Digital Switching in Telecom- Munication

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Abstract- Telecommunication networks carry infor- mation signals among entities, which are geographically far apart. An entity may be a computer or human being, a facsimile machine, a Tele-printer, a data terminal and so on. The entities are involved in the process of infor- mation Transfer which may be in the form of a telephone conversation (telephony) or a file transfer between two computers or message transfer between two terminals etc. Today it is almost truism to state that telecommuni- cation systems are the symbol of our information age. With the rapidly growing traffic and untargeted growth of cyberspace, telecommunication becomes a fabric of our life. The future challenges are enormous as we antic- ipate rapid growth items of new services and number of users. What comes with the challenge is a genuine need for more advanced methodology supporting analysis and design of telecommunication architectures. Telecommu- nication has evaluated and growth at an explosive rate in recent years and will undoubtedly continue to do so.

The communication switching system enables the universal connectivity. The universal Connectivity is realized when any entity in one part of the world can communicate with any other entity in another part of the world. In many ways telecommunication will acts as a substitute for the increasingly expensive physical trans- portation.

The telecommunication links and switching were mainly designed for voice communication. With the appropriate attachments/equipment's, they can be used to transmit data. A modern society, therefore needs new facilities including very high bandwidth switched data networks, and large communication satellites with small, cheap earth antennas.

1. INTRODUCTION

Switch is generally used to connect two terminals. In telecommunication we use switching for establishing connection between two customers. In the early days we use manual switching and then electro-mechanical there are so many limitations in this manual switching so to overcome these limita- tions we migrated to digital switching. The first automatic exchange was started at La Porte (Indi- ana) in 1892. Although it is an improved version of switching than manual switching there are many disadvantages in this technology like a large num- ber of mechanical parts are required, inflexibility, limited availability of equipment these made equipment bulk in size. To overcome these many researches and developments were held. And the developed version of exchange was introduced in 1926 at Sundsvall, Sweden with crossbar exchange and having indirect control system. And also so many developments and researches were done in improving reliability, computer interface, high flex- ibility, noise free communication and easily man- ageable with no preventive maintenance etc.

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In digital switching we generally use two techniques for switching they are:

1. Space division switching.
2. Time division switching.

The first space division switching was commissioned in 1965 at Succasunna, New Jersey. This exchange used one physical path for one call so full availability could still not be achieved. Fur- ther researches have resulted in introducing of time division switching which enable sharing single path for several calls so full availability was achieved. The first digital switching was commissioned in 1970 at Brittany, France. Actually space division switching was analog and time division switching was digital in the beginning.

II. NEED FOR DIGITAL SWITCHING:

In starting we use manual switching in this number of customers existing were less in number, a copper wire is laid between customer and ex- change terminal when a customer want to make a call the process to make a call is as follows:

First customer will hook off (lifts hand set). Then a signal will be sent to exchange that the customer was trying to make a call by using indication light. The person at exchange asks for the number he wants to establish a connection. And after receiving the number person at exchange will connect termi- nal of calling subscriber (subscriber who made the call) with called subscriber (the person who is go- ing to get the call) by using a wire.

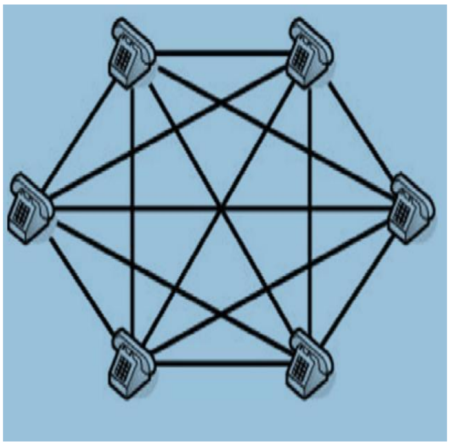
After when customer goes to hook on then connec- tion between was removed and metering will be done as per time customer communicated. Disadvantages of manual (analog) switching:

Man power is required at exchange end to perform switching.

Time delay was high as the process involves more man power for switching.

Number of connections between customer to cus- tomer are more this increases loss and introduces more noise.

In this manual process there are so many disad- vantages and losses will be high to avoid these dis- advantages electro mechanical switching(use of relays for switching) and even then there are many disadvantages in this technique like more space is required and more complexity of circuit to over- come these digital switching technique was intro- duced. Switching is of two types they were space division switching and time division switching. Space division switching is called as highway changer as it changes the highway (line of commu- nication i.e. PCM) from source to destination and whereas time switching was done by changing time factor by using same highway. If switching was not introduced the connections will be as follows:



And after switching was done the circuit will be as follows:

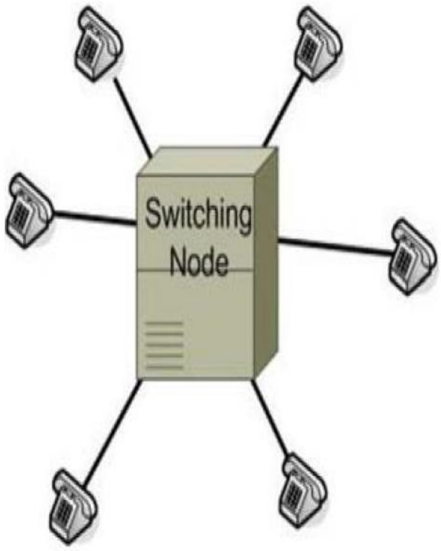


Table - Advantages of Electronic Exchange over Electromechanical Exchanges

Electromechanical Ex- changes -	Electronic Exchanges
Category, Analysis, Routing, translation, etc;, done by relays.	Translation, speech path Sub's Facilities, etc., managed by MAP and other DATA.
Any changes in facilities require addition of hard- ware and/or large amount of wiring change. Flexibility lim- ited.	Changes can be carried out by simple commands. A few changes can be made by Subs himself. Hence, highly flexible.
Testing is done manually externally and is time consuming. No logic analysis carried out.	Testing carried out peri- odically automatically and analysis printed out.
Partial full-availability, hence blocking. Limited facilities to the subscrib- ers.	Full availability, hence no blocking. A large number of different types of services possible very easily.
Slow in speed. Dialing speed is max. 11 Ips and switching speed is in 1 milliseconds.	Very fast. Dialing speed up to 11 digits /sec pos- sible. Switching is achieved in a few micro- seconds.
Switch room occupies large volume.	Much lesser volume re- quired floor space of switch room reduced to about one-sixth.
Lot of switching noise.	Almost noiseless.
Long installation and testing time.	Short installation and testing period.
Large maintenance effort and preventive mainte- nance necessary.	Remedial maintenance is very easy due to plug-in type circuit boards. Pre- ventive maintenance not required.

III. DIGITAL SWITCHING

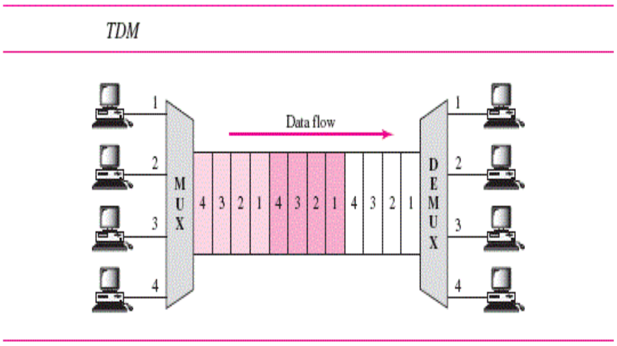
In digital switching there are mainly two techniques they are as follows:

1. Space division switching.
2. Time division switching.

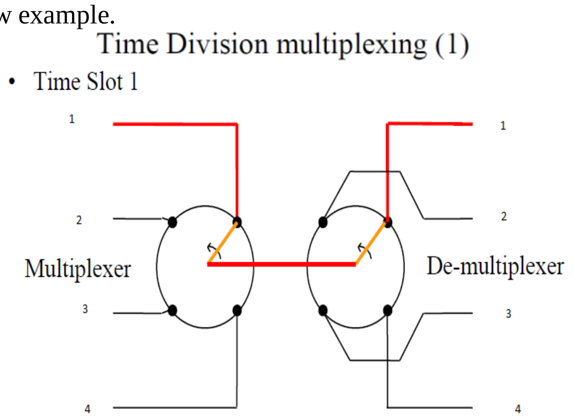
Before going into switching we need to know about multiplexing that helps to understand switching easily. Multiplexing is the process of combining different lines of communication into a single line of communication. Multiplexing was done to avoid more number of communication medium lines. There are different types of multiplexing tech- niques but manly three types they are as follows: Time division multiplexing.

1. Frequency division multiplexing.
2. Space division multiplexing. Time division multiplexing:

In Time division multiplexing number of information sources were combined and sent through a single line by allotting separate time for each information source. The process of time divi- sion multiplexing was as shown below:



Let us consider there are four sources as 1,2,3&4 those should be transferred to the corresponding destinations. The time division multiplexing pro- cess was explained in the below example.



In this complete line of communication was established to one source number1 for a certain time limit. And at the same time at the receiver end the corresponding destination was allotted for that communication line for that allotment of same corresponding end terminal a synchronous line was established between multiplexer and de- multiplexer. Frequency Division Multiplexing: In frequency division multiplexing numbers of sources were connected to a single line of communication by sharing the frequency in the medium. That is as shown below : The whole frequency band was shared by all the sources in this process there is a problem of frequency spectrum. There is a continuous medium between source and destination. Space division multiplexing:

Space-Division Multiple Access (SDMA) is a channel access method based on creating parallel spatial pipes next to higher capacity pipes through spatial multiplexing and/or diversity, by which it is able to offer superior performance in radio multiple access communication systems. In traditional mobile cellular network systems, the base station has no information on the position of the mobile units within the cell and radiates the signal in all directions within the cell in order to provide radio coverage. These results in wasting power on transmissions when there are no mobile units to reach, in addition to caus- ing interference for adjacent cells using the same frequency, so called co-channel cells. Likewise, in reception, the antenna receives signals coming from all directions including noise and interference signals.

IV. DIGITAL SPACE SWITCHING

The Digital Space Switch consists of sev- eral input highways, X1, X2,...Xn and several out- put highways, Y1,Y2,.........Ym, inter connected by a cross point matrix of n rows and m columns. The individual cross point consists of electronic AND gates. The operation of an appropriate cross point connects any channel, a , of I/C PCM high- way to the same channel, a, of O/G PCM highway, during each appropriate time-slot which occurs once per frame as shown in Figure. During other time-slots, the same cross point may be used to connect other channels. This cross point matrix works as a normal space divided matrix with full availability between incoming and outgoing high- ways during each time-slot.

Each cross point column, associated with one O/G highway, is assigned a column of control memory. The control memory has as many words as there are time-slot per frame in the PCM signal. In practice, this number could range from 32 to 1024. Each cross point in the column is assigned a binary address, so that only one cross point per column is closed during each time-slot. The binary addresses are stored in the control memory, in the order of time-slots. The word size of the control memory is x bits, so that 2x = n, where n is the number of cross points in each column.

A new word is read from the control memory dur- ing each time-slot, in a cyclic order. Each word is read during its corresponding time-slot, i.e., Word 0 (corresponding to TSO), followed by word 1 (corresponding to TS1) and so on. The word con-tents are contained on the vertical address lines for the duration of the time-slot. Thus, the cross point corresponding to the address, is operated during a particular time-slot. This cross point operates every time the particular time-slot appears at the inlet in successive frames. Normally, a call may last for around a million frames.

As the next time-slot follows, the control memory is also advanced by one step, so that during each new time-slot new corresponding words are read from the various control memory columns. This results in operation of a completely different set of cross points being activated in different columns. Depending upon the number of timeslots in one frame, this time division action increases the utilization of cross point 32 to 1024 times compared with that of conventional space-divided switch matrix.

Consider the transfer of a sample arriving in TS7 of I/C HWY X1 to O/G HWY Y3. Since this is a space switch, there will be no reordering of time i.e., the sample will be transferred without any time delay, via the appropriate crosspoint. In other words, the objective is to connect TS7 of HWY X1 and TS7 of HWY Y3.

The central control (CC) selects the control memory column corresponding output highway Y3. In this column, the memory location corresponding to the TS7 is chosen. The address of the crosspoint is written in this location, i.e., 1, in binary, is written in location 7, as shown in figure. This cross point remains operated for the duration of the time-slot TS7, in each successive frame till the call lasts.

In a practical switch, the digital bits are transmitted in parallel rather than serially, through the switching matrix.

In a serial 32 time-slot PCM multiplex, 2048 Kb/s are carried on a single wire sequentially, i.e., all the bits of the various time-slots follow one another. This single wire stream of bits, when fed to Serial to Parallel Converter is converted into 8-wire parallel output. For example, all 8 bits corresponding to TS3 serial input are available simultaneously on eight output wires (one bit on each output wire), during just one bit period, as shown in figure. This parallel output on the eight wires is fed to the switching matrix. It can be seen that during one full time-slot period, only one bit was carried on the each output line, whereas 8 bits are carried on the input line during the same period. Therefore, bit rate on individual output wires, is reduced to 1/8th of input bit rate=2048/8=256Kb/s.

Due to reduced bit rate in parallel mode, the crosspoint is required to be operated only for 1/8th of the time required for serial working. It can, thus, be shared by eight times more channels, i.e.,32 x 8 = 256 channels, in the same frame.

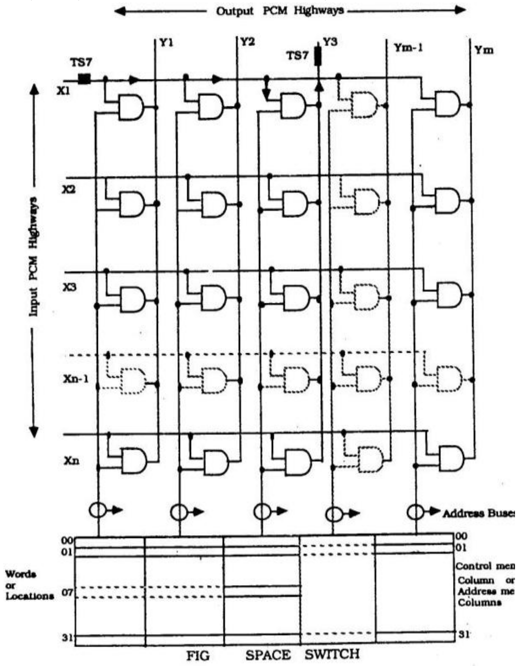
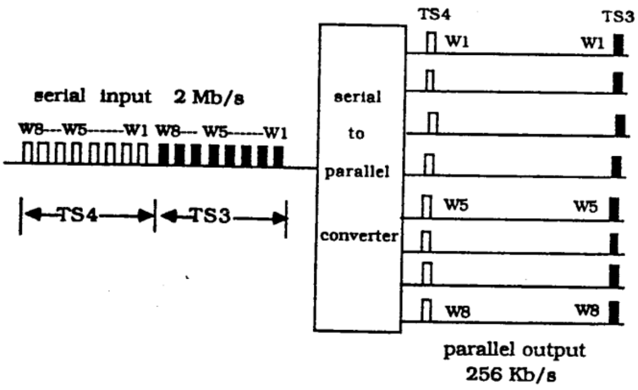


FIG SPACE SWITCH

However, since the eight bits of one TS are carried on eight wires, each cross point have eight switches to interconnect eight input wires to eight output wires. Each crosspoint (all the eight switches) will remain operated now for the duration of one bit only, i.e., only for 488 ns (1/8th of the TS period of 3.9 μs) Serial parallel converter.



For example, to connect 40 PCM I/C highways, a matrix of 40x 40 = 1600 cross points each having a single switch, is required in serial mode working. Whereas in parallel mode working, a matrix of (40/8 x 40/8) = 25 cross point is sufficient. As eight switches are required at each cross point 25 x 8 = 200 switches only are required. Thus, there is a reduction of the matrix by 1/8th in parallel mode working, hence reduction in size and cost of the switching matrix.

V.DIGITAL TIME SWITCHING

A Digital Time Switch consists of two memories, viz., a speech or buffer memory to store the samples till destination time-slots arrive, and a control or connection or address memory to control the writing and reading of the samples in the buffer memory and directing them on to the appropriate time-slots.

Speech memory has as many storage loca- tions as the number of time-slots in input PCM, e.g., 32 locations for 32 channel PCM system.

The writing/reading operation in the speech memory is controlled by the Control Memory. It has same number of memory locations as for speech memory, i.e., 32 locations for 32 channel PCM system. Each location contains the address of one of the speech memory locations where the channel sample is either written or read during a time-slot. These addresses are written in the control memory of the CC of the exchange, depending upon the connection objective.

A Time-Slot Counter which usually is a synchronous binary counter is used to count the time-slots from 0 to 31, as they occur. At the end of each frame, It gets reset and the counting starts again. It is used to control the timing for writ-ing/reading of the samples in the speech memory. Illustration:

Consider the objective that TS4 of incoming PCM is to be connected to TS6 of outgoing PCM. In other words, the sample arriving in TS4 on the I/C PCM has to be delayed by 6 -4= 2 time-slots, till the destination time-slot, viz., TS6 appears in the O/G PCM. The required delay is given to the samples by storing it in the speech memory. TheI/C PCM samples are written cyclically i.e. sequentially time-slot wise, in the speech memory locations. Thus, the sample in TS4 will be written in location 4, as shown in figure.

The reading of the sample is controlled by the Control Memory. The Control Memory location corresponding to output time-slot TS6 is 6. In this location, the CC writes the input time-slot number, viz., 4, in binary. These contents give the read address for the speech memory, i.e., it indicates the speech memory locations from which the sample is to be read out, during read cycle.

When the time-slot TS6 arrives, the control memory location 6 is read. Its content addresses the location 4 of the speech memory in the read mode and sample is read on to the O/G PCM.

In every frame, whenever time-slot 4 comes a new sample will be written in location 4. This will be read when TS6 occurs. This process is repeated till the call lasts.

For disconnection of the call, the CC erases the contents of the control memory location to halt further transfer of samples.

Time switch can operate in two modes, viz.

i. Output associated control

ii. Input associated control

Output associated control:

In this mode of working, samples of I/C PCM are written cyclically in the speech memory locations in the order of time-slots of I/C PCM, i.e., TS1 is written in location 1, TS2 is written in location 2, and so on, as discussed in the example of Sec.4.2.

The contents of speech memory are read on output PCM in the order specified by control memory. Each location of control memory is rigidly associated with the

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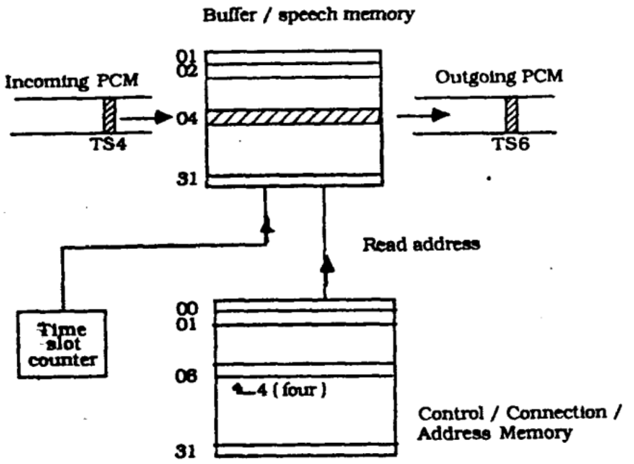
corresponding time-slot of the O/G PCM and contains the address of the TS of incoming PCM to be connected to. The control memory is always read cyclically, in synchronism with the occurrence of the time-slot. The entire process of writing and reading is repeated in every frame, till the call is disconnected.

It may be noticed that the writing in the speech memory is sequential and independent of the control memory, while reading is controlled by the control memory, i.e., there is a sequential writing but controlled reading.

Input associated control:

Here, the samples of I/C PCM are written in a con- trolled way, i.e., in the order specified by control memory, and read sequentially.

Each location of control memory is rigidly associated with the corresponding TS of I/C PCM and contains the address of TS of O/G PCM to be connected to.

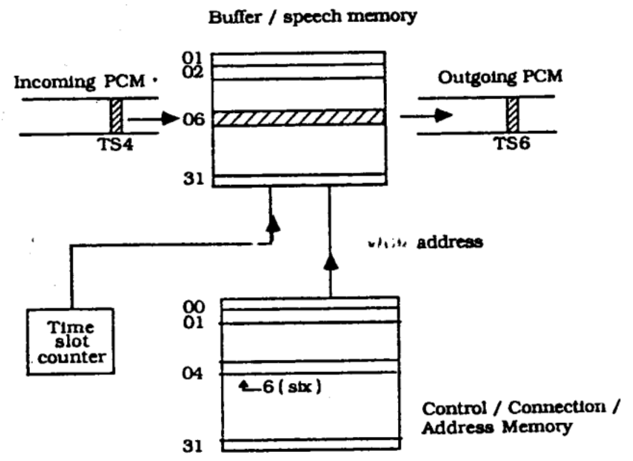


VI. OUTPUT ASSOCIATED CONTROL SWITCH

The previous example with the same connection objective of connecting TS4 of I/C PCM to TS6 of O/G PCM may be considered for its restoration. The location 4 of the control memory is associated with incoming PCM TS4. Hence, it should contain the address of the location where the contents of TS4 of I/C PCM are to be written in speech memory. CC writes the number of the destination TS, viz., 6 in this case, in location 4 of the control memory. The contents of TS4 are therefore, written in location of speech memory, as shown in figure. The contents of speech memory are read in the O/G PCM in a sequential way, i.e., location 1 is read during TS1, location 2 is read during TS2, and so on. In this case, the contents of location 6 will ap- pear in the output PCM at TS6. Thus the input PCM TS4 is switched to output PCM TS6. In this switch, there is sequential reading but controlled writing.

Time Delay Switching:

The writing and reading, of all time-slots in a frame, has to be completed within one frame time period (before the start of the next frame). TS of incoming PCM may, therefore, get delayed by a time period ranging from 1 TS to 31 TS periods, before being transmitted on outgoing PCM. For example, consider a case when TS6 of incoming PCM is to be switched to TS5 in outgoing PCM. In this case switching can be completed in two con- secutive frames only, i.e., 121 microseconds for a 32 channel PCM system. However, this delay is imperceptible to human beings.



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