Digital Switching
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Lecture – 15

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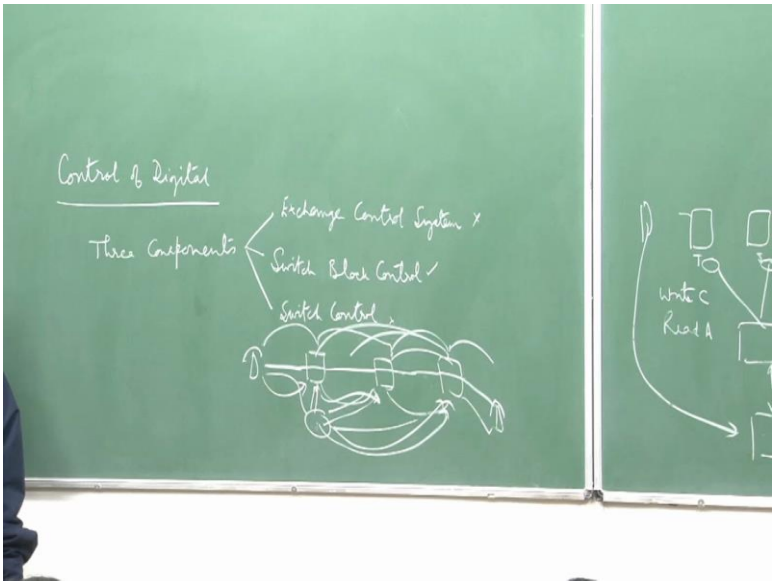

You are actually, looking at the time space, time configuration. I will just go through the control structure, which will be implemented for this. This actually now technically we are going to talk about control of digital switching, and I am talking about certain a specific variant, which is the TST configuration.

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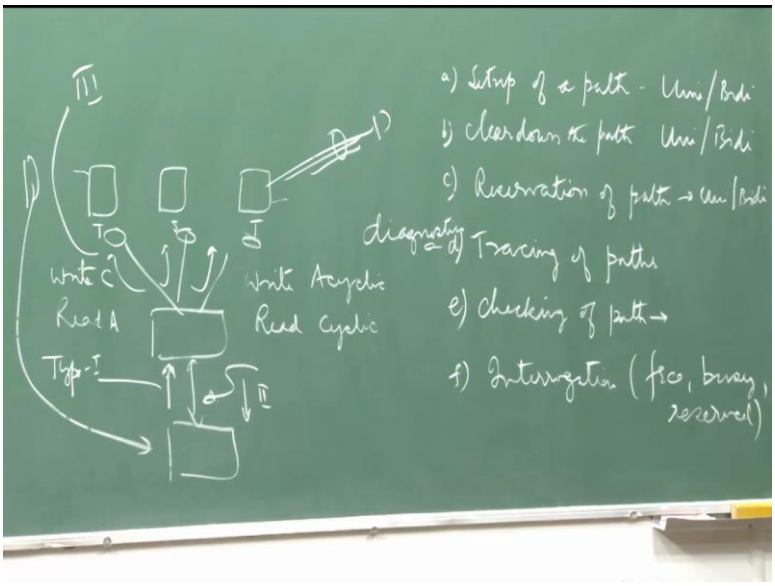

So, I am going to now, look into only T, s and T configuration, and of course, I am going to assume that it is right-cyclic; read a cyclic on this side; write a cyclic, read cyclic, so that, all control memories; you will be accessing the same location at any point of time. Usually, what you will be controlling in this switch; that is the first question. That will actually, decide what kind of actions have to be applied; just like, kind of building up what we called basic instruction set of a machine. So, there is a basic instruction set of a switch also, correspondingly.

So, basic operations; you have to identify, and what basically, we are doing is; there are control memories for all three systems, and what we are doing is we are just putting in, writing into those control memory. Rest, everything keeps on happening in this are being done by the circuits, all the time. So, that is our objective, and there are basically, three components, which will be there. These components are; the first one is switch itself. You take a time switch; its control memory, how you write into that, how it is been read out; that is the control interface. So, whatever, the bus, data bus, address bus; everything, which goes into control memory; that is your interface. That is the switch control which, we have already talked about, while looking for the implementation.

Similarly, for a space switch, again, it is a memory. It is the column, which will figure out, which particular junction has to be switched on, in which particular time slot. So, again, it is a control memory; that is switch control. Again third stage time; similar kind

of structure. Next, we are going to always, have a switch block control. Now, this whole combination itself can be called as switching block; a larger size switching block, and we would like to communicate. There will be a master command, which will be now, sending information to individual switch controls; did not that the whole switch block has to be controlled, actually. This individual has to be separately, referred or separately, the information has to be pumped into that. Then, of course, that is a switch block control usually, will be implemented in hardware, but this switch block control has to be given information by somebody, who is looking into destination address, how the call has to be set up, and then, based on that, it will be doing some kind of routing calculation; to whom, it has been forwarded, everything.

So, that most intelligent software entity, running in the system, has to talk to switch block control. So, that particular control is known as exchange control system. Of course, with this telephony, all this has been now, done away with. We actually, have technically removed switching, and transport function, separately. It has been done totally, separately; currently transport is much more tightly integrated with the switching, as of now, because I am setting up a transport path. There, you do not do any set up of transport paths. Switching runs in IP layer; it is independent of transport. So far, you can set up a TCP connection between two entities; you create a transport, but you do not tell IP layer; what has to be done, and what not has to be done.

Here, both are tightly integrated, because it is circuit switching system. There, you actually, create an over laid circuit over a packet switching system; that is only difference. With that actually, creates more decoupling there. So, these are three things, and now, the switch block control, which is this. I am not bothered about this; I will talk about the message types. I am more interested in this. This, we have already done, anyway. There, actually now, category which, we will be doing. Through this, we have to somehow, set up the path from incoming port to outgoing port. So, first function will be always set up of a path.

Now, I am giving a sample, which is a hypothetical sample, as of now, but it is very close to reality. In real switch implementation, whenever, a manufacture does it; he will make his own listing. So, if you are actually, going to design a complete switch from the scratch, you have to build up your own listing of what all operations will be required. May be when you will build up your first version; it will go into use. You will figure out

something is missing; some more functionalities have to be added. You will even, add those and redesign the switch; version 2 will come.

Once it becomes stable, you will release it as a product, actually. So, this one of those identification, but it is more or less, what almost everybody does, and the forward and reverse paths are set up, separately, so that, your switch is much more general. Usually, you will voice circuit is always going to be bi-directional. If I talk to you, you also talk to me, but then, that is not a general switch.

Tomorrow, I might have a requirement where, I talk and hundred people will listen, but the problem is remaining with hundred people. When they will talk back, there will be so much of even, the noise which is being picked up. So, those hundred people, I will sup up the noise itself; is going to higher than signal, actually. So, usually, reverse channels are switched off at that point of time, or they will be rooted through a different place, and then, it will be selected; one of those depending on who is active, depending on the voice activity. I require some such, that kind of a structure. So, I should be able to set up each direction, separately.

That usually, will be the way I will be designing, because it gives me much more flexibility in design. When I want to only, point to point voice circuit to be set up, I can set up front and reverse, simultaneously, but has two separate connections. So, setting up of path; unidirectional and bidirectional; there are two options in this case, again. So, there are two kinds of messages. These messages have to be given by exchange control to the switch block control. So, there is the exchange master command, which is going to; there is a switch block control, which controls this, and the exchange control is sitting here; this is the message, which has to go; unidirectional or bidirectional; both options have to be there. Control is a switch control; that is the switch control, at last.

Student: But control memory will be written by switch block control.

Yes.

So, depending on control memory, switch, anyway, is getting controlled by circuit by the hardware. Second thing, which you will be doing, is of course, once you set up, you have to clear now. It can also be unidirectional or bidirectional, both. I think, we should expect very similar thing also, should be happening in (( )) system, but (( )) is, I think, more

general. It is not only voice, but also many other media types also, which can be hooked on to. See, sometimes, for example, a call is not through still; you have not started billing; voice has not happened, but you would like to reserve a path for certain time. You have not set up the complete path; it is not being, but you keep it blocked.

Because, if you do not block it, and you send some next guy to set up the signal, to set up the signal, you set up the signal, and by that time, the confirmation comes; this path has been already, taken over by somebody else. Most of the real life switches are not restricted on blocking. They are all blocking switches. So, that is why if you decide that I would like to try to set up this particular connection that you have to make a reservation, and then, send the request forward. The next exchange will also, again, do the set up and forward the request. Once the confirmation comes in the reverse direction, all reservations get confirmed actually, and then, you do the set up of path. So, path gets cleared and they will start actually, working. The status bit will actually, be changed for every port or every path, actually. So, you require reservation of paths. Again, this can be unidirectional or bidirectional; this guy is informing him.

Student: There is instruction and being making reservation or anybody can do. everybody making a reservation for that.

There is no everybody; there is only one exchange control, which is commanding the switch block.

See, I am not talking about you, telling somebody to make the reservation. As the result of your interference, you are talking to some line called here; then, information is going, being pumped on to this exchange control. So, whatever signaling you are doing, your phone is doing with the exchange, is never being given to switch block control, directly known. It is being trapped or even PRI; there is a signaling channel that is being trapped and goes to the master software. This in turn, is going to send the message to switch block control. There is no direct thing; you cannot make direct things. You talk with your own language, which is specified for you. This is user to network interface specific in UNI specification where, there is a generic term being used. Depending on kind of network, this UNI specification will be different.

For you, you have now, DTMF tone; you will look for a dial tone; you will dial number; that is the only limited thing which you can do nothing much.

Student: (( )).

He is doing, even it figures out, whether I should actually, make a reservation or not. If the path itself is not available, I will not make reservations.

Student: It is true, (( )) but what is the right time to make the reservation; that is what our doubt.

Suppose, if this particular port is busy, I want to send it to some, say Delhi. Delhi; all lines or ports are busy; anyway, we will not be able to forward the request. So, I will deny the call, there itself. So, I will not make any reservations. It knows from the status table that these ports are busy, or it can enquire about the status of the call; various ports which I have, towards Delhi.

Student: This reservation is within the exchange or between two exchanges, sir?

Within the exchange, I have to set up a path from input port to output port. I have to make a reservation, before I forward my request to further set up. Technically, what we are doing; you are not only reserving these, but you are also reserving this line; outgoing line also, to the next exchange. Because, this cannot be used, this slot cannot be used by anybody else, to root the call to next exchange.

Student: (( )) what scenario is there exchange in the master plan will be the reservation that is my doubt.

When you make a call, how the call is made? Question is this; the call is, your instrument talks to the box, the exchange. Exchange, if it sets up a path, send a request here, sets up the path. If the question is I want to actually, make sure that I can clear it pretty fast. Will this is one of the ways, you set up the path; you keep on and then, informs the next guy; he sets up the path. You inform the next guy; he sets up the path, and everything. Usually this is way, which is never done. The reservation means; no stable, nobody can write their log currently; it is like semaphore. I will write the final value when things are, but nobody else is permitted to write, because I am still trying to set up, because this guy talks to him; this guy talks to him; this guy talks to him; then only, picks up the hand set. That time, the confirmation comes, and this confirmation that propagates.

This will remove the ringing tone, which you are listening at that point of time. All reserved path will be then, confirmed and the path will be set up, immediately. Problem is the path you have to identify. You have to understand what is happening. When the path is being set up from input port to output port, you have to identify, which particular intermediate slot is available. You have to identify lot of things; you have to do computation, and this computation does take time. Once the computation has been done, now, let us take two scenarios. First scenario is let there be no reservation. Something comes to me, and I am not bothered; I know this is OK and so I say this particular line I can use. So, I send key, I probably, can set up, because input and output are free.

Some resources, as of now, are available; I have not blocked them. I just estimated the resources by their status; it is available. You set up the connection. Then, it keeps on happening, till it goes to the last guy. Nobody has set up the connection; they have only identified resources that it is possible to set up; there is no confirmation. It actually, puts a ringing current; this guy lifts the hand set. Once the confirmation comes, now, its job is to set up the path. It only knows about the IO ports, which have been freezed; not the interval paths.

Now, everybody has to do a computation. Once the computation is done, this confirmation will be happening, and a path will be set up. Again, a computation is done; path will be set up. Computation is done; path is set up. Once the path is set up, then I will remove the ringing current; the delay will be higher. While, if before even, I will apply the ringing current, I make the reservations, and there is another possibility; when you come back in the reverse direction, the resource itself might get consumed by some other call.

There might be contention, because you have not blocked the resources. The same resource is going to be used by; same middle switch, which can be used by formality pulsar case, for setting up of them. So, when you try attempting, it is like railway reservation book. There is only two tickets available. You say I want to book; you do everything; you make the payment; your ticket is not confirmed by the time. Unless, you make the payment and confirmation happens. By that time, somebody also tries it, and he books the tickets first; you would not get the ticket at the end of payment; you will be very furious. In fact, what happens is when you are doing this railway reservation booking, actually, now, reserve the resource, immediately, before the final confirmation;

the move that you start the booking process. At certain point of time, when the status there; it remains blocked for certain period. By that time, nothing goes; no reservation happens; or you do not come out with it; it will be released, automatically, for the next booking. So, there is some period where, the locking actually happens. It is a similar kind of thing; locking of resources. In the reverse direction, because the resources are already locked and identified, you have to just flip the status bit; path will be immediately, start functioning. You keep on; it happens very fast, and you can immediately, remove the ringing tone, which is coming back, and two people can start talking. Of course, billing will be generated by this guy, always; billing record.

Student: Hunting, part of this reservation.

Hunting is the part of it, and that is why, the hunting always takes more time, but once the guy, other guy lifts the hand set, it does not take time.

Student: This will be part of the reservation only?

Yes.

Student: But, how many lines in exchange, percentage wise?

For?

Student: In the exchange block control, reserves certain amount of lines.

One line for each call, which is being made. If the call is not complete within certain time, then the resources will be released, automatically. Those statuses are again, the control memory which, I have shown. I have not actually, shown other fields. Their extra field attach to every word memory, word which is there, which even, talks about their status, because remember location in the control memory, specifies path. It actually tells the middle stage path. It tells exactly, what is the status. So, there actually, some other extra bits, which are there, which can be used in the design, but again there is no standard on this. A standard is not required, because this whole box will be manufactured by one single manufacturer. You are not going to buy control memory from somebody else, and switch from somebody else, and put the things together. You buy this whole from one single guy, and buy another thing from another person; these two should be able to talk.

So, the standards are only, when two different vendors are involved; interfacing between them. Single vendor thing; you do not try to do anything, because you leave it to the imagination of the vendor, or his design thing will keep on innovating inside. You cannot be too rigid, actually. Well, that is the way the industry has revolved. So, reservation is essentially, in the forward direction; this. So, most of your hunting delay, which happens is because of this.

Student: Sir, it means all the calls, they slip to they get two way direction of path.

First the reservation happens and reverses. Then, there is a confirmation, when the set up actually, happens. That is the process where, there is no other possible way, I think. In fact, this does not require any technology; this is all common sense. Best way is, you say ok; I am going to design my own system. In fact, if you have ever any confusion, you do not have books; you think I am going to design the system; how I would have designed the system. 99 percent chance is; you would have designed the system exactly, in same way, the way it is already being implemented.

So, lot of, actually, you do not need to look into manuals to understand the existing system, because of this. This is a common sense. Here, while in the reverse path set up, there will be delay. So, these guys will get annoyed, actually always. Even, the reverse confirmation; I start putting up the delay. So, forward set up; you keep the delay, there is no issue, but the moment, he lifts the hand set, it has to be almost, instantaneous. Because you have to start also, doing the billing at the same time; you will be losing, otherwise, these precious seconds for which, you could have billed. You are actually, increasing the load.

Student: Do we cannot do the weak computation instantaneously before coming the confirmation from reverse direction?

Usually, there is even a better and a smarter thing is done. It is not cascading thing. What usually, done is the moment this guy talks, I have not actually, talked about this. Because this signaling is if it is in-band signal; in-band means in the voice circuit itself, you do the signal. We call it channel associated signal. If I am using a separate packet switch network, which is for signaling, which is what (( )) does; this guy once that figures out a call has to be set up, it estimates the root. It can send a packet parallely to each one of

them. There is a parallel transmission, which happens. All of them will make the reservation of resources, when the packets will come; it will be for certain duration.

They will respond back with packets, actually, to this guy. If it figures out, or I have got all the responses, resources are through on all, the whole path is now clear; it just simply, will send a message to him to put up the dial tone, sorry, that ringing current. The phone will ring here, once the ringing confirmation happens; it picks up; it comes. This will simply, do is nothing; will send the same parallel packets to all the elements, parallelly; again to SS7. SS7 is like TCP, IP; similar stack like five layer stack. They do not call it physical layer or network layer or data link layer; they will call it MTP level 1, MTP level 2, MTP level 3, and so on. So, only the name changes of the layer. Functionality wise, they are all exactly same. They also use same kind of routing principles, whatever, we did in 673, and then, they have already made the reservations, happening parallely now.

So, call set up is still faster. Now, that is the difference between your 20 years back or 25 years back, if you would have made a call, and now, you make a call; there is a difference. Difference is because of this; the most of our signaling is now, on SS7; it is not CAS. Earlier days, 1000 times, it was actually, still worse. You might have waited for talking only, for one minute, but signaling and call set up might have taken five minutes, actually. So, I do not know these older systems. I think they are no more operational, anywhere, except probably, in some (( )) location where, you do not want to put in the money, but in India, I think almost, we are fully on SS7. Now, I think in next 10 years, even SS7will be done away with fully, and we will have purely SIP. In between H dot 323, what would have been there, but now, it all discarded out. H dot 323 is not picking up, because there is an open source better equivalent than that, which is there, with version 3, running currently, as of now; SIP v 3, which we have. Of course, with IP v 6, and SIP v 3, if both thing combinations is, I think, a good option, always.

Because you have QS support available in IP v 6, which is required for; this is called media transport, actually; all voice transport is a media transport; it is not a data transport. Anything, which is real time is a media transport, whether it is a voice or video; it does not matter, and for the first time, all kind of media can be transported by same signaling, which is actually, not permitted. For example, you cannot make video calls with the conventional telephone; it was not possible, because that support was

never. It was basically, only for voice, but SIP is general, actually, you can extend all kind of media types. Next, the D part; tracing of path, digital circuit does not make sense except, you try to find out, whether control memory; that memory location has gone defective or not. There might be a byte, which might go bad in a control memory. That only means that switch is actually, still functional; only, there would be number of possibilities or intermediate options are going to be less. So, you should not use those combinations.

So, this is basically, tracing of all possible combinations. This is basically, used for diagnostics, again unidirectional and bidirectional; both. E is, this is the performance basically, checking of path we call it, but basically, performance analysis; whether something has gone missy or not, typically, on the boards. So, you will be actually, putting some source at the input, and something at output, you set up and you will check the performance. Tracing is, you will read; you will write and then, read back; kind of thing to whether, things have been written correctly or not in the control memories. These were exactly, also setting up the path. You are looking even at the wiring, timing synchronization, everything, will get verified.

Student: At what time it will be tracing on the call?

Whenever, the load will be less, that time usually, it will be done. You never do all the diagnostics, and everything are never done all the time, now. Usually, whenever, you will actually, find out in that day, is the Delhi kind of variation, time variation, when the load is least; that time you will put the resources for all diagnostic test.

Student: It is done, automatically?

It is done usually, automatically. This is, because this can be done by this guy; this guy is sending a message corresponding to these events.

Student: what happens if searching if we discover something doing?

He will just, generate a log report; he will at least, give an alarm. Somebody can come and then, repair it; otherwise, how you will know. You cannot go and manually, keep on checking all paths. If you are going to, there exchanges of size of, like one lakh lines, almost in some big cities. Fifty thousand is pretty common; fifty to sixty thousand; like

exchanges are build up that even size, but they were having multiple switch blocks. Even, IIT, Kanpur here, we are going to have actually, now currently, I think, 20,000 lines, that is what we have requested. Seven thousand will be commissioned by next month end. Currently, operating exchange is 6000 lines, extendable to 10,000, which is now going to be actually, taken out, apart from the service, actually. The numbers are used 6000 lines manually, is going to be impossible. In fact, our fault rate should not be very large, because I cannot sustain manpower, if not commercially, viable.

It requires a large manpower to maintain. Number of phone lines at the homes, which goes bad, has to be very small. The number of phone equipments, which goes bad, has to be extremely, small. Typically, the harsh conditions are put; we buy complete telephone equipments; the condition is that within first two years, if more than two percent of the phones, actually goes bad, then the whole lot has to be replaced by the manufacturer. Under that condition only, you buy the telephone equipments. He has to give a warranty for that; we do not repair. We do not have that much of time. Telephone equipments is something, which is currently is being maintained usually, by the provider, but I think now, the scenario is going to change. Usually, people should buy; company only provides you a port at your home; that is it, but I think, still in India, everywhere is that operator, which provides you the phone instrument, but they usually, outsource it directly to manufacturers, and he will be making loss.

I think the production quality of the equipment has to be extremely, good. If failure, it is too high, it will become non viable, because ordinary equipment or ordinary telephone are not SIP based. For us, if you buy a bulb, costs about 175 to 200 rupees, roughly in between that; that is when, we purchase with all honesty, and other government defend that cost must be slightly, higher; not this much. But here, because I do the negotiation; I know the price, roughly. So, next is F; this is interrogation. Whatever is the status of any path, which has been set up, whether it is free, busy, clear, reserved; there are various statuses for every path. So, they have to be modified. Modification is done through these; set up, clear, reservation; these three things basically, are used for setting up all the status, but these statuses also, have to be queried back. When you have, for example, trying to set up a new path, you have to periodically, now synchronize your locally status table, with whatever is there actually, inside the switch. So, these statuses are also

maintained in the control memories, here. So, this interrogation is typically, will be for the free, busy, reserve; three things, three statuses.

Student: This will not part a form of the interrogation and reservation will and movement together?

No, this, you are actually, now setting up the values, here. You are enquiring about the lines; you are enquiring; what is the current status.

Student: I mean first, interrogation, then, reservation or?

Yes, usually, that is the way. Interrogation is usually, you are, most of these, the way it will be operating; it maintains a local table. Usually, it will not be inconsistence, because all set ups and all release are done by this, but with time, there is always a possibility; I have to work with that; I cannot be unidirectional. I have a database. Before I always send a message, I will always make the changes in the entries, here. Chances are that most of the time, whatever is my status says is actually, what is going to happen in reality, at the other end, but the other end also, can go wrong actually, someone said in a while, which you will find out for checking and tracing all that thing; I can still make my local database thing.

But, I think I will, as an engineer, I will keep an extra precaution. I will always run a separate trade in the software; you will keep on enquiring the actual status and see, if there is a mismatch. If there is a mismatch, correct it. Running a small thread is always, makes a sense. I think you all understand what is the thread. So, thread is a separate, what we call sequence of execution, which runs in a program. A computer actually, can be of multiple threads; it is the same binary, contain multiple separate threads, which run independently, of each other.

So, it is like multiple CPU is running, but technically, once if you, it is time share. All the threads run separately. So, same thing also, we have to run, just like a computer. So, exchange the way, I always say is nothing, but highly specialized computer, which does all the time computation, but of a different kind. These are also known as stoat program control switches; SPC, that is another term commonly, used. I have never told that. So, you have now, six categories. So, what will happen is, there will be six of these; there will be total twelve kind of messages; this technically, because it is bidirectional

unidirectional combination is there. So, six into two; totally, twelve possibilities, and this message type need to be identified.

Now, these messages are between this and this; exchange control to switch block control. Switch block control to switch; I have not done so far. Usually, there will be three kind of type one messages will be going in this direction, but remember, this is manufacturer specific. You need to follow exactly, this thing; you may design on your own, because whole thing will be still build by one single vendor. So, it does not matter, whether use type 1, type 2, how it is.

Student: It may be any type 1?

Type 1 is, which is going from exchange control to the switch block control. Type 2, there basically, message formats will be different. Type 2 is this, and type 3 is done, given actually, over hardware lines on a distributed bus, on a bus structure. So, type 3 is this. So, there is actually, no message being sent over a serial communication link. These are the parallel lines. This is over a serial line. This is actually, like a packet structure; proper packet structure. So, left side bit is always, sent first, and the lower order bit is always, sent later on, and kind of thing. There will be IP packets or other packets are identified. This one is a parallel hardware structure. So, I just quickly go through the generic message types here.

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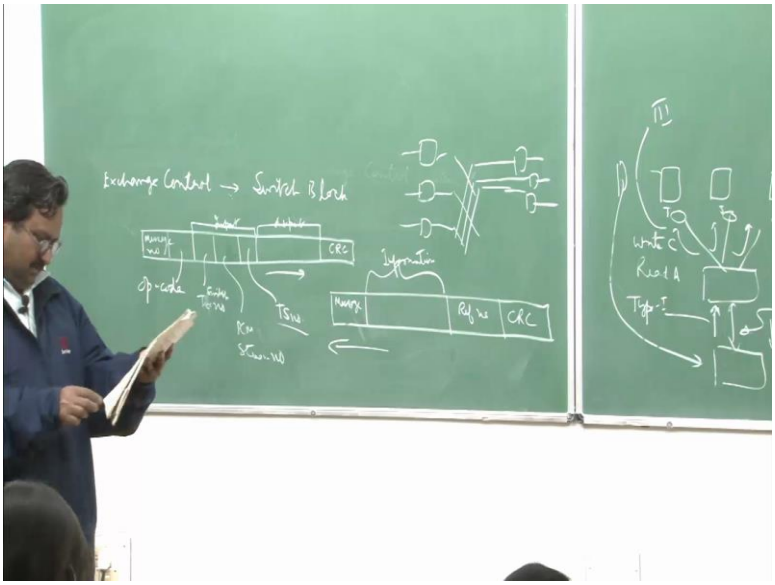

So, this is the type 1 message. This always goes from exchange control to switch block control. You have to remember this direction; this is important. The reverse direction is type 2, and whatever, you had yesterday, read 673, your digital communication networks also, applies here. Similar concept; whatever we have done there. You will actually, probably, appreciate some of the things, because fundamentals will never change, wherever, you apply them. They will always remain the same. So, you will typically, have the message number. Every packet has a sequence number, because if I transmitted duplicate, I need to identify that. When I respond back, I have to tell; I am responding to this particular message number and what typically, the message will be the opcode of; operational code of one of these 12 options. So, next is opcode; operation code, is very similar to how you build up the instruction set. So, I am technically, making instruction set targeting.

Student: (( )) options?

Unidirectional, bidirectional; two options are there. In each one of thing, there are totally, six values; total twelve; six into two.

Next is opcode. Opcode will be representing one of these twelve options. You want to set up certain thing; we will write I want to do a set up, and it is unidirectional or bidirectional. If it is unidirectional, source and destination makes a matter, and if it is bidirectional, source to destination and destination to source; both have to be done. Usually, there will be some. It is not that software is not running here; it will be like somewhere, which is setting in. It is not on a computer. It is an internal microprocessor, which is setting inside on the board, which is going to run the issue with limited capabilities. It will not be exhausted computing system.

Student: So, needed why to build up speed up the process.

Yes, always. You are inserting cards. In fact, does not matter even, your computer is on a board and whatever, and software writing is. You used to have some firmware to boot load from some disk. Usually, you would not be actually, having a hard disk; you would not be actually, directly managing hard disk here; here, you will be managing, in fact, the initial image, which will be loaded, will be decided by the boot loader. I think all of you do understand how a computer starts. So, there is always a bios, and usually, the initial; whenever, you power on a CPU, there is a location to which, from which, it will be

loading the first instruction, is always well specified, is depends on the design of the processor.

So, it will always go to that. In that place, usually, that those address memory locations are being covered up by bios, and now, of course, there is another variant, which has come in place of bios, and this is almost, very genetic; usually, it is a non usable kind of memory, which is there. So, even a power fails, anything happens; you do not read or write into that. Usually, nowadays, we use flash, and remember; when you are doing a flash upgrade, because it is possible to do the upgrade of this ROMS. Anyway, computer itself can do it when it is running by switching bios, but that is a risky thing, because if you are doing at that time, and if the power goes; something happens. Your machine is gone then, because there is no way you can boot, reboot it back, actually; unless, you take the chip out and flash it again, from somewhere else.

So, in laptops, typically, this problem is there; the power should not fail; you should fully charge before you do flash upgrade, or ROM upgrade. Same thing is too even, with your mobile phones. Whenever, you do android upgrade, typically, says that power should be full at that point of time. If power failure happens, you will not be able to reboot, but most of the android phones have done a very smart thing. They actually, have small bios, which is never written. What you actually flash, is something which is after that. So, original boot loader is never rewritten. So, you can actually, connect it to your PC, and then, again, re flash it.

Therefore, such a large number of people, because number of phones used, will usually, be larger than PCs, and this kind of thing happens; it will be problem for company to manage. When you give a warranty of one year, is going to be non viable thing. So, commercial thing always, has to be looked into. Usually, again, you can reboot, do anything; does not matter. Nothing will be lost; it is actually, somewhere is flashed. Here, it is always when you start, it will take some time to boot load, actually. Then, initially, ROM will start the boot load report. It will then say, OK, I have to; it will mount at this; this disk drive will be there, as part of the ROM, the boot loader and then, from there, from certain location, usually, say this sector, cylinder 1, platter 1, on that it will start loading from there; some (( )) code side. Based on that, there too, it can read the file system; it can load the whole image, and that image will be then, controlled, will be transferred; you have the complete thing running after that. Here, it would not be; it is

directly flashed on to this; that is why we call it this way; somewhere is never loaded again, dynamically, while your PC, your kernel image is there in your flash boot, if you see. When you have go into Linux file system, in the slash boot you will have that kernel image. You can actually, maintain multiple kernel images. When boot loader starts, you can select the kernel image. That is why, you can have dual boot systems, but this is also possible with mobile phones, because they are also, now being actually, built in the same fashion.

You can actually, have multiple OS, running on a same mobile phone; people have done that. So, that is the difference between firmware and software. Firmware is usually executed inside. So, this is the opcode and then, of course, what else is required. Operation code has to operate on something, some parameter. So, in this case, usually, it will be input port's specification and output port's specification, and in the last, because this can be corrupted by noise, by error, even if you are in a very small environment, lens are not very large; I always will be going to have a CRC check.

Some systematic code will be there, which can always be verified, equivalent to parent tables, actually, and then, of course, in our case, I have this kind of system; I have multiple time switches. So, what will be my input specification? Input port, physical port, which particular input thing, and then, time slot number; these two things will be important. It usually, will be time switch number, and when I am taking the input, it can be even, very well super multiplex time switch, and I may have multiple PCMs; plus four PCM streams, multiple events. So, I have to specify the events. First of all, the time switch, because there is only one physical port, within that what is the PCM stream code. So, I am just putting addition; otherwise, if there is only one single event, you simply can say input port and slot number. So, this is variable; this has to be again, depend on the switch; there is no standard on this. So, time switch, PCM stream number, and then, of course, time slot number.

Student: Physical port number physical port number.

Physical port is time switch number. Remember, time switch diagram; when I say time switch number, I am giving port numbers only, but this might have multiple PCM streams coming; that is why, this additional field is being provided. So, same thing will repeat for the output.

Student: If I have a single event, suppose?

Then, you do not require a PCM stream number.

Student: But the format will be generally, sir?

Format need not be; it is vendor specific, because this equipment is part of the exchange; this is actually, one of the boards, which will be sitting inside the exchange. There are multiple boards connected to buses, or the back plane; this one of those boards actually, which is there.

Student: What is PCM, there?

Prof: Pulse code modulation. Even, carrier is a PCM stream. Similarly, it will be done for this particular part, for this output. So, that is the message, which will be sent and this is fine, and in response to that, type 2 message will come. Do you have a class, afternoons? Otherwise, I will take five more minutes and at least, complete with the message; type 2 messages also. Type 2 message is pretty simple, and of course, opcode, I said, twelve options; we require four bits here, in this case. Type 2 message typically, will again, in the backward direction, there is a separate message number. This message number is not this. This is in the forward direction, the message will be numbered 1, 2, 3, 4, 5. In the reverse also, similarly, message numbers will be there. If I receive 1, 2, 3, 4, but 5 is not there; 6 comes and 5 as last; I can always, now refer back and then, send that information for each message number.

So, I can say this is the information, which is depending on what was the opcode, and another thing, what I want to send back; this structure will be decided by that. Usually, this is the reference message number, and this information is about this message number, which was received. So, when the reverse direction, when this will be going, when this way; this reference message number will be just, simply copied from here; If I am talking about this. For example, if I say reserve the path from this port to this port with this thing; this was received correctly. Reverse direction; then I will copy this message number here, put my own message number depending on whatever is my sequence; I might put an information; it was successful. Path has been reserved from this port to this port, kind of thing. Some encoding will be there for the messages. It is not a text message; it is an encoded, compressed message, and then, ultimately, you will have a

CRC; some mandatory pin code has to be there. Error correction; usually, is not used, because you can always ask for a retransmission. This is always a response; the initiator is always this. So, when it sends, there is a response; this can keep on responding; this can send multiple responses for every request.

Student: How to do identify the response of this particular forward direction that will be?

Reference number is there. I can put same reference numbers and multiple responses. That is why, this does not have a reference number to this message. You have to understand, that is why, when it sends this message in response to this, this will never do, this always the initiator; other persons always, the responder. So, this slave is this and master is this. This is the reference message number is because of this. That is typically, what we call pattern, which will be there in master slave configurations. So, I think, next is the hardware part type 3, which is managed from here to switch. So, I think that is a very small thing. So, what we will do is we will discuss this thing in the next lecture.

On Monday, and if I can finish it, before within that lecture, then we will start with what we call input and output queuing switches; the performance of them. We will now start basically, with packet switching. I want to create packet switch. I will take simply a cross bar; apply the packets at the input; synchronized ones and see how, the input queuing or output queuing; which one of them is better; how to make an estimate. Some mathematics actually, will be required. I hope, each one of you have already done, especially, movement generating functions and all that stuff; you must be aware of; must have done at some places and some course. If it is not there, I will give the reference and you can start that thing.

Student: Sir since we are assuming that write a cyclic read a cyclic and will there be difference in configuration if i…

See, there is an advantage, because in type 3 thing, I require less amount of lines; if I use this. You can do other way or around also, but you will be investing; you will be actually, adding more copper on to your board; your board size will be larger. There is a manufacturer you will be losing. So, your computer fee is going to make a cheaper one; you will lose the market. You try to reduce every wire, every line, which is on your board, as far as possible in your design. You try to reduce path; you try to reduce computation; every bit counts, because this is going to be replicated, large number of

times. So, you have to be cost conscious. So, cost conscious is always, has to come from the day one, when you start drawing on your board. It cannot that you build up a design, and later on, you can do cost cutting; it cannot happen. Do not do cost cutting; I say, just to do cost optimization. So, engineering and science; there is one major difference is; in science, you never do look for optimization.

Engineering means optimization, reducing the cost. So, it has become viable; commercially, viable for more number of people; otherwise, only it can be used by the Kings. Common people would not get the phone. So, we have been trying to reduce first, the whole telecom, in fact, whole network, which I have been telling is nothing, but reducing cost by sharing; sharing the links. So, anything, which is dedicated to; I am trying to minimize on that. The cost can go down, and thus, true I think in every engineering sector.

Student: What are the type 3 messages?

Type 3 is a hardware message being sent from here, to the switch; switching their limits. This is not a structure, because this is a serial communication; from here to here, usually, there will be a serial line. May be parallel line, I do not care; it does not matter to me; it can be USB. So, you will start from this bit and you will send it as serial transmission of bits. You have to do framing, deframing, everything will be involved in this case, and then, you will interpret that, but from here, it will be actually, sent from the bus. It is like there is a bus on which, you will send. In the back plane, you will be putting up the card of this.

Student: Sir, suppose I want to transmit that type 2 message. It is for example, so there are the message number will be same in the three cases only my reference will be?

No, reference number, for example, for this message, number 1 was sent; it resulted in generation of three type 2 messages. All three type 2 messages will now, be numbered 1, 2, 3 in the reverse direction; this message number, but they all should be referring to message number 1

Student: Sir, the reference number should be common.

It depends on your responding to which particular type and message; you are telling that specifically, because it is a slave; it does not do anything on its own. You send a command; it responds. You do not give; they ask for anything. So, there is no pull it here; everything is pushed. So, this guy, other guy has to push all commands, all control actions.