Indian Institute of Technology Kanpur
National Programme on Technology Enhanced Learning (NPTEL)

Course Title
Digital Switching

Lecture – 02

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Okay so we will start we actually have done in the earlier lectures what I had to discuss about the network and also talk about the manual telephone and as usual manual telephonic actually does have it is own problems the basically the problems which one will face is.

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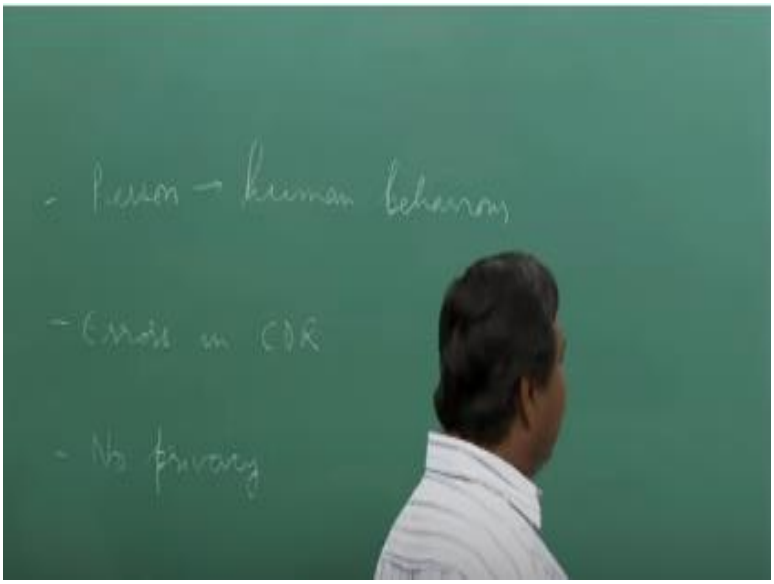

Because of humans so remember there is a telephone operator visits in the exchange and which actually he or she will manually connect the connections between various people it the person will also interact with the corresponding users are the telephone owners so all communications essentially is still depend on that particular person now if that person is not in a good mood so

maybe she may not pick up the phone if he or she cannot see the light which is blinking which is indicator that the handset actually has been taken of the cradle.

So that indication if he or she is not able to see he just ignores in that case you want to make a call but you cannot talk to the person you cannot tell him to how to which place you want to make the call so this kind of inefficiency can actually can come in so the human problems are human behavioral problems actually will remain will crepe in actually and then you will have possibility that errors in CDR the cold detail record so you have to pay for say permanent kind of charges to the telephone company for making a call.

But the person there actually had made a wrong entry in the register itself so when then bill will come there is going to be a problem and of course that will have to fight with the telephone company for rectifying the bills so it can CTR's as to be as accurate as possible there should not be any error which should come and this can always happen when a human is recording it on a sheet of paper if that sheet of paper gets lost is tone is burn out or may be rats will eat it then of course the whole bill cannot be generated.

So those kind of issues will come in and of course the biggest problem is there is no privacy what actually it means is that the telecom operator can actually listen to your communication so when you are making a call she has setup a call between two people now you should not expect any privacy because she actually he or she can listen to what you are talking to the other person now that is I think one of the biggest problems in fact under the telephonic that is problem but manual telephonic this is a bigger problem because nobody as to go and do something telecom operator itself know that what we are talking about .

And of course one gentlemen this of course anode diode we do not know whether it was right or wrong but it is been mentioned at various places that this anode diode the gentleman named Almon Broun Strowger

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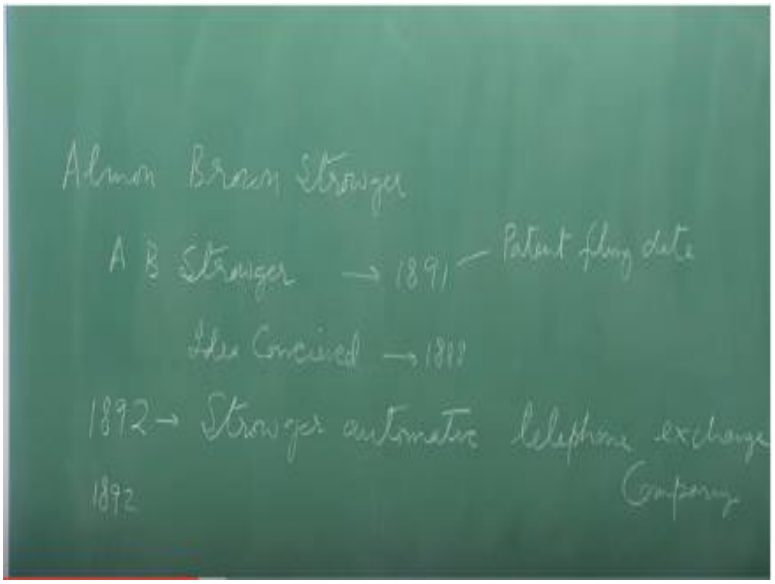

And of course most of the people know a A, B Strowger is a person who is responsible for removing this manual telephonic and then of course putting all these people operators out of the job of course they must have move to the different jobs and gave birth to something on automatic telephone.

Okay automatic BPX automatic electronic private branch automatic exchange and of course he actually filed a patent for this in 1891 Idea was basically conceived in 1888 and of course the story goes that this guy was not an engineer but he was also working as under write at some point of time so under writer are the people who was trying provide insurance to the people okay they under write their whatever is the commitment for a person against the librates.

So whenever the cots used to come to this person for the under writing business the clients used to call him, him Mr. Strowger but the operator this his office actually was connected through a phone and that telecom operator the exchange operator there she was a lady and she husband was also a under writer.

She was mostly actually routing all; the calls which were coming for Mr. Strowger to her husband and of course that is where it pinched actually to him that is the way the story goes and then he decided that he will build up the automatic exchange and that is when of course the birth of a Strowger exchange has actually had happen.

He started in 1892 after filing it is a fit and filing gate this fit end of course you can reach your on the net, he started a company in 1892, is the quite long time back, this company name was a Strowger automatic telephone exchange company. And of course CI deployed his first exchange which was the 75 subscribers with a capacity of 99, maximum possible subscriber in the automatic exchange and he started this also in 1892 itself.

And ultimately he actually sold it off at this particular patent at some point of time to another company and Bellth laboratories ultimately acquired that patent later on and that time when the it was acquired it was in 1916 that time the patent was acquired for 2.5 million dollars which was a huge among a some for which the simple patent actually was may acquired by Bell which was a major telephone service provider in US set one point of time.

But now most important thing I actually mention in the previous lecture that you have to tell his some by some method to the switch what you intend to do when you going to receive a call that switch has to tell you that a call is coming to you, so that is a signaling which has to be there, so of the signaling at can be implemented in this kind of system that was that is an issue. So in fact when the manual telephone is there I can always say I would like to talk to so and so gentlemen.

Who resides in this particular city so you kindly set up a call for me and was the caller set up give me a backer call and connect me I will talk to him, so that is the way that you are doing signaling with the exchange but here it is automatic system, how you will do this? And remember that time you where not having sophisticated computers so this was actually build with electro mechanical system.

It basically used electro magnets, a springs, ratchet wheels that is the concept which was used and the relays which were used to essentially program it technically, so let us see how this was actually done. So for signaling purpose one of the major thing infect this was a news for a long time the pulsing they keep actually come at this point of time, so remember if.

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If you have seen the older phones of this kind, so when you want to dial 1 so last one will be 0, so when you want to dial you will put a figure here come all the way here and just leave it, it goes back it actually generates a train of pulses, it generate the train of pulses which are calibrated so most of the equipments this mechanical kind of equipments have to be calibrated, this pulses where the mechanism by which digits can be communicated to the exchange and there was a reason why this was done.

Because each one of them will cause electro magnet to get captivated which will Cause a ratchet wheel movement by one step so number of pulses means those many steps will be applied and it can actually move, so that was the basic principle that is the reason why this actually got invented with this Strowger exchanges, so that was the mechanism by which communication was happening.

The reverse communication from exchange to the user was happening only by ringing thing, okay. So it was not telling that who is calling you, so earlier the telephone operator used exchange operator actually tell the destination guy that a call is coming from so and so gentlemen would you like to take it up, in this case this was not feasible, so there was no caller ID thing implemented.

In this thing but most important thing there is no telecom exchange operator participating, so secrecy is kind of guaranteed unless somebody goes there and actually connects his head phone inserted into the circuit and listens to what you are communicate, till that time it remains secure and of course it works automatically, so that was the beautiful thing.

So the basic components infect for 1 you will be using one pulse for two part for 0 you will be using 10 pulses for 0 there was nothing like a 0 pulse because unless you provide a pulse your circuit will remains on a home location and it actually moves depending on the number of pulse is so 0 was always in the hand so now let see a what are basic is stuff which was actually used to build this Strowger exchange is in fact our rule in three components which were used.

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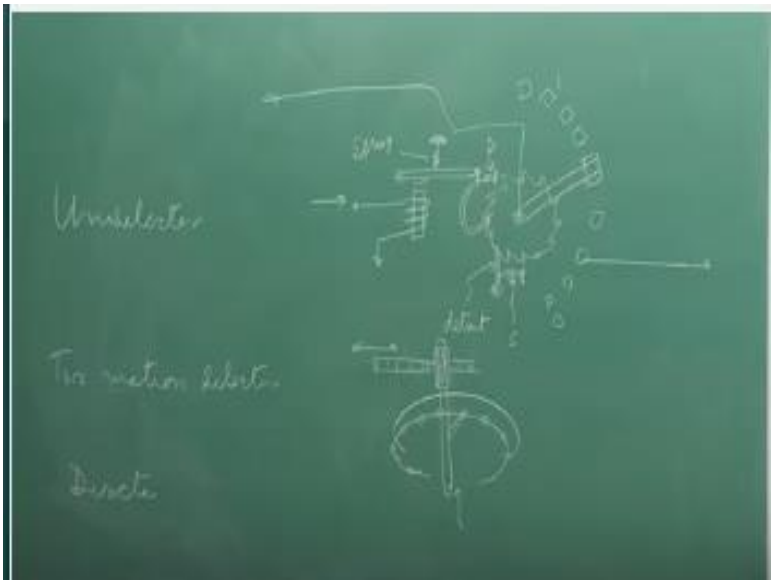

So one of them is unit selector second one was two motion selector and third thing was director so these were basically the components which were pretty much kind of a standard the combination of these were actually use to build up the these is our action is and it is a basically as mechanical system so normally for a un- selector you will have the rigid wheel of this kind can actually see this is and they are so it can rotate okay it can rotate only in one direction and normally there is a stick.

Which is attached to this so there are central point where the current will come and then you well of the connections the various points so it is starts from 1 and goes to 0 and there is a home location so when the call there is no call going on this should always rests at the home location and depending on the requirement you will give the pulses to the control circuit and it will move and make a connection to that particular pass which will be decide by the number of pulses which have been.

Inserted into this system and first the first round of that dial actually is over in the second round there will relay circuit by which should can be now the next sequence of pulses can be fact to the next circuit and so on okay and similarly when the call is going on that time a rotary counter will start and counter will stop when the call is over this all being manage to release so even metering was automatic in this case now how this ratchet wheel is going to work it is basically mean thing I am actually showing.

So when I am showing this reference this means is a rigid element it cannot move so usually there will be a hinge this kind of mechanism and there is this the spring and with this, this kind of loop so whenever I am going to have this in fact we call it to the return type of un-selector so here you are going to apply the electrical pulse first the pulse is applied this will tried this will pull the hum downward and this will engage with the next teeth and when the current is when the pulse is over this will return back because of the force of the spring and this ratchet wheel will rotate by one step.

You put more number of pulses to rotate those mine of number of times so if you would happen there in the exchange you will actually see their look here the sound like tick, tick so every time there is ratchet will moves there is a click kind of sound which will come up and of course this should not go back unless you want it to push it back to the home location so for that you will put the device which is again it we call it detent so this was the basic mechanism which was used and of course you need have spring this is also hinged.

So into have a spring here also so this is another spring which is used and that is how the un-selector will actually work so give the number of pulses it will go from home location to that corresponding point and if you want to push it back to the home location the idea is that you again rotate it completely till it comes backs to the home location so it can rotate continuously and this through a brush it is this particular electrical circuit is connected so this is the input line from the guard this is the destination side so you can actually put one to ten switch so remember this l.ike a switch which has ten output and one input and one of those ten outputs only one of them can be connected to the input.

This of course equivalently can be done through a electrical switch like this also but of course you will have ten of these but depending on how many number of pulses are coming each one of them one of this has to be switched on so here this is done through a electro mechanical system so this is also counting in that sense in that logic was unbilled. Second kind of thing also which was built was because this is only connecting one to ten users okay.

There is another kind of device which was used which is known as two motion selector of course I think none of this equipments are in use now days you can only find them in museum the second one was something like this you will have this particular array of contacts are there along this circle so there is one place where is a there is a split so that they are turn which is being he is on the to the central axis when it is in this location outside in this split it can move upward and down ward.

So there were in two motions you are actually at the base location you move upward first and then you rotate okay so that way you can actually connect one input to the 100 outputs, so first

digit is used for the upward movement second digit is used for the lateral movement or the horizontal thing. So this part of a shaft was typically having a gear drive so this shaft itself can move up and down by using similar receipt will kind of motion.

So backward and now force to that ten locations to which it can move so instead of the horn now you put a gear and then make this motion possible and second one is this motion which is again kind of arrangement so with the first pulse you do a vertical thing in second pulse you do a circular horizontal thing so this was the two motion selector, basically using this two components and relays this Strowger was able to build up the basic exchanges.

Which because of the privacy reasons big actually took off and that series and while a objects some point of time bought a patent and I use amount of some. And of course you will have problems also one more innovation which was done by him was something known as common control system so the control circuitry which is going to control this can be shared across multiple of this elements that was the innovation which was there which reduce the cost.

Otherwise you have to build up a control system for each one of this element if you are putting large number of them in the system so common control system was.

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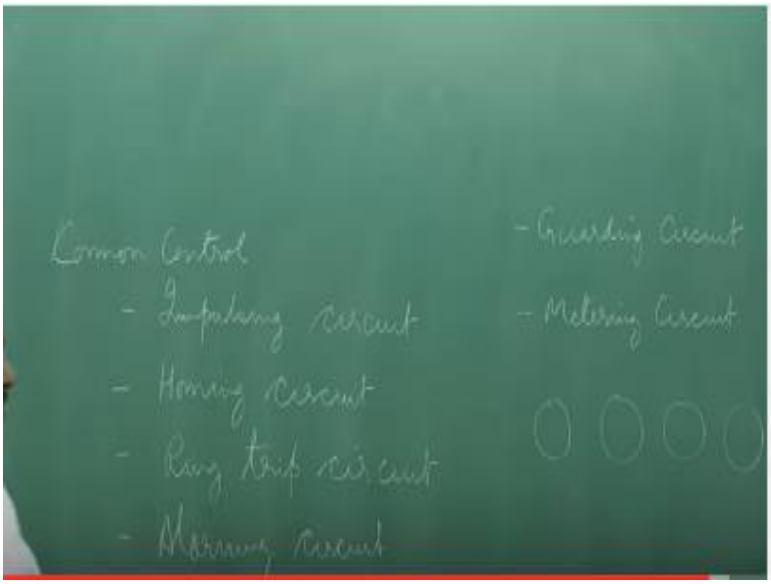

Common control was the innovation which was involves which actually reduce the cost drastically and of course maintenance wise also because more the mechanical component more the failure will be there more you have to keep track of them okay. So whenever the mechanical failure will happens because of here and tear you have to replace those components, and of course there was actually many, kind of circuits which were built which were available.

I am just going to list all this so there they have been in use in circuit switching systems in similar form and ultimately they actually have been transform in to something equivalent when we comes to voice over IP telephoning okay but we will not be talk about voice over at IP telephoning in this course but at some point of time in the part two of this course it will be coming up.

So currently I am actually worried about only the how the switches are implemented the basic theory abutted so there was a impulsion circuit is which was done so this use to create the power because the whatever is small short pulse which is electrical current which is coming is only signals that there is a one which have been dialed or two had been dialed it has to be now

converted to a power impulse which can drive the electro magnets. So there use to be impulsion circuit for that, there was a homing circuit.

So once the call is over so you have put the all your head sets back to the creedal in that case thus this devices should go back to the home location, so at when the next set of dialing will happen it should connect correctly okay there is no memory test to reset back to the home location so this two motion has to come down and it has to go 00 it has to go to 11 location.

Just before that there is a home location it has to go to that so that when you dial the pulse it will again take connect to the right output so there was the homing circuit which was there in trip circuit remember this is an automatic action when you are connecting ringing current to the phone destination when the guy lifts the hand set.

Earlier time there was a some person who can actually disconnect the ringing current, so let the your phone stop ringing and then you can talk now this has to be done automatically here so for that there was a ring trip circuit, there is a learning which was for maintenance purpose so this also has gone through its own evaluation.

There was a guarding so you should not get in to abnormal states in the switch and of course the metering thing so normally for metering there use to be a oscillator which generating pulse periodically and there was a counter so whenever the call is ON that time that oscillator is being connected to the counter so that rotary counter will be counting.

So there we used to be dials for everybody for every user there use to be a dial for how many seconds the call has been made and depending on weather you making a local call or a STD call the oscillator will be different so for a STD call the oscillator will be oscillating at a higher frequency so the counter will move faster okay.

So this is the reason why in earlier days in the BSNL use to have there is one pulse one unit for five seconds one unit for one minute depending on the distance of the calls which was there and

now of course because of the electronic systems and we are using exact time and we can actually write a software by which we can estimate the bill earlier days this was not possible.

Only this meters actually was being recorded what was your last reading what is your current reading and based on that the bill was generated okay so per unit the cost is going to be same it will not change, only thing that per minute how many units will be counted that will change depending on the distance so that was done through the metering circuit.

So that's how this all cross bar kind of systems sorry this Strowger systems use to work but there use to be a very fundamental problem this is a mechanical system lot of moving components wear and tear so maintenance was big problem specially in large exchanges and maintaining trend man power and everybody is the big addict okay.

And you need to very good quality material to build up the contacts, and there is to be oxidization there is to be a dirt ultimately this for not very much preferred, so over time people decide we have to do away with these is Strowger exchanges in fact now there out of service all most from everywhere, and people moved on the something called cross bar.

So in the next lecture we will be now looking into the cross bar systems how the cross bar technique is built and how it is to being operated what is the algorithm by which operate the cross bar and then we will look in to the how this cross bar can be what's the limitation which happens on the cross bar in terms of the size can I have actually any number of cross bar size which is possible. So we will look in to that in the next lecture.

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