SECRETS OF CONNECTIVITY

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During the decade of 1980 people were highly satisfied with their PCs at homes and offices. They worked individually with their own data and knowledge. But as the power of the PCs were being increased with the complexity of human life, people had to communicate with others for information that they couldn't have to solve the day to day problems. Now one way to solve this communication problem is to establish computer networks, where different computers are connected by communication channels. LAN, MAN and WAN are the networks that were designed to facilitate for this purpose. One of the most promising way to connect computer is to use existing telephone network. Using this established wide network we can easily communicate with others at the different corner of the world. But to use this voice network for data transmission there need some intermediate processing to convert digital data to compatible with voice signal and vice versa.

As we know, a microcomputer data is transferred in parallel, because that is the fastest way to do it. For transferring data over long distances, however, parallel data transmission requires too many wires. Therefore, data to be sent long distances is usually converted from parallel form to serial form so that it can be sent on a single pair of wire. Serial data received from a distant source is converted to parallel form so that it can easily be transferred on the computer buses. Three terms often encountered in literature on serial data systems are SIMPLEX, HALF-DUPLEX and FULL-DUPLEX. A simplex data line can transmit data only in one direction. Half-duplex transmission means that communication can take place in either direction between two system, but can only occur in one direction at a time. The term full-duplex means that each system can send and receive data at the same time.

Serial data can be sent synchronously or asynchronously. For synchronous transmission, data is sent in blocks at constant rate. The start and end of a block are identified with specific bytes. For asynchronous transmission each data character has a bit which identifies its start and one or two bits which identify its end. Since each character is individually identified, character can be sent at any time asynchronously.

Depending on the system, the data word may consist of 5, 6, 7 or 8 bits. A low pulse at the beginning of the data word is used to identify the start of the data word and at least a high pulse for one bit time to identify the end of character. This high bit is referred to as a stop bit. The efficiency of this format is low, because 10 or 11 bit times are required to transmit a 7 or 8 bit data word.

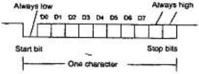

Figure shows the data format for asynchronous data transmission

The term baud rate is used to indicate the rate at which serial data is being transferred. Baud rate is defined as 1/(the time for one bit cell). If a bit time is 3.33ms, for example, the baud rate is 1/(3.33 ms), or 300 Bd. There is a tendency to indicate it as a 300 bits/sec. But in some cases, 2 to 4 actual data bits are encoded within one transmitted bit time, so data bits per second and baud do not correspond. Commonly used baud rates are 300, 1200, 2400, 4800, 9600 Bd.

In every modern PC there contains at least one serial port for data communication. This communication port is commonly known as COM port. Behind every COM port there is at least one device such as the Intel 8251A, which can be programmed to do either asynchronous or synchronous communication, is often called a Universal Synchronous Asynchronous Receiver Transmitter or USART. You may find this device on I/O card attached to your motherboard. The purpose of this device is to convert parallel data into high-speed serial data and vice versa. Once the data is converted into serial form it must in some way be sent from the transmitting USART to receiving USART. There are several ways of transmitting this serial data. One method is to use a current to represent 1 and no current to represent 0. Some manufacturers use a nominal current of 20 mA-60mA to represent a 1 and no current to represent 0.

The serial data generated by USART can't transmitted no more than a few feet. The serial rectangular pulse stream generated by USART contain very high frequency component. This high frequency signal that represents the rectangular pulse stream can't be transmitted within the band limited telephone network. The standard telephone line have a bandwidth of only about 300 to 3000 Hz. The solution to this problem is to convert USART generated digital signals to audio frequency tones, which are in the frequency range that the phone line can transmit. The device used to do this conversion and to convert transmitted tones back to digital information is called a modem. The term is contraction of modulator-demodulator. During modulation process digital data is converted into audio-frequency tones and during demodulation process audio-frequency tones are converted into digital signals. Three major forms of modulation used are amplitude, frequency-shift keying (FSK) and phase-shift keying (PSK).

To produce amplitude modulation, a single frequency tone of perhaps 387Hz is turned on to represent a 1 and turned off to represent 0. Amplitude modulation is only used for very low speed channel transmission because of its poor noise rejection characteristics.

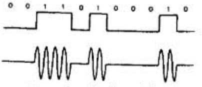

Figure of amplitude modulation

Frequency-shift keying uses one tone to represent 0 and another tone to represent 1. Some commonly used modems use 1200Hz to represent 0 and 1700Hz to represent 1.

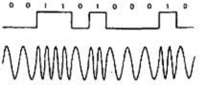

Fig . of frequency-shift keying modulation

In the simplest form of the phase-shift keying modulation, the phase of a constant frequency sign wave carrier of perhaps 1700Hz is shifted by 180 degree to represent a change in the data from a one to zero or from zero to one. However, by using additional phase angles besides 180, 2 or three bits can be sent in baud time. Two bits send in one baud time is called dibits, and 3 bits send in one baud time is called tribits. For dibit encoding each pair of bits in the data stream is treated together. The value of these two bits determines the amount that the phase of the carrier will be shifted. Dibit and tribit phase shift modulation permits higher data rates on phone lines.

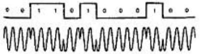

Figure of the phase shift keying modulation

Now, it is time to understand how all these devices like USART, modem and telephone exchange work together to establish a connection between two remote computer.

The following figure shows how two remote computers are connected with the telephone exchange. Here the computer which makes a call is called the calling computer and the computer which receives the call is referred to a called computer.

modem unit. The main function of DAA (data access arrangement) circuit is to receive ringing signal and knock to the called modem to indicate that a call has just arrived. In fact, the components beginning from logic translator to DAA unit are integrated as a single unit and sold in the market as a complete modem.

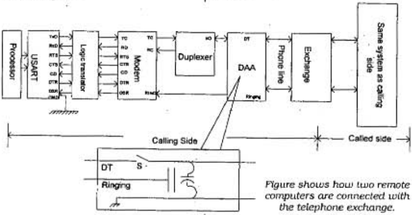

Figure shows how two remote computers are connected with the telephone exchange.

Both calling and called computers have microprocessor, USART, logic translator, modem, duplexer and DAA (data access arrangement) circuits. The function of the microprocessor is obvious and directly connected with USART. At the calling computer, the USART converts parallel data into serial form sent by the microprocessor for transmission and at the receiving end, it converts serial data into parallel form to the processor. In computer communication literature, the USART is commonly referred as DTE (data terminal equipment)and the modem as DCE (data communication equipment). The modem unit use-12 V as logic 1 and +12V as logic 0 and, on the other hand, USART uses TTL compatible logic levels. The logic translator unit translates these different logic voltage levels. Duplexer unit transmits modulated signal generated by TC pin of the modem to the phone line through DAA unit and receives modulated signal from the phone line through DT pin of the DAA unit to the RC pin of the

To establish a connection between two computers, the power of the two computers must be ON. This asserts the DTR (data terminal ready) signal to tell the modem that they are ready. Having this signal the modem then asserts DSR (data set ready) signal to the terminal. Under manual control or terminal control, the calling modem then dials up to the called modem. Initially the switch S in both DAA unit remains open before connection setup. When the calling modem begins dial, it closes the S switch of the DAA unit at the calling side and passes the dialed signal to the exchange. After having the complete dialed signal, the exchange will generate the ringing signal to the DAA unit of the called modem. This signal on the line will cause the DAA circuitry to assert the ringing input of the modem. The modem then closes the S switch of DAA unit either under hardware or software control at the receiving side. In response to the ringing signal the called modem will send an answer tone of 2025Hz to the calling modem for 2 seconds. If the DTR and DSR of the calling modem are then still asserted, indicating that data is ready to be sent, calling modem then puts a tone of 2225Hz on the line for 8ms to let the called modem know that contact is complete. In response to this signal the called modem asserts its CD (carrier detect) output to enable the receiving USART. The calling modem then sends data until its RTS (request to send) input signal is released by the terminal sending data. Data are transmitted from TxD (transmit data) of the calling USART and received by RxD (receive data) of the called USART. Releasing RTS of the calling USART, causes the modem to release CTS (clear to send) to the calling USART and remove the carrier from the line. The called modem senses the loss of carrier and unasserts the CD (carrier detect) signal to called USART.

The following table gives the brief description of the pin diagram of USART

Pin Number	Common Name	Description	Signal Direction on DCE
2	TxD	Transmitted data	IN
3	RxD	Received data	OUT
4	RTS	Request to send	IN
5	CTS	Clear to send	OUT
6	DSR	Data set ready	OUT
7	GND	Ground	-
8	CD	Carrier detect	OUT
20	DTR	Data terminal ready	OUT

The above discussion shows the SIMPLEX transmission protocol. The HALF-DUPLEX and FULL-DUPLEX communication is almost as the same as SIMPLEX transmission protocol except some little variation. I think, the above discussion is a very simple form, will make the readers understand any commnication protocols in future. ▲