Indian Institute of Technology Kanpur

National Programme on Technology Enhanced Learning (NPTEL)

Course Title
Digital Switching

Lecture – 11

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Okay in the previous lecture we had actually had looked at Karnaugh's approximation for a three-stage closed network basically estimating the blocking probability before now we go move forward I would like to introduce another small concept which we call as time switch okay so far when I was talking about a switch.

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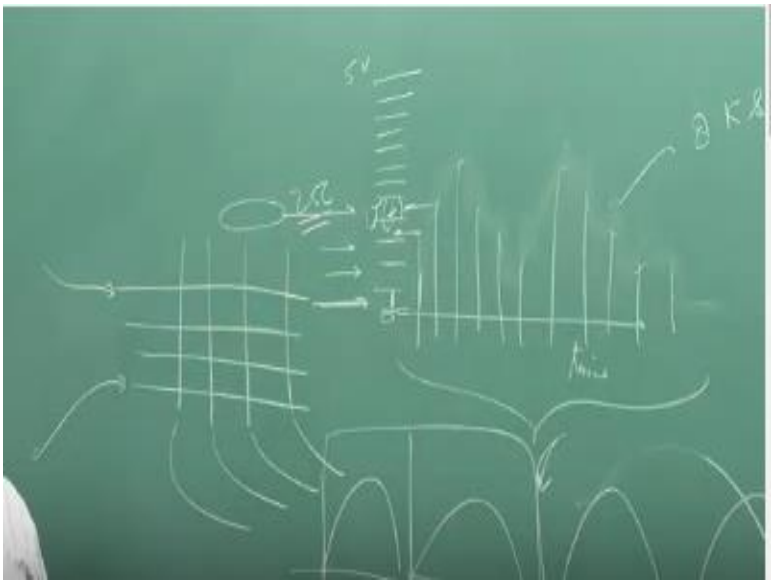

I was always drawing a figure something like this and I always said a telephone is connected here a telephone is connected here this is input port there is a telephone connected on this side or trunk lines and only one voice communication can happen here we call it a circuit actually okay

but as we all know this is fine if it is analog telephony because analog signals can pass through separate wires but this actually analog communication is not that much lucrative people have moved on to digital communication.

So reason being what basically is the difference is if I have put a time axis here and I would like to measure the voltage which is representing the signal analog will be something like this so in fact when I want to actually excite a speaker system signal the voice signal which is actually put amplified voice signal into the speaker is something which is varying in this section because of it is diaphragm moves back and forth and we listen to the audio.

But this can actually when we transmit this kind of thing over a communication channel this gets corrupted and you cannot remove the noise just keeps on adding keeps on accumulating so people moved on to something called a digital signals advantage of digital signal is that when I am transmitting I can actually multiplexer put many voice channels together on one single wire there is one advantage secondly I am not representing my voice in this analog waveform I represent it I in fact do two things here first of all in fact if I draw the spectrum this is a random process and if I draw the spectrum power spectral density mostly it will be something like this.

And for human voice communication till kHz I have drawn it in bidirectional this is zero so negative and positive both I have drawn so this is actually good enough so roughly it is 50 to 3.6 kHz that is a band and then there is a guard band so that if I want to do frequency division multiplexing transmit something else so this much guard band does exist so in fact most of the communication devices will capture your voice and will band limited to 3.6 KhZ we call it 4kHz actually that is a last one.

And of course now this we can transmit in digital format but how so first thing which we have to do is we have to do the sampling so if any signal which is in baseband is still 4kHz I need to sample at twice the higher rate so which actually means 8kHz so 4k sample /s so I will create a signal which will be something like this if this was the baseband signal this was the baseband signal this one this is the replicas which will get created when I will do sampling and I can always filter it out by using a low pass filter get back my original signal.

So this frequency twice the maximum 22 FM so this frequency of sampling should be equal to 2 should be greater than 2 FM this is what is known as Nyquist frequency okay so if I sample add more than this rate that is good enough I can always recover back my original analog signal so n in fact most of the voice in most in all telephones they are being sampled because of the season 8 k samples/s but once you do that the voice will look something like this thing is gone these are sample values which.

I have got the samples and the envelope of this will tell me what the signal is and I will be able to play it back this can be done using low pass filtering we do one more thing but remember this is turn log my variation is continuous and because of which if noise corrupts this level I will not be able to figure out how much was the noise and how much was the signal so we also do something called quantization this is a dis-criticizing in time I can do dis-criticizing amplitude also so normally for telephony systems.

What we do is we define the range so zero volt to say 5 volt is the range signal so we will divide this whole thing into 256 levels, so if you are in the first level or you can be in a second you can be third so I will just need to remember in which level you are, so any value which is within this range will be represented by this level. So since I have only 256 levels I require only eight bits to represent a level to identify a level, so for each one of them I will quantify identify the level.

And we will find out what is 8 - bit representation for that, so for each one of these samples now can be dis-criticized in amplitude and then represented by eight bits, so I will be now sending eight bits for every sample and a bit means actually one in zero kind of combination.

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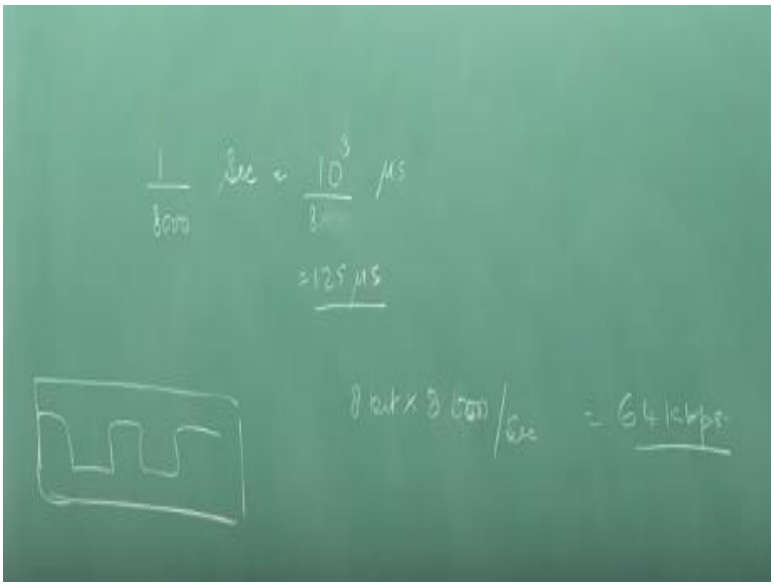

So 1010 sequence some number it is 8-bit number which I will be sending for each sample and now the number of samples it means what is a period between these two 8, 8 row samples per second represents if I want to find out 8000 samples per second, so I can actually do it 10^6 micro second by 8,000 so which will be 10^3 /8 which turns out to125 microseconds, so every 125 microsecond one octet.

We call it we do not call it bite in telecom word we call it octet, one octet will be transmitted and once you do that I end up in actually eight bits into eight kilo samples per second or 8000 samples per second so these many bits per second which is 64 kbps, so most of the voice telephony circuits are 64 kbps digital circuits, so once we know that now we are actually doing digital switching, okay.

So far it does not matter it could have worked even for n log as well as for distal booth so once this distal format has permitted me to use another kind of configuration which is equivalent to cross bar but is not a crossbar we call it a time switch.

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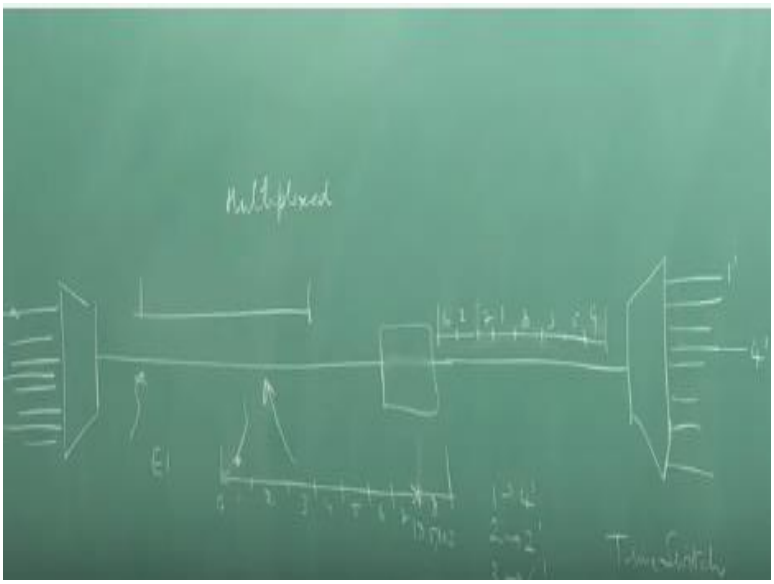

So normally 64 kbps when I am actually having going to have a communication link it can actually have a very high bandwidth I can use optical fiber I can use wireless or even a twisted pair but the bandwidth is pretty high. So I can actually transmit much higher number of bits per second so it means I can transmit multiple number of voice channels, so normally if in communication we will actually collect multiple voice signals which are coming.

At 64 kbps you will put them together and form a multiplex scheme, so we have even carrier system or t1carrier system in us even is what we use in India these are multiplexed time driven multiplex streams voice streams and they of course means there will be digital thing, if you have an even carrier system it will be requiring it will be having a frame which is identified by exactly 1 25 micro second.

So this 125 microseconds comes because eight thousand samples per second had to be generated for a appropriate voice representation this becomes a kind of a uniform standard in all multiplexing systems whether it is STH, E1, T1 everywhere it is 125 micro second frame duration, within this I can transmit multiple octets, so if I transmit 1, 2, 3, 4, 5, 6, 7 oh maybe I cancel another one.

8 octets in one frame I am transmitting eight voice eight voice circuits, so eight voice communication now can be transported over this frame, so I can actually put them I can get eight inputs I am generating 64 or eight bits everyone 25 microsecond putting them in order and then sending it, but now this actually means I have multiplexed I am sending it at other end I will just de-multiplex and connect back.

So the guy who was one here his voice was simple was transmitted in slot one, it came here it was taken out and so on, I can now implement a switching functionality here itself, okay. If I can if I can somehow have a box here we will discuss how this will be done and on this side this frame was available here I have another frame on this side, so whatever was the octet in the first slot if I put that octet in third slot here.

Whatever is operated and second I can put in each slot, I can do this kind of shuffling between the voice samples how this will be done is a different question but if I can do that I actually put my voice was here but it got connected here, it is something which was here got connected somewhere here, so infact in this case because I have moved I should draw actually everything is a full example so let me do this.

So again these are eight slots so let me do that generate the mapping so if one comes here to comes here three comes here for here five six seven and eight so what has happened so one which was coming in here if this box would not have been there this would have come out from this one port 1 prime but now it is coming atone two three and four.

So it is coming I should also make it one two three four five six seven of course I put it yeah, so one now is getting connected to four prime if I can actually do this swapping of slots one can get connected to four prime two can get connected to in this case to prime three can get connected to six prime and so on so last one the eighth one will get connected to fifth so I was able to do switching and if I can control this map if I can give a command and say okay the map is going to be changed.

I am able to implement something which is known as time switching okay, and the advantage is this is like going to be full cross bar 8/8 crossbar I can actually connect anybody to anybody else I can even do multitasking but dead multi-casting case we are not considering as of now okay and if I create this scenario this is nothing but can be represented equivalently by a crossbar 1 2 3 4 5 6 7 8 so 8 by 8 crossbars and the which cross points are being snapped in so one was connected to four prime.

So this cross point is snapped in two is connected to two prime so this cross point is snapped in three is connected to six prime so this is snapped in and I can build up one to one equivalence and both are restrictive non-blocking configurations okay so in it I can also build up a three-stage interconnection Network we will actually come back to that thing at some point of mine now how you will build up this switch how will build up this particular time switch so logically if you think if i can write all this thing into a memory.

So if I can write in order for example the first by it goes into first location second one goes into second location third interred and so on while I am reading it out I may not read it in the same order I may read the sixth location first second location then seven then first and so on I will be able to achieve this time switching functionality so I can use random access memory to create this so let us look at how you can actually build up a simple circuit for doing this a basic time switch so I need something called speech memory.

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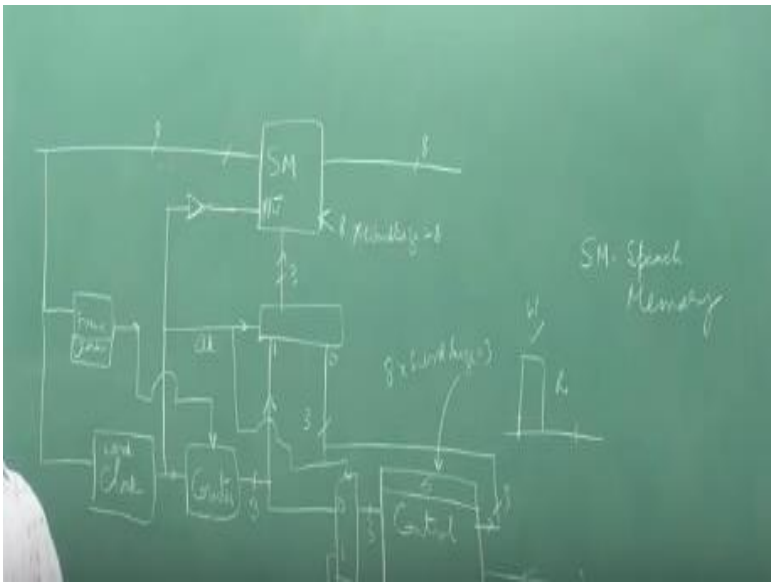

SM we call it so as I M stands for okay and the voice will be coming into this each voice consists of 8 bits so 8 parallel wires can actually come because I have to store a bus has to go data bus has to go where the data will be stored in this Ram mm normally consists of an address bus consists of a data base consists of a read/write control okay so this I will be doing it to a clock so this is a 8-bit bus I need to generate a frame clock so I need to figure out where the frame begins so frame clock recovery will be done here.

I also need to do the bite clock recovery in fact design of a bite has been converted to 8-bit parallel system so it is a bit clock so is a clock recovery will call it or word clock I can call it so one word is a bit parallel system now so the eight bits are not coming in this case in even carrier system the highest order bit will come first the lower order in the last order will be coming later on and so on okay in this case there will be eight parallel wires this is what 8 / actually indicates now this word clock once I recover.

I can give it to a counter so this counter will count how many times if it is a there this is not an even frame I think do not get confused even consists of 32 slots in 125 microseconds this was an example if I am going to use the same exact example here in fact yeah the same X exact example

so this counter will be counting from 0 1 2 3 4 5 6 7 that is a10 again it has to go back to zero because frame clock will give a pulse at that time new frame will start okay so there will be only eight pulses which will be generated per 125 microseconds and this counter is can be used to generate the address where you are going to store your world okay so first slot will be stored in first location second between second location and so on.

So i am going to use a MUX here and this clock this counter will give you count from 0 to 7 and back to zero said requires three buses okay so then this word clock now can be used to trigger it and I am going to use a mechanism thereby in a clock when the clock is high it is going to write when clock is low it is going to read okay.

So I can use that or I can use the other way around also it does not matter okay the consequence of this is the word which you are writing in this time slot it will be read in the same time slot in same frame other way around it will be ready later on for some slots it will be happening you will be writing now but reading in the next frame for some you will be writing now itself and reading in the same frame itself so this kind of things does happen because as a consequence of this.

So when the word clock I am actually taking this configuration so it has to write and the address should be used will be counter so this has to be one and this has to be 0 this is a clock which I am putting and when this clock goes here this RW bar so this should become 0 when the right has to happen so I have to put a not get here this is also 3 now I have put this line for what purpose there are so also has to be read out there has to be a bus which will be reading 8 bits the location which has to be read out in the first slot who will govern this.

So this will be governed by something known as control memory there is n by ram the two ram's basically which are required of course the good thing for us is the input side number of slots per frame an output side number of slots per frame are same.

So life is far simpler in this scenario I can take this out from the data output from here i can also read right into this will be done so that I can write down whatever you are going to write here

will decide the map here if I want to change the map app we just change the values which are restored here so in the first slot you are going to read from six so the first location here will be having 6 this six will be coming in during right that six will the location will be actually readout in the first slot.

o first slot will be triggered during the read time in fact the same clock I should put here now these two will be coming mike from my control centre so there is a control unit for a switch which will be sending this command which actually changes this map so this is one of the important things so when you do a call set up the call setup is done by actually writing into the control memory.

So in this case when the clock is one you are connecting here when clock is 0 this should get connected here so this should be 0 and they should be one ok so in this case whenever the clock is high you are writing 1 2 3 4 5 and this counter is going as an address you are writing in order whenever you are actually having the second half of the clock when it is to read my clock actually becomes zero at that time.

So the output of this gets connected and you will read from that location and this control will be connected to pick up which location so it will be locating finding out the first location so this address will be telling in which slot and from where you have to read that will be given what is written here so during second half when the reed is happening you are reading from here but during first half when you are writing in speech memory that time you can your control system also can write into this control memory and henceforth can change the map of this particular switch this is a very Elementary in a basic system and of course you can also now write down the sizes.

This one for example will be requiring how many locations it is eight words which will be their size of each word will be eight in this memory this one will require how many you only need three bits to be stored so what size is three here word size is three and eight such words and you require eight words here of this thing what size three an important thing is these frame this frame generator will be required need to be connected to the reset so that the counter gets the reset

when a new frame starts and this is the basic elementary time switch which actually can be used as a crossbar a simple crossbar.

So if you want to build up a small Epbx a 16by 16 port for your home or for your office you can actually use this technique to build it of course you have to build up lot of other stuff for signalling control logic and a software also but this will be the core switch which will be there for a small exchange okay so this is one of the things which I want it before I move ahead with the remaining theoretical background and before moving on to time and space hybrid switches which actually can be built.

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