressed when considering its use. High peak to average power ratio: An OFDM signal has a noise like amplitude variation and has a relatively high large dynamic range, or peak to average power ratio.

This impacts the RF amplifier efficiency as the amplifiers need to be linear and accommodate the large amplitude variations and these factors mean the amplifier cannot operate with a high efficiency level. Sensitive to carrier offset and drift: Another disadvantage of OFDM is that is sensitive to carrier frequency offset and drift. Single carrier systems are less sensitive. These follow the basic format for OFDM, but have additional attributes or variations: Coded Orthogonal frequency division multiplexing. A form of OFDM where error correction coding is incorporated into the signal. It uses multiple tones and fast hopping to spread signals over a given spectrum band. Orthogonal frequency division multiple access. A scheme used to provide a multiple access capability for applications such as cellular telecommunications when using OFDM technologies. MIMO stands for Multiple Input Multiple output and it uses multiple antennas to transmit and receive the signals so that multi-path effects can be utilised to enhance the signal reception and improve the transmission speeds that can be supported. The concept of this form of OFDM is that it uses a degree of spacing between the channels that is large enough that any frequency errors between transmitter and receiver do not affect the performance. It is particularly applicable to Wi-Fi systems. Each of these forms of OFDM utilise the same basic concept of using close spaced orthogonal carriers each carrying low data rate signals. During the demodulation phase the data is then combined to provide the complete signal. OFDM, orthogonal frequency division multiplexing has gained a significant presence in the wireless market place.

Chapter 4 : DCN Multiplexing

Code Division Multiplexing Multiple data signals can be transmitted over a single frequency by using Code Division Multiplexing. FDM divides the frequency in smaller channels but CDM allows its users to full bandwidth and transmit signals all the time using a unique code.

Next Page Multiplexing is a technique by which different analog and digital streams of transmission can be simultaneously processed over a shared link. Multiplexing divides the high capacity medium into low capacity logical medium which is then shared by different streams. Communication is possible over the air radio frequency , using a physical media cable , and light optical fiber. All mediums are capable of multiplexing. When multiple senders try to send over a single medium, a device called Multiplexer divides the physical channel and allocates one to each. On the other end of communication, a De-multiplexer receives data from a single medium, identifies each, and sends to different receivers. FDM is an analog technology. FDM divides the spectrum or carrier bandwidth in logical channels and allocates one user to each channel. Each user can use the channel frequency independently and has exclusive access of it. All channels are divided in such a way that they do not overlap with each other. Channels are separated by guard bands. Guard band is a frequency which is not used by either channel. Time Division Multiplexing TDM is applied primarily on digital signals but can be applied on analog signals as well. In TDM the shared channel is divided among its user by means of time slot. Each user can transmit data within the provided time slot only. Digital signals are divided in frames, equivalent to time slot i. TDM works in synchronized mode. Multiplexer and De-multiplexer are timely synchronized and both switch to next channel simultaneously. When channel A transmits its frame at one end,the De-multiplexer provides media to channel A on the other end. On the other end, the De-multiplexer works in a synchronized manner and provides media to channel B. Signals from different channels travel the path in interleaved manner. Wavelength Division Multiplexing Light has different wavelength colors. In fiber optic mode, multiple optical carrier signals are multiplexed into an optical fiber by using different wavelengths. This is an analog multiplexing technique and is done conceptually in the same manner as FDM but uses light as signals. Further, on each wavelength time division multiplexing can be incorporated to accommodate more data signals. Code Division Multiplexing Multiple data signals can be transmitted over a single frequency by using Code Division Multiplexing. FDM divides the frequency in smaller channels but CDM allows its users to full bandwidth and transmit signals all the time using a unique code. CDM uses orthogonal codes to spread signals. Each station is assigned with a unique code, called chip. Signals travel with these codes independently, inside the whole bandwidth. The receiver knows in advance the chip code signal it has to receive.

Chapter 5 : Time Division Multiplexing

Time Division Multiplexing (TDM) is the digital multiplexing theinnatdunvilla.com TDM, the channel/link is not divided on the basis of frequency but on the basis of theinnatdunvilla.com of TDM 1.

History[edit] Time-division multiplexing was first developed for applications in telegraphy to route multiple transmissions simultaneously over a single transmission line. This allowed commanders in the field to keep in contact with the staff in England across the English Channel. The communication was by a microwave system throughout Long Island. A channel bank sliced a 1. Channel banks used the fixed position temporal alignment of one byte in the frame to identify the call it belonged to. The time domain is divided into several recurrent time slots of fixed length, one for each sub-channel. A sample byte or data block of sub-channel 1 is transmitted during time slot 1, sub-channel 2 during time slot 2, etc. One TDM frame consists of one time slot per sub-channel plus a synchronization channel and sometimes error correction channel before the synchronization. After the last sub-channel, error correction, and synchronization, the cycle starts all over again with a new frame, starting with the second sample, byte or data block from sub-channel 1, etc. The RIFF WAV audio standard interleaves left and right stereo signals on a per-sample basis TDM can be further extended into the time-division multiple access TDMA scheme, where several stations connected to the same physical medium, for example sharing the same frequency channel, can communicate. The GSM telephone system The Tactical Data Links Link 16 and Link 22 Multiplexed digital transmission[edit] In circuit-switched networks, such as the public switched telephone network PSTN , it is desirable to transmit multiple subscriber calls over the same transmission medium to effectively utilize the bandwidth of the medium. Both standards also contain extra bits or bit time slots for signaling and synchronization bits. Higher order multiplexing is accomplished by multiplexing the standard TDM frames. This solution worked for a while; however PDH suffered from several inherent drawbacks which ultimately resulted in the development of the Synchronous Digital Hierarchy SDH. The requirements which drove the development of SDH were these: Be service-oriented â€” SDH must route traffic from End Exchange to End Exchange without worrying about exchanges in between, where the bandwidth can be reserved at a fixed level for a fixed period of time. Allow frames of any size to be removed or inserted into an SDH frame of any size. Easily manageable with the capability of transferring management data across links. Provide high levels of recovery from faults. Provide high data rates by multiplexing any size frame, limited only by technology. Give reduced bit rate errors. It was developed to allow streams 1. The STM-1 frame consists of smaller streams that are multiplexed to create a SDH can also multiplex packet based frames e. It connects any channel on any of its inputs to any channel on any of its outputs. Below this level, standard TDM can be performed. Optic fibre uses light pulses to transmit data and is therefore extremely fast. Modern optic fibre transmission makes use of wavelength-division multiplexing WDM where signals transmitted across the fibre are transmitted at different wavelengths, creating additional channels for transmission. This increases the speed and capacity of the link, which in turn reduces both unit and total costs. Using STDM allows bandwidth to be split over one line. Many college and corporate campuses use this type of TDM to distribute bandwidth. A more common use however is to only grant the bandwidth when that much is needed. STDM does not reserve a time slot for each terminal, rather it assigns a slot when the terminal is requiring data to be sent or received. In its primary form, TDM is used for circuit mode communication with a fixed number of channels and constant bandwidth per channel. Bandwidth reservation distinguishes time-division multiplexing from statistical multiplexing such as statistical time-division multiplexing. In pure TDM, the time slots are recurrent in a fixed order and pre-allocated to the channels, rather than scheduled on a packet-by-packet basis. In dynamic TDMA , a scheduling algorithm dynamically reserves a variable number of time slots in each frame to variable bit-rate data streams, based on the traffic demand of each data stream.

Chapter 6 : RF Academy - National Instruments

Time division multiplexing (TDM) is a communications process that transmits two or more streaming digital signals over a common channel. In TDM, incoming signals are divided into equal fixed-length time slots.

Transient Protection Multiplexing LED displays Multiplexing LED displays can make them more efficient by using fewer components, simplifying the printed circuit board, and consuming less power. One segment from each of the digits is connected to a common line which is controlled by a single output pin from the microcontroller. This is done for each segment on a digit, so only seven output drive pins are needed for a multi-digit seven-segment display panel to control all the segments. Likewise, fourteen output pins are needed for a fourteen segment display panel, and so on. Of course, only one digit is activated at a time using this method, as each digit is enabled one at a time in sequence by a separate signal which connects to the common cathode or common anode pin on a digit. There would be a separate control line from the microcontroller output port for each digit on the display panel. The segment data lines are updated for each digit as it is selected by its separate digit select control line. This makes sure that each digit on the panel displays the intended information, which could be a number, letter, or some other symbol. The brightness of a panel is lower on a multiplexed panel because of this on-off duty cycle, but the light intensity can be increased to an acceptable level by a small increase in LED current. Using separate control signals for each digit in this fashion can be inefficient in a way because only one control line signal is activated at a time while the others are left in an idle state. Each of the segment data lines are being continually used, while the digit select control lines are each used only part of the time. A more efficient method of multiplexing would be to combine the segment data lines and the digit select control lines into the same set of lines such that each line can alternate between driving individual segments and selecting a digit. The example diagram below shows how the lines are connected in this way as a four digit seven-segment common-cathode display with a decimal point. Only nine pins from the microcontroller can control the entire display. A digit would need a total of eight drive pins to control the segments plus one extra one to provide the common anode or cathode connection. Click to enlarge Five of the segment data lines operate the same as before, while the lower four segment lines are combined with the digit select lines. As a digit is selected, the segment data lines supply the source current for the individual segments while the digit select line is activated which sinks the current. The same segment data is also applied to each of the other digits, but they are not activated because there would be no way to sink the current. For this to work, each four lower lines need to operate in a tri-state mode, where the third state is a high-impedance state that can neither source nor sink current. A non-selected segment on a selected digit would have to be in this third state because if it went low, it could inadvertently select another digit at the same time. The only time a control line goes low would be to select a digit. The only time a control line goes high would be to energize a segment on the selected digit. There is also one other problem in that a segment on one digit might be connected to a different segment on another.

Chapter 7 : What is Time Division Multiplexing (TDM)? - Definition from Techopedia

Time Division Multiplexing Time Division Multiplexing (TDM) basically a communication process which involved with transmitting digital signals over a common channel. Incoming signals received divided into an equal length of time slots.

Types[edit] Multiple variable bit rate digital bit streams may be transferred efficiently over a single fixed bandwidth channel by means of statistical multiplexing. This is an asynchronous mode time-domain multiplexing which is a form of time-division multiplexing. Digital bit streams can be transferred over an analog channel by means of code-division multiplexing techniques such as frequency-hopping spread spectrum FHSS and direct-sequence spread spectrum DSSS. Space-division multiplexing[edit] In wired communication, space-division multiplexing , also known as Space-division multiple access is the use of separate point-to-point electrical conductors for each transmitted channel. Examples include an analogue stereo audio cable, with one pair of wires for the left channel and another for the right channel, and a multi-pair telephone cable , a switched star network such as a telephone access network, a switched Ethernet network, and a mesh network. In wireless communication, space-division multiplexing is achieved with multiple antenna elements forming a phased array antenna. Different antennas would give different multi-path propagation echo signatures, making it possible for digital signal processing techniques to separate different signals from each other. These techniques may also be utilized for space diversity improved robustness to fading or beamforming improved selectivity rather than multiplexing. Frequency-division multiplexing[edit] Frequency-division multiplexing FDM: The spectrum of each input signal is shifted to a distinct frequency range. Frequency-division multiplexing FDM is inherently an analog technology. FDM achieves the combining of several signals into one medium by sending signals in several distinct frequency ranges over a single medium. In FDM the signals are electrical signals. One of the most common applications for FDM is traditional radio and television broadcasting from terrestrial, mobile or satellite stations, or cable television. Receivers must tune to the appropriate frequency channel to access the desired signal. 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. Consider an application requiring four terminals at an airport to reach a central computer. Each terminal communicated at baud , so rather than acquire four individual circuits to carry such a low-speed transmission, the airline has installed a pair of multiplexers. A pair of baud modems and one dedicated analog communications circuit from the airport ticket desk back to the airline data center are also installed. Orbital angular momentum multiplexing[edit] Orbital angular momentum multiplexing is a relatively new and experimental technique for multiplexing multiple channels of signals carried using electromagnetic radiation over a single path. As of [update] it is still in its early research phase, with small-scale laboratory demonstrations of bandwidths of up to 2. One form is frequency hopping, another is direct sequence spread spectrum. In the latter case, each channel transmits its bits as a coded channel-specific sequence of pulses called chips. Number of chips per bit, or chips per symbol, is the spreading factor. This coded transmission typically is accomplished by transmitting a unique time-dependent series of short pulses, which are placed within chip times within the larger bit time. All channels, each with a different code, can be transmitted on the same fiber or radio channel or other medium, and asynchronously demultiplexed. Advantages over conventional techniques are that variable bandwidth is possible just as in statistical multiplexing , that the wide bandwidth allows poor signal-to-noise ratio according to Shannon-Hartley theorem , and that multi-path propagation in wireless communication can be combated by rake receivers. Telecommunication multiplexing Multiple access method[edit] A multiplexing technique may be further extended into a multiple access method or channel access method , for example, TDM into time-division multiple access TDMA and statistical multiplexing into carrier-sense multiple access CSMA. A multiple access method makes it possible for several transmitters connected to the same physical medium to share its capacity. Multiplexing is provided by the Physical Layer of the OSI model , while multiple access also involves a media access control protocol, which is part of the Data Link Layer. Code-division multiplexing CDM is a technique in which each channel transmits its bits as a coded channel-specific sequence of pulses. All channels, each with a different code, can be transmitted on the same fiber and asynchronously demultiplexed. Early experiments allowed two separate messages to travel in opposite directions simultaneously, first using an electric battery at both ends, then at only one end. In , the quadruplex telegraph developed by Thomas Edison transmitted two messages in each direction simultaneously, for a total of four messages transiting the same wire at the same time. This is likewise also true for digital subscriber lines DSL. Fiber in the loop FITL is a common method of multiplexing, which uses optical fiber as the backbone. Asynchronous Transfer Mode is often the communications protocol used. IPTV also depends on multiplexing. Demultiplexer media file In video editing and processing systems, multiplexing refers to the process of interleaving audio and video into one coherent data stream. In digital video , such a transport stream is normally a feature of a container format which may include metadata and other information, such as subtitles. The audio and video streams may have variable bit rate. A demuxer is software that extracts or otherwise makes available for separate processing the components of such a stream or container. Digital broadcasting[edit] In digital television systems, several variable bit-rate data streams are multiplexed together to a fixed bitrate transport stream by means of statistical multiplexing. This makes it possible to transfer several video and audio channels simultaneously over the same frequency channel, together with various services. The device that accomplishes this is called a statistical multiplexer. In several of these systems, the multiplexing results in an MPEG transport stream. A multiplex is a stream of digital information that includes audio and other data. Where multiplexing is not practical such as where there are different sources using a single transponder , single channel per carrier mode is used. In fact, the stereo multiplex signal can be generated using time-division multiplexing, by switching between the two left channel and right channel input signals at an ultrasonic rate the subcarrier , and then filtering out the higher harmonics. Multiplexing in this sense is sometimes known as MPX, which in turn is also an old term for stereophonic FM, seen on stereo systems since the s. Other meanings[edit] In spectroscopy the term is used to indicate that the experiment is performed with a mixture of frequencies at once and their respective response unravelled afterwards using the Fourier transform principle. In computer programming , it may refer to using a single in-memory resource such as a file handle to handle multiple external resources such as on-disk files. Multiplexing may refer to the design of a multiplexed display non-multiplexed displays are immune to break up. Multiplexing may refer to the design of a "switch matrix" non-multiplexed buttons are immune to "phantom keys" and also immune to "phantom key blocking". In high-throughput DNA sequencing , the term is used to indicate that some artificial sequences often called barcodes or indexes have been added to link given sequence reads to a given sample, and thus allow for the sequencing of multiple samples in the same reaction.

Chapter 8 : Embedded Adventures - Tutorials - Multiplexing LED displays

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.

These signals may be interleaved at the bit, byte, or some other level. The resulting pattern may be transmitted directly, as in digital carrier systems, or passed through a modem to allow the data to pass over an analog network. Digital data is generally organized into frames for transmission and individual users assigned a time slot, during which frames may be sent. If a user requires a higher data rate than that provided by a single channel, multiple time slots can be assigned. Digital transmission schemes in North America and Europe have developed along two slightly different paths, leading to considerable incompatibility between the networks found on the two continents. BRA basic rate access is a single digitized voice channel, the basic unit of digital multiplexing. North American TDM[edit] The various transmission rates are not integral numbers of the basic rate. This is because additional framing and synchronization bits are required at every multiplexing level. In North America, the basic digital channel format is known as DS These are grouped into frames of 24 channels each. A concatenation of 24 channels and a start bit is called a frame. Groups of 12 frames are called multiframes or superframes. These vary the start bit to aid in synchronizing the link and add signaling bits to pass control messages. There are 8 thousand S bits per second. They have an encoded pattern, to aid in locating channel position within the frame. This forms a regular pattern of 1 0 1 0 1 0 for the odd frames and 0 0 1 1 1 0 for the even frames. Additional synchronization information is encoded in the DS-1 frame when it is used for digital data applications, so lock is more readily acquired and maintained. For data customers, channel 24 is reserved as a special sync byte, and bit 8 of the other channels is used to indicate if the remaining 7 bits are user data or system control information. Under such conditions, the customer has an effective channel capacity of 56 Kbps. Each DS-0 can be utilized as: In the DS-2 format, 4 DS-1 links are interleaved, 12 bits at a time. An additional Kbps is added for framing and control functions resulting in a total bit rate of 6. Signaling[edit] Signaling provides control and routing information. Two bits, called the A and B bits, are taken from each channel in frames 6 and 12 in the multiframe. The A bit is the least significant bit in each channel in frame 6, and the B bit is the least significant bit in each channel in frame For data, it may be a different story. If the data is encoded in an analog format such as FSK or PSK, then robbing bits is of no consequence, but if the data is already in digital form, then robbing bits results in unacceptable error rates. This means that data customers are limited to 56 Kbps clear channels. This simple condition has a profound effect on the development of new services such as ISDN. ESF consists of 24 DS-0 channels in a frame, but groups them into a frame multiframe instead of the usual frame multiframe. This is possible because of improvements in frame search techniques and allows more signaling states to be defined. Instead, channel 24 is used to support a D channel. In many cases, heavy users of voice or data services can reduce their transmission costs by concentrating their numerous low speed lines on to a high speed facility. There are many types of T1 multiplexers available today. Some are relatively simple devices, while others allow for channel concatenation, thus supporting a wide range of data rates. The ability to support multiple DS-0s allows for easy facilitation of such protocols as the video teleconferencing standard, Px Multiplexers[edit] Multiplexing units are often designated by the generic term Mab where a is input DS level and b is the output DS level. Four DS-1 frames are loaded into a register, and renumbered 1â€" If there are any empty slots [all zeros], the first framing bit is inverted and all blank slots are relocated to the front of the frame. Channel 1 is then loaded with a 7-bit number corresponding to the original position of the first empty slot. Bit 8 used to indicate whether the following channel contains user information or another address for an empty slot. If there is a second vacancy, bit 8 in the previous channel is set, and the empty slot address is placed in channel 2. This process continues until all empty positions are filled. The decoding process at the receiver is done in reverse. Borrowing 1 in 4 framing bits for this system is not enough to cause loss of synchronization and provides a 64 Kbps clear channel to the end-user. The 64 Kbps channel is still the basic unit, but signaling is not included in each channel. Instead, common channel signaling is used. In a level 1 carrier, channels 0 and 16 are reserved for signaling and control. This subtle difference means that European systems did not experience the toll fraud and 56 k bottlenecks common to North American systems, and they experience a much larger penetration of ISDN services. Zero Substitutions[edit] In order to prevent transmission systems from loosing lock on the data stream, it is necessary to avoid long strings of zeros. One of the most effective ways of doing this is to replace the zeros with a predetermined code. This substitution must be done in such a way that the receiver can identify it and strip it off before passing the data stream to the client. AMI provides a simple means of detecting substitutions. In the normal course of events, alternate marks are inverted. Therefor, deliberately inducing a bipolarvariation at the transmitter can alert the receiver of a substitution. However, a single violation is indistinguishable from a transmission error. Consequently, some additional condition must also occur. There are two common methods to create a second condition: This has the effect of keeping the average signal level at zero. Synchronization can be maintained by replacing strings of zeros with bipolar violations. Since alternate marks have alternate polarity, two consecutive pulses of the same polarity constitute a violation. Therefore, violations can be substituted for strings of zeros, and the receiver can determine where substitutions were made. These substitutions force two consecutive violations. A single bit error does not create this condition.

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Chapter 9 : Communication Systems/Time-Division Multiplexing - Wikibooks, open books for an open world

As a result, the industry has adopted a Time Division Multiplexed (TDM) interface that allows multiple channels of data to be transmitted on a single data line. The TDM interface is by far the most.

In synchronous TDM, each device is given same time slot to transmit the data over the link, irrespective of the fact that the device has any data to transmit or not. Hence the name Synchronous TDM. Synchronous TDM requires that the total speed of various input lines should not exceed the capacity of path. Each device places its data onto the link when its time slot arrives i. If any device does not have data to send then its time slot remains empty. The various time slots are organized into frames and each frame consists of one or more time slots dedicated to each sending device. If there are n sending devices, there will be n slots in frame i. As show in fig, there are 3 input devices , so there are 3 slots in each frame. In STDM every device is given the opportunity to transmit a specific amount of data onto the link. Each device gets its turn in fixed order and for fixed amount of time. This process is known as interleaving. We can say that the operation of STDM is similar to that of a fast interleaved switch. The switch opens in front of a device; the device gets a chance to place the data onto the link. Such an interleaving may be done on the basis of a hit, a byte or by any other data unit. In STDM, the interleaved units are of same size i. As shown in the fig. Each frame consists of four slots as there are four input devices. The slots of some devices go empty if they do not have any data to send. At the receiver, demultiplexer decomposes each frame by extracting each character in turn. As a character is removed from frame, it is passed to the appropriate receiving device. Disadvantages of Synchronous TDM 1. The channel capacity cannot be fully utilized. Some of the slots go empty in certain frames. As shown in fig only first two frames are completely filled. The last three frames have 6 empty slot. It means out of 20 slots in all, 6 slots are empty. The capacity of single communication line that is used to carry the various transmission should be greater than the total speed of input lines. It is also known as statistical time division multiplexing. Asynchronous TDM is called so because is this type of multiplexing, time slots are not fixed i. Here, the total speed of input lines can be greater than the capacity of the path. In synchronous TDM, if we have n input lines then there are n slots in one frame. But in asynchronous it is not so. In asynchronous TDM, the number of time slots in a frame is based on a statistical analysis of number of input lines. In this system slots are not predefined, the slots are allocated to any of the device that has data to send. The multiplexer scans the various input lines, accepts the data from the lines that have data to send, fills the frame and then sends the frame across the link. If there are not enough data to fill all the slots in a frame, then the frames are transmitted partially filled. Asynchronous Time Division Multiplexing is depicted in fig. Here we have five input lines and three slots per frame. In Case 1, only three out of five input lines place data onto the link i. In Case 2, four out of five input lines are active. Here number of input line is one more than the number of slots per frame. In Case 3, all five input lines are active. In all these cases, multiplexer scans the various lines in order and fills the frames and transmits them across the channel. The distribution of various slots in the frames is not symmetrical. In case 2, device 1 occupies first slot in first frame, second slot in second frame and third slot in third frame.