Data Communications
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Switching Techniques: Packet Switching
Lecture 19

Hello viewers welcome to today's lecture on packet switching. In the last lecture I have introduced to you the switched communication network and in switch communication network different types of switching are done and one of them is circuit switching. In the last lecture I have discussed in detail the circuit switching technique and how circuit switching is done, its advantages and limitations.

Now in this lecture I shall I shall first identify the limitations of circuit switching technique which will give you the background for packet switching. However, before I discuss packet switching there is another technique known as message switching which essentially can be considered as a first step of packet switching. So in this lecture we shall discuss about packet switching and here is the outline of the lecture.

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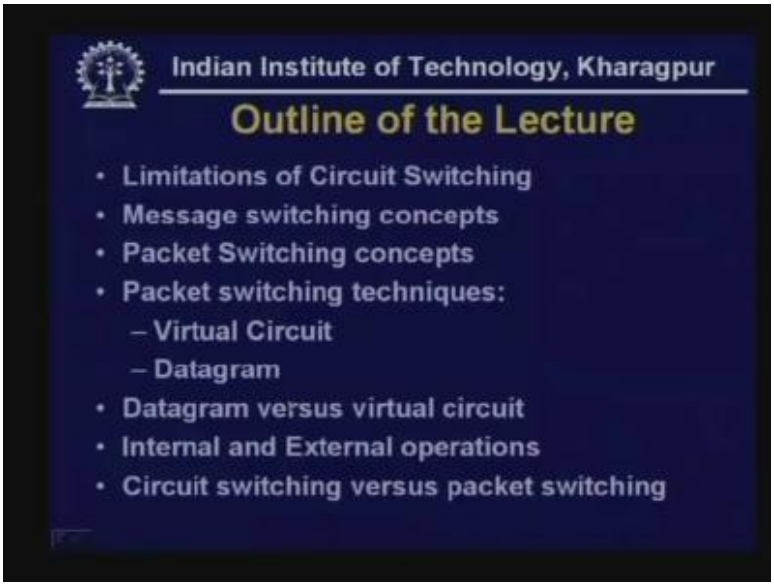

As I mentioned first I shall discuss the limitations of circuit switching then I shall introduce to you the message switching concepts and explain how it overcomes some of the limitations of circuit switching techniques. Then there are some disadvantages of message switching technique which can be overcome by using packet switching. So I shall introduce to you the packet switching concepts and as we shall see there are two different techniques used in packet switching; one is known as virtual circuit packet switching and the other is known as datagram packet switching. Let us also compare the datagram versus virtual circuit packet switching techniques, their relative advantages and disadvantages then we shall see the possibility of combining datagram and virtual circuit.

For example, it can be internal datagram, external virtual circuit etc having four combinations and finally I shall conclude my lecture with discussion on circuit switching versus packet switching.

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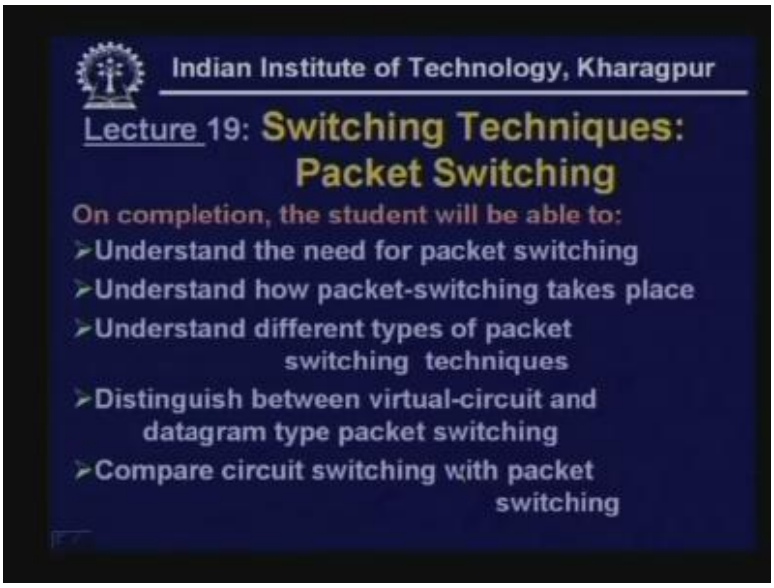

On completion of this lecture the students will be able to understand the need for packet switching, they will be able to understand how packet switching takes place, how different types of packet switching techniques are used namely datagram and virtual circuit then they will distinguish between virtual circuit and datagram type packet switching and finally they will be able to compare circuit switching with packet switching. So let me first start with the problems that is present in circuit switching. As we have seen in the last lecture the network resources are dedicated to a particular connection in circuit switching. As we know, before any data transfer can be done a path has to be established and that path remains active until it is terminated whereas data is sent or not and it is fully dedicated for that particular session.

There are two important short comings particularly when we use data communication. For example, in a typical user host data connection the utilization is very low. As we have seen even for voice utilization is not very high. Particularly when the traffic is busty as it happens in user host data connection then the utilization will be very very low and also it provides facility for data transmission at a constant rate. That means it does not allow variable data rate.

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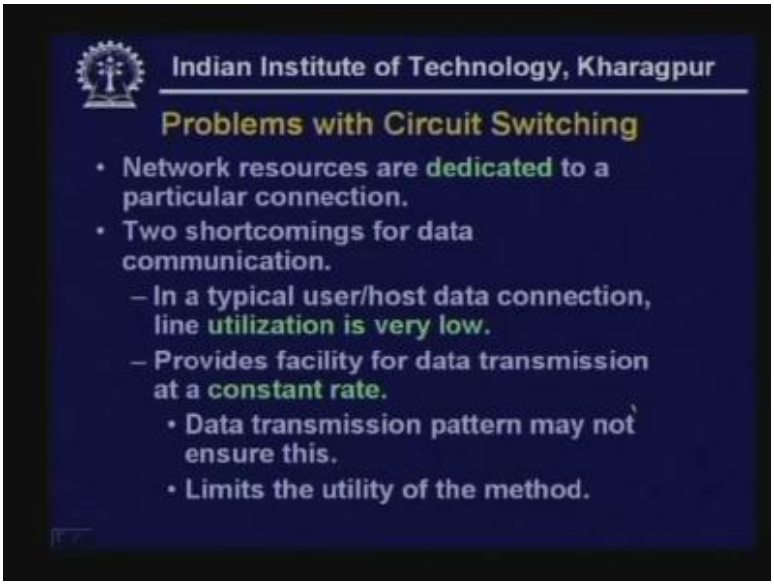

As we have seen the link between the nodes have much higher data rate capability by using TDM and FDM techniques and moreover for the use of transmission media of higher bandwidth such as optical fiber, coaxial cable for them it is possible to transmit at a higher rate at intermediate points but that cannot be done in circuit switching.

Obviously data transmission pattern which is burst in nature may not ensure this constant rate of flow, ultimately it limits the utility of the circuit switching technique. These limitations can be overcome by using message switching. The basic idea of message switching is each network node receives and stores the packet store the message essentially, determines the next leg of the route and queues to go out on that link. That means here what is being done it is essentially a store and forward approach. Message is stored that means nodes are provided with some buffer and they are stored until a link is available or a path is available in the direction of the destination. So the queues of message to go out on that link so obviously it has to do routing and then on that route the message can be sent in the form of queues.

Here the advantage is line efficiency is greater because essentially it is a store and forward approach so at a particular link any point of time can be shared by a number of source destination pairs. That means a message is sent and the next moment another message is sent so a queue is formed and from that queue a message is sent so as a consequence the link is shared.

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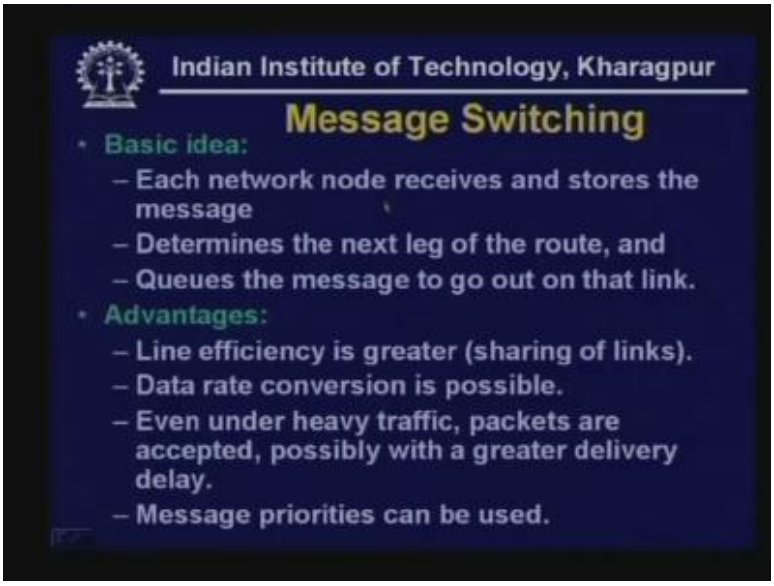

Data rate conversion is possible. Let us look at the diagram (Refer Slide Time: 7:28) for example this is the station A which is sending data to station D. So this is the source and this is the destination. Now as we can see each node is provided with a storage which is shown by this symbol that means there is a storage capability at each node so this storage is able to store the messages. So A will store the message in none 1 then from node 1 if the destination is D it can go via this route from 1 to 2 that means when the path is available it is free that message can be sent to 2 then again it will be stored here until this path link is available. That means in both these places the messages are stored and queued and then to the destination node where this station is connected and then it comes to 6 from where it will go to the station D so this is how it takes place.

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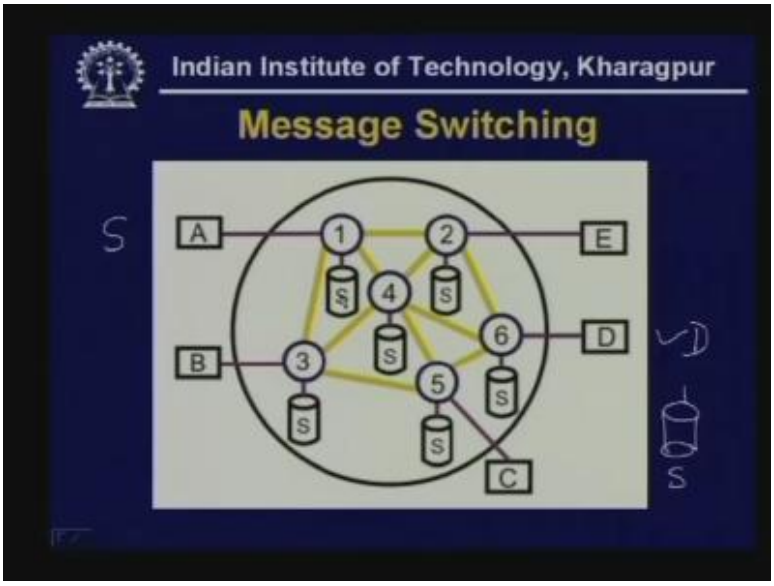

And as a consequence as you can see data rate conversion is possible.

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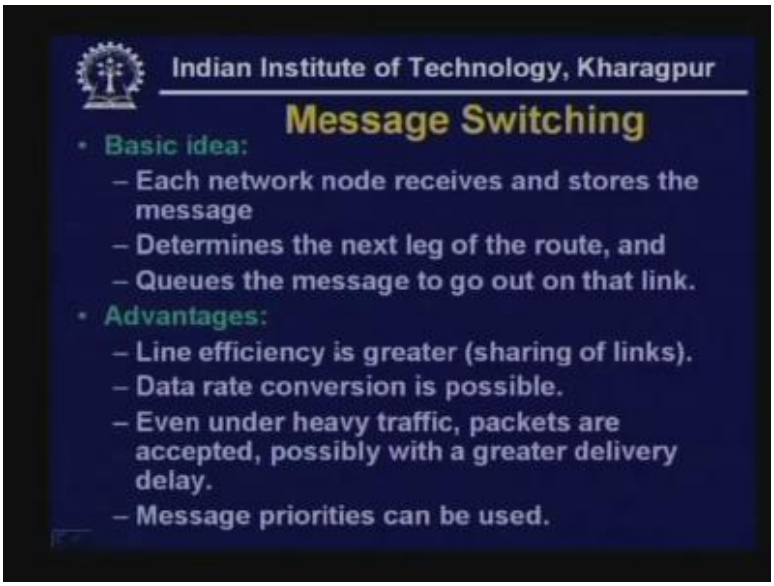

That means here for example this may be a slow link (Refer Slide Time: 8:38) A to this particular node 1. So here data rate transfer can be small on the other hand whenever it is sent from node one to node two data can go at much higher rate. Not only can it go at much higher rate if one can use different encoding techniques.

For example, depending on whether it is analog line or a digital line one can do encoding or modulation depending on how it is done. So data rate conversion is possible and

encoding can also be done. So, even under heavy traffic packets are accepted possibly with a greater delivery delay. that means in this particular case in case of circuit switching in case of heavy load a path may not be available it may be blocked but in case of message switching if there is heavy load then still this node will keep on accepting messages however the packets will be accepted but the only outcome will be the delay in delivery and nothing more than that.

Another important characteristic is that whenever the messages are queued and stored in the storage it is possible to assign some priority to them. That means high priority traffic real time traffic can be getting higher priorities and they can be sent fast before simple data traffic can be sent. So these are the advantages of message switching technique. Let us see how exactly it occurs.

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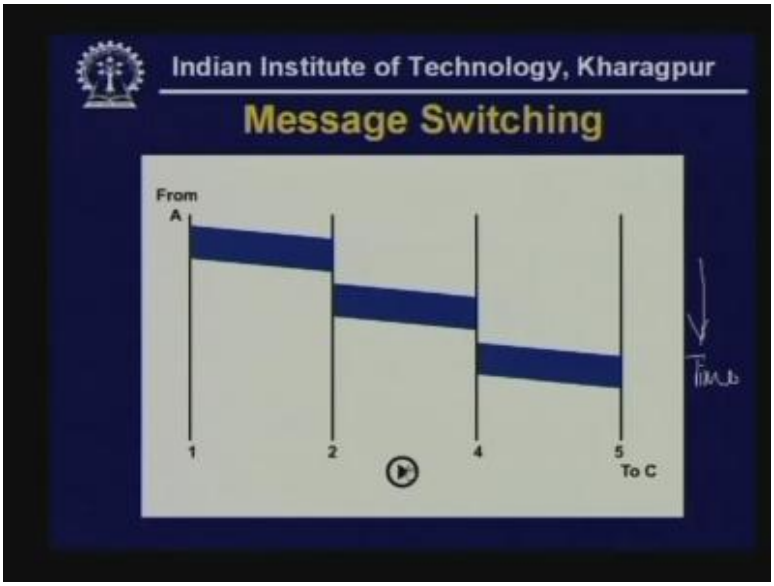

here for example from A to C it is going so first it will go from node 1 to node 2 the entire message is sent then it is stored there for strip duration and as you can see there is some delay in this direction, you have got the time and here you have got the time in this direction so again it is stored here for some duration then again it goes from node 4 to node 5 where this destination station is attached. This is how message goes from a node to another node and at each place it is stored and there is some delay and then the entire message is sent this thickness or the width of this line is essentially showing the volume of the message, the size of the message. The bigger the message wider will be this particular……. so this is how the message communication takes place.

Now, what is the disadvantage of this? Obviously message switching overcomes some of the limitations of the circuit switching. Is there any disadvantage of this? Disadvantage is that whenever the message is large obviously there is no restriction on the limit of the message; it can be very very large. In such a case what will happen is it monopolizes the link and the storage.

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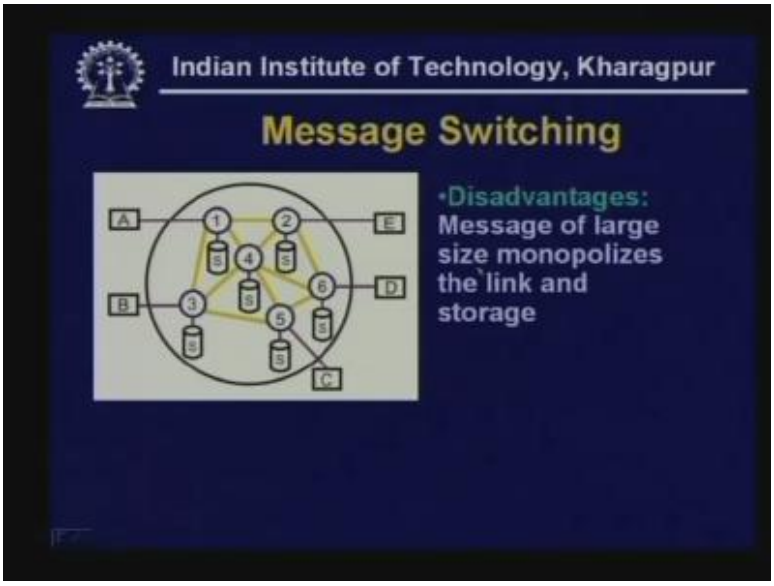

That means whenever a message is stored here it will occupy a large storage area so the other messages coming from other directions cannot be stored here to monopolize. Similarly, whenever transfer is taking place it may take very long time and it monopolizes the link so if very large messages are sent it will not only lead to long delay but it may monopolize the link and storage. Hence this is the advantage of message switching. That is why this message switching concept has been extended to another technique is known as packet switching.

So this new form of architecture for long distance communication is being used since 1970 it was first used in ARPANET. ARPANET used packet switching technique to overcome the limitations of circuit switching. However, the packet switching technology has evolved over time although it was in use in 70s but over the years the technology has improved it has evolved however the basic technology has not changed, the basic concepts, the basic technology has remained the same and packet switching remains as one of the few effective technologies for long distance data communication.

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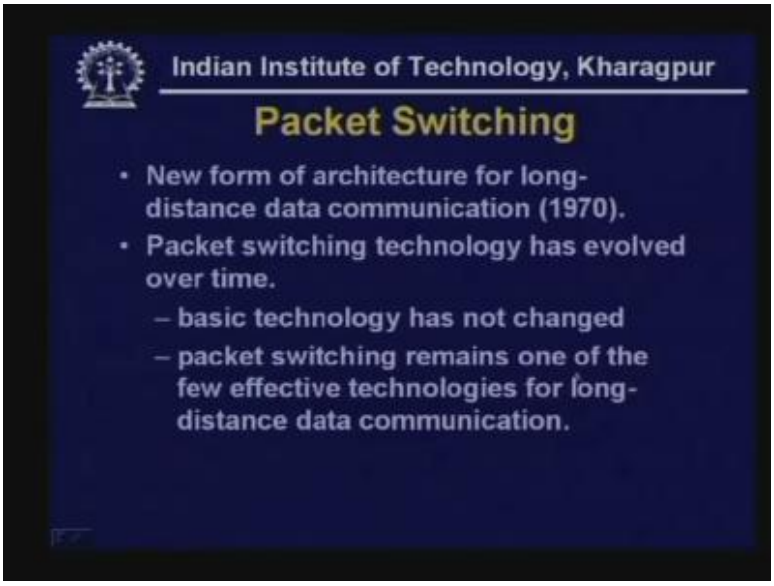

So nowadays particularly for wide area networks this packet switching is the technique used in the internet. Let us see how it is being done.

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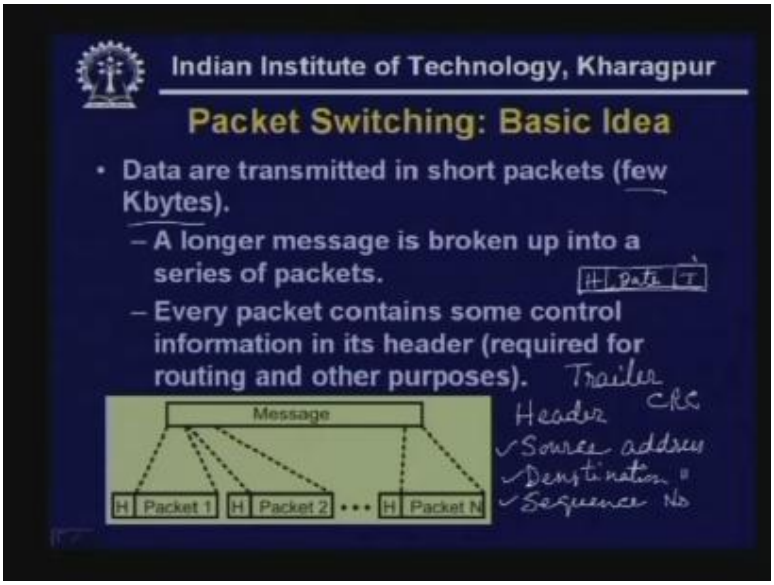

First of all data transmitted in short packets few kilobytes not very big so that it can overcome the limitation of message switching. So a longer message is broken up into series of packets. If you have got a long message as it is shown here (Refer Slide Time: 13:57) it is broken down into several packets such as packet 1, 2 up to packet n. Every packet contains some control information in its header required for routing and other purposes. The header will contain some information like source address, destination

address then the sequence number so this information is necessary for control. So each such packet is provided with this information source address, destination address and sequence number.

Not only this but if it is necessary to perform error detection and error control then the packet must be provided with the trailer and the trailer usually is provided with CRC. That means a packet may have a header then you have got the packet that is your data and it will have a trailer. So this is the formation of a frame of a packet and this is how a message is broken down into a number of packets. Here only header is shown however trailer may also be present. So as I mentioned earlier a packet switching network breaks up a message into packets and there are two approaches commonly used for handling these packets one is known as virtual circuit and another is known as datagram.

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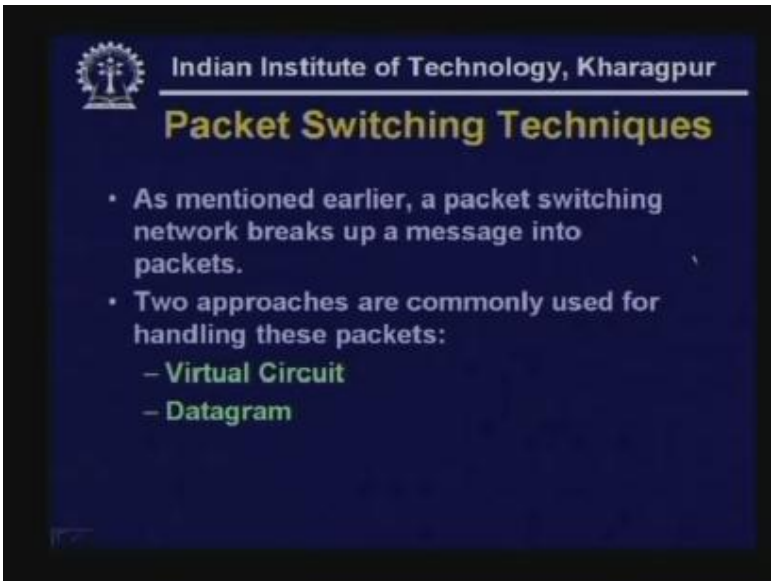

First we shall consider the virtual circuit approach.

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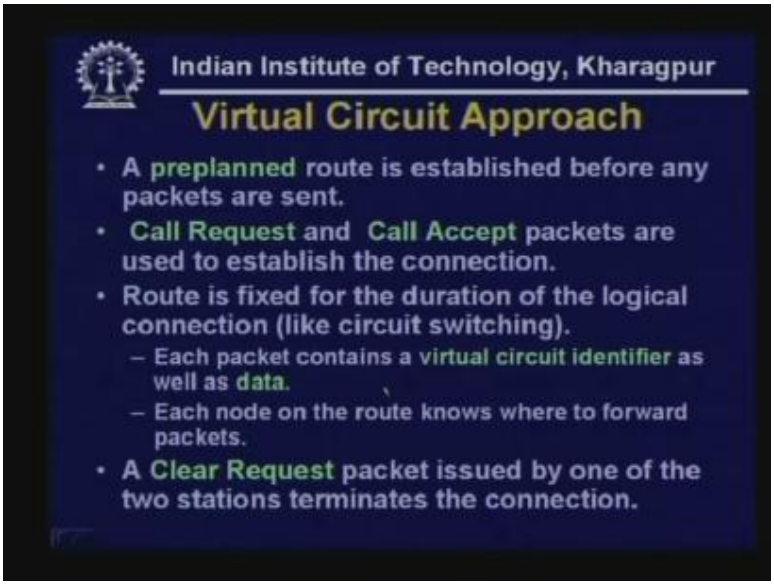

In virtual circuit approach a preplanned route is established before any packets are sent. it is somewhat similar to circuit switching that is why it is called virtual circuit approach. So essentially it is packet switching. Again here the store and forward approach is used.

However, just like circuit switching some route is established there is a preplanned route that is why it is called virtual circuit although effectively it is store and forward approach used in packet switching. So call request and call accept packets are used to establish the connection then the route is fixed for the duration of the logical connection like circuit switching. Here there is no dedicated path only the route is fixed that does not mean it is not shared so it is being shared by other source destination pairs but the only thing is it follows the same route and each packet contains a virtual circuit identifier as well as data.

That means along with the data some virtual circuit identifier is provided and that virtual circuit identifier is used to route the packet through the packet switch network and each node on the route knows where to forward the packets. That means the node need not really do the routing but the only thing is after receiving the virtual circuit identifier it finds out where to forward or in which direction to forward. Finally a clear request packet issued by one of the two stations terminates the connection.

So just like circuit switching it is also having some kind of three distinct phases. First of all a route is established then the packet transfer takes place then with the help of a clear request the route is terminated. Here let us see how it really works. From A it has to go to C through nodes 1, 2, 4 and 5 so through the circuit switch network as you can see call request packets are sent and since it is a packet this call request packet is also stored and forwarded here so there will be some delay before call request packet is sent to the next node.

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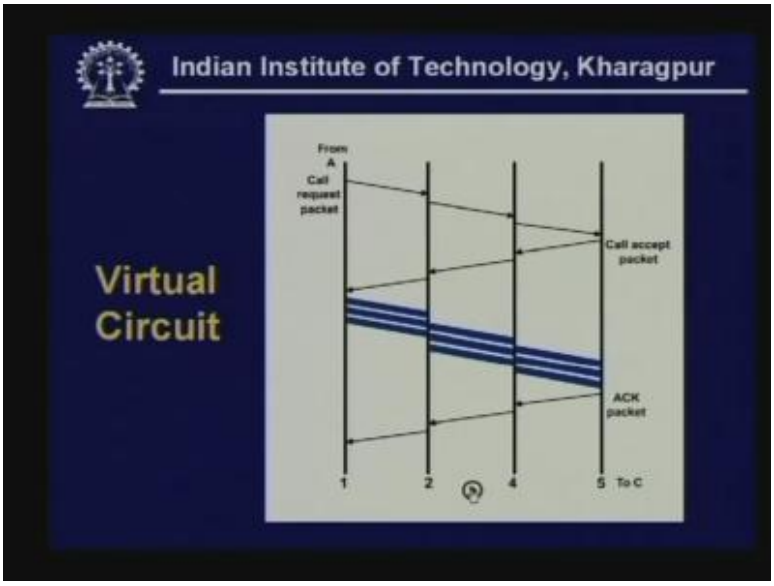

Again they call request packet goes to the next node (Refer Slide Time: 18:15) and ultimately the other side will send call accept packet and call accept packets are also stored and forwarded just like any other packet it goes in the reverse direction and when it reaches the source node where the packets are originating the packets may be sent one after the other.

As you can see, now the thickness is smaller than the message so this essentially tells you the size of the packet. So one packet is sent from node 1 to 2 then as you see here two packets are going from 1 to 2 and 2 to 4 so some kind of parallelism is being performed and again now see three packets of the same message are going and finally in this way the packets will reach the destination. So a single message has been divided into three packets and all the three packets are going in this manner and because parallelism is possible it takes much shorter time.

Finally acknowledgement packet comes and the link is terminated. So in this way (Refer Slide Time: 19:34) the acknowledgement packet will come in the reverse direction and as it reaches the source node it can be terminated. This is how the virtual packet switching works. Though we have seen virtual packet switching one main advantage is that different packets of same message can go parallel just like somewhat similar to pipeline that is used in processes. So these are the main characteristics of virtual circuit packet switching.

Route between stations is set up prior to data transfer as I have already shown. So packet is buffered at each node and queued for output over a line. That means just like message switching there also the packets are buffered but since the packets are of smaller size it does not monopolize the buffer, it does not occupy larger storage and also it does not take longer transmission time as a consequence the link is also not monopolized. So a data packet needs to carry only the virtual circuit identifier for effective routing decisions. The

virtual circuit identifier is used for the purpose of routing. The nodes do not perform any routing operation except it uses the virtual circuit identifier for forwarding the packets. So as I mentioned intermediate nodes take no routing decisions.

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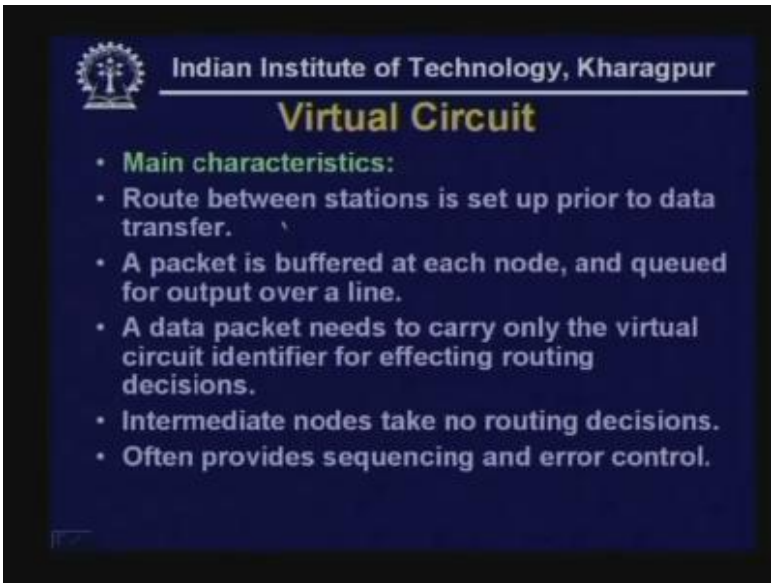

Another point is it often provides sequencing and error control. Some kind of sequencing and error control may be provided in that case CRC is provided and suitable ARQ technique can be used.

Now coming to the datagram approach it is different from the virtual circuit.

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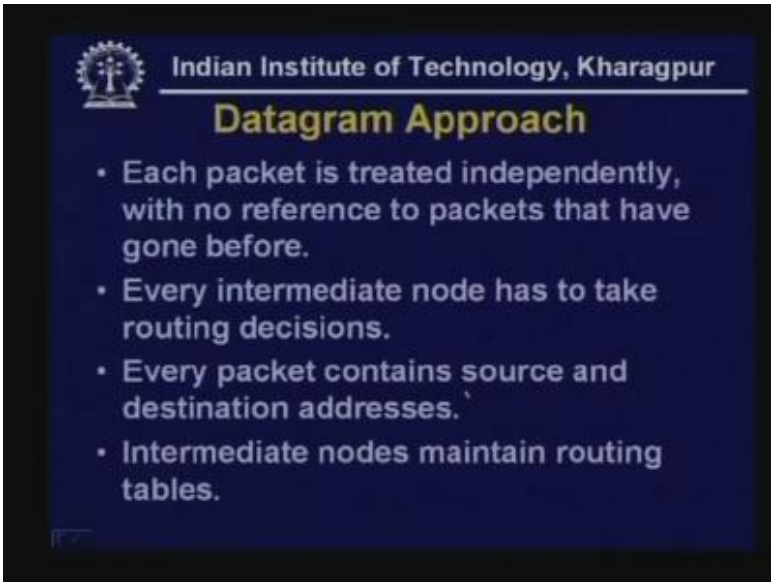

Here each packet is treated independently with no reference to packets that have gone before. In the previous case we have seen all the packets of the same message goes through the same route but here it is not so, each packet is treated independently as a separate entity just like what you do in postal system. suppose say five volumes of a book if you send through post office there is a possibility that if you send say volume I today volume II after two days volume III after three days volume IV after four days volume V after five days but at the destination there is a possibility that volume III will reach before earlier than the volume I or volume IV will reach before volume V. Similarly in datagram approach this situation can happen just like postal system. And here every intermediate node has to take routing decision because each packet is treated independently and there is no predetermined route as a consequence each node has to take routing decision. Hence there is an overhead on the node to perform routing decision.

However, this routing decision can be taken care of with the help of the source and destination addresses provided as part of the packet. So packet should contain the information about the source address and the destination address and based on that this routing decision is performed by the intermediate nodes.

Usually intermediate nodes maintain routing tables. However there are various routing algorithms routing techniques. We shall discuss about them in the next lecture.

Let us see how the datagram packet switching works. here as you see (Refer Slide Time: 23:49) a packet is going from 1 to 2 then two other packets are going that is 1 to 2 and the previous packet is going 2 to 4 and three packets are going 1 to 2, 2 to 4 and 4 to 5 so packets of the same messages are going. Also, there is no call request or call forwarding delay so each of these packets can go independently.

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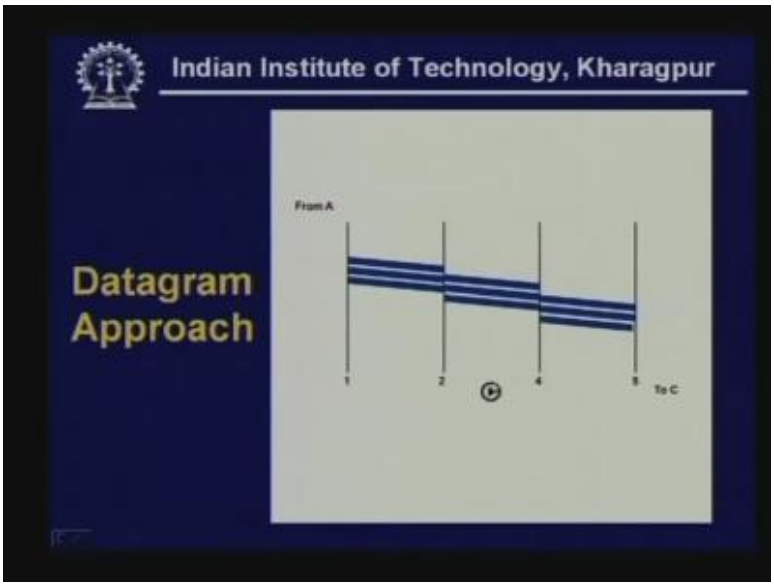

What is the advantage?

The advantage of this datagram approach is that call setup phase is fully avoided, there is no call set up time required like circuit switching or virtual circuit switching. So, for transmission of packets datagram will be faster. That means here it will take shorter time because it is more primitive and it is more flexible. It is quite flexible because congestion or failed link can be avoided so it is more reliable.

So here the advantage is in virtual circuit as we have seen each and every packet of the same message has to go through the same route but suppose a link fails in between in such a case the subsequent packets cannot be delivered cannot go the destination or if there is some congestion on one part of that node in such a case that packet delivery will take long time. This can be avoided in datagram approach because it is more flexible, each node can take the routing decision.

So, if there is any failed link if there is any congestion in the path of the packet then what it will do is it will simply send the packet through some other node so it is not necessary that the packet 1 of a message will go through a particular route and packet 2 has to follow the same route it can go through a different route and as a result different packets can reach out of border. Packets may be delivered out of order so this is a disadvantage.

That means since the packets are delivered out of order the receiver must store all the packets then they have to order them to form the message. The message has to be formed by combining the packets before it can be forwarded to the upper layer of the software. So the destination node will require much processing power and storage space so that all the received packets can be stored and then they can be combined to form a message and then it can be forwarded it to the upper layers.

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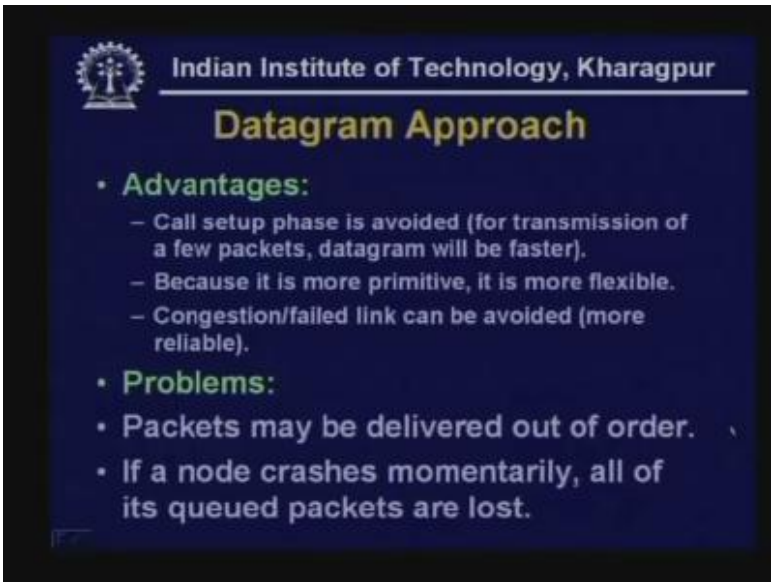

As a consequence if a node crashes momentarily suppose some packets are coming and it crashes momentarily that may lead to a problem where all of the queued packets are lost. So these are the two problems or disadvantages of datagram approach.

Let us now compare between the datagram packet switching with virtual circuit packet switching.

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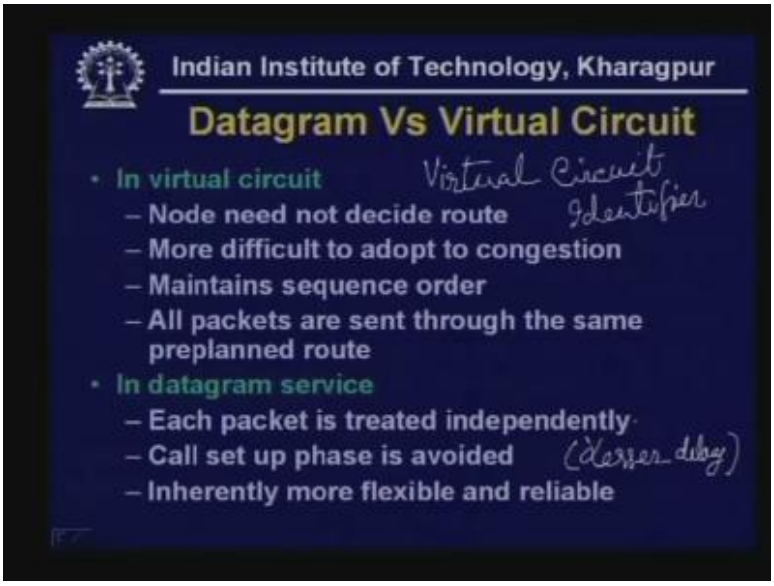

In virtual circuit the node need not decide route. The virtual circuit identifier generated while performing the routing using the call request and call acknowledgement signals used to perform the route so the nodes can be very simple in this case. It is no difficult to adopt congestion. If there is any congestion in the network it cannot really take care so it cannot adapt to the congestion because all the packets has to go in the same route whether there is congestion or not. It also maintains the sequence order.

As I mentioned all the packets are going to the same route so all the packets are delivered in the same order so the messages or the packets need not be re-ordered in the destination station. As a result it is advantageous that each packet can be forwarded to the upper layer without forming the complete message. The typical characteristic of the virtual circuit is that all packets are sent through the same preplanned route on the other hand in datagram service each packet is treated independently. We have seen that although they belong to the same message but each of them is considered as a separate entity and as a consequence for the purpose of routing each of the packets can be sent independently through different routes depending on availability of path, depending congestion, and depending on failure of links.

The call set up phase is avoided and as it is not required the delay will be less and it is inherently more flexible and reliable because it can adapt to failure and it can deliver the packet more reliably compared to virtual circuit.

Now there is a question about the packet size.

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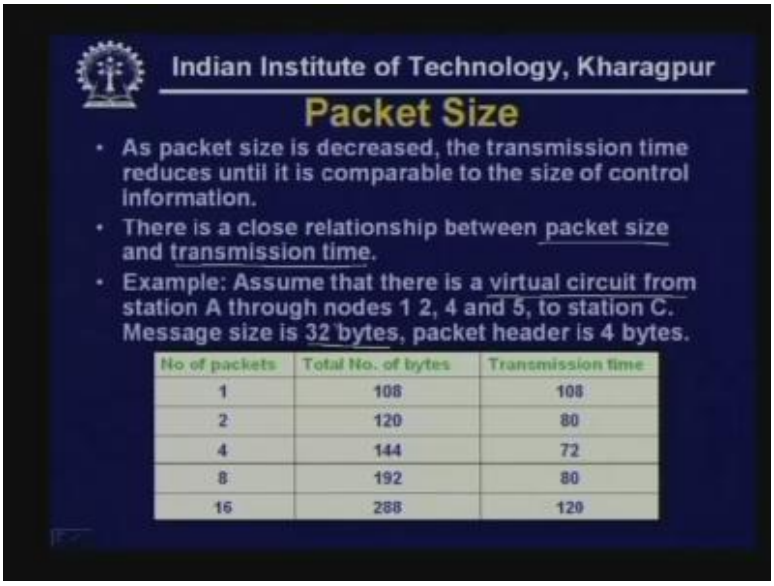

We have seen that a message is broken down into smaller size packets, the question is how small, should it be very small? Obviously that cannot be done. As packet size decreases the transmission time reduces until it is comparable to the size of the control information. So there is a close relationship between packet size and transmission time. So, as we have seen if the size of the packet is large transmission time will be longer and if the size of the packet is transmission time is smaller. On the other hand there is another important parameter. As I said a packet will have header and trailer. The header and trailer bytes will be the overhead. Thus if the size is very small then the overhead will be much higher although transmission time will be short.

Let us take up an example to illustrate the situation. Here let us assume that there is a virtual circuit from station A through nodes 1, 2, 4 and 5 to station C. So message size is 32 bytes and packet header is 4 bytes .so here wherever the number of packet is 1 that means essentially it is message switching and the total number of bytes that is being sent is 108. It is shown in this diagram.

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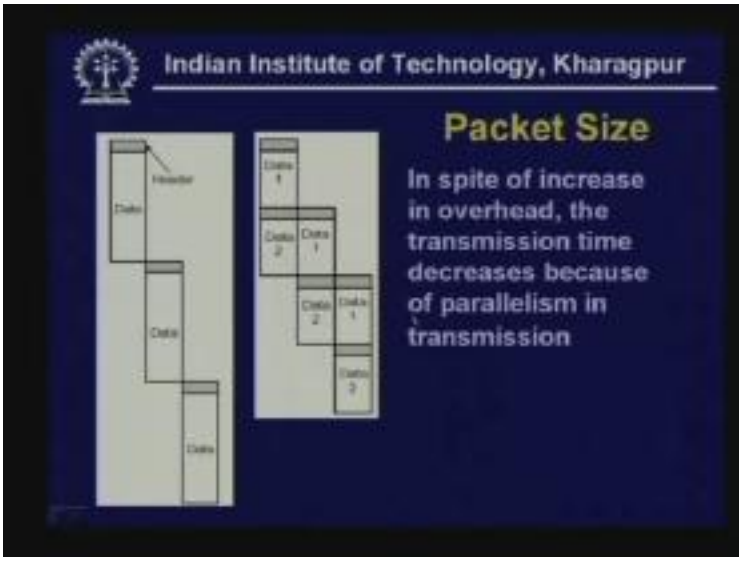

For example, this is the header four bytes and here is the data 32 so 4 plus 32 is equal to 36 then it will require three hops so 36 into 3 is equal to 108 hence that many bytes are to be transmitted which is the total transmission time. We are assuming here that there is no time needed for storage and there is no other processing time, the propagation time is very very small. So, assuming that propagation time is small transmission time will be the time required to send 108 bytes. So depending on the data rate this time will be different.

Whenever a message is divided into two packets as it is shown in this diagram (Refer Slide Time: 32:34) so here we see each message is divided into two packets so this is message 1, this is message 2 and this is message 3 or message 1 data 1 data 2, message 2 data 1 data 2, message 3 data 1 data 2. So here as we see the total number of bytes to be transmitted is 120. However, because of parallelism this packet and this packet is being sent simultaneously and as a consequence the total transmission time will be shorter. So here we find transmission time has been decreased although more number of bytes are transmitted through the network the overall transmission time the source to destination transmission time has reduced to from 108 to 80 that is the normalized value as we can say.

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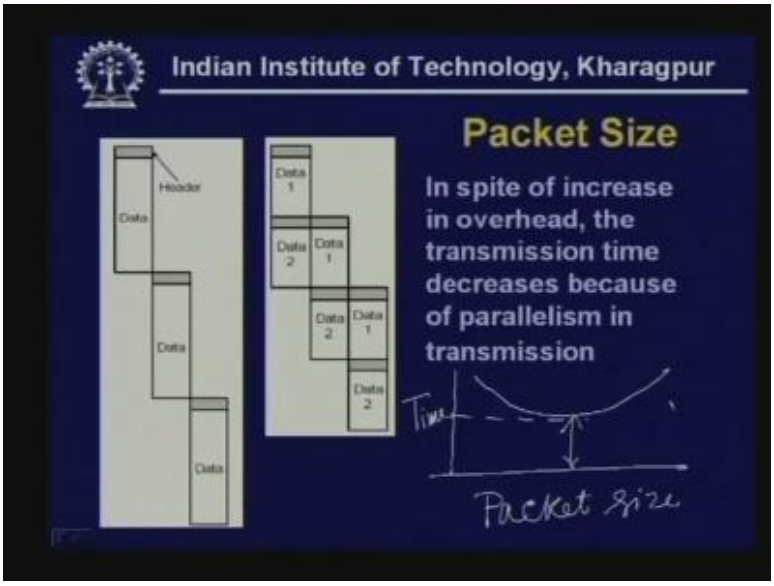

Now as we increase further that means if we divide into four packets we do it in the same manner then we find that the transmission time required will be 72. However, if we increase the packet size further like divide the message into eight packets we find that total number of bytes become 192. However, the transmission time is now increased to 80 because the benefit of parallelism is compensated and the higher number of bytes is essentially responsible or the overhead is responsible for longer transmission time.

Now, if it is divided into sixteen packets the total number of bytes to be transmitted is 288 bytes and the transmission time is 120. So what does it indicate? it indicates that if we plot a curve say on this if it is the packet size and here is the transmission time (Refer Slide Time: 35:01) as the packet size is increased and as you can see here for smaller packets it takes longer time for longer packets it takes also longer time so there is an optimum packet size when the transmission time will be smaller.

This is the transmission time. So transmission time is small for some intermediate value that is some value in between the maximum and minimum. So we find that in the previous example whenever the message is divided into four packets each of eight bytes then it gives you the minimum transmission time. So this clearly shows that packet should not be too large that is why we have come from message switching to package switching and the packet should not be too small then also the transmission time will be longer.

Now as I mentioned there is a possibility of external and internal operation that means whether we are using virtual circuit or datagram.

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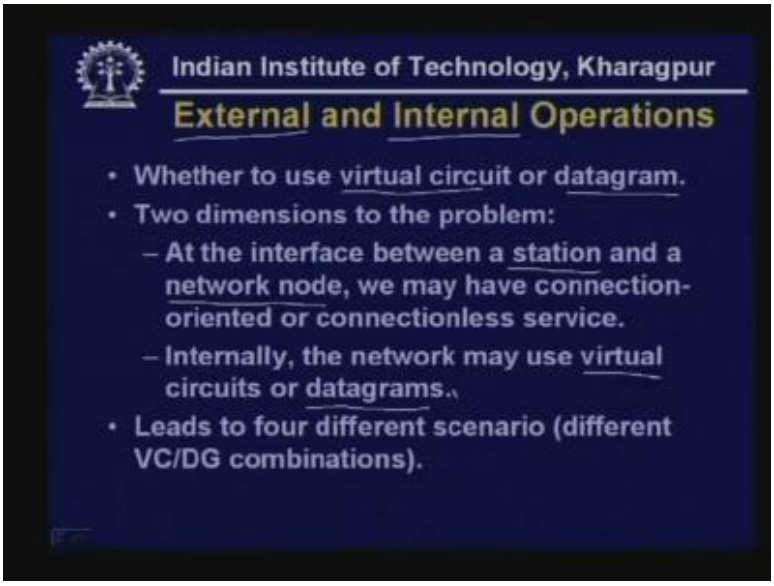

We have seen that in the network we have got stations connected to nodes and nodes are also communicated. So when the station is connecting to the node that is external to the switched communication network. On the other hand node-to-node communication is essentially part of the switched communication network. That is why external means from station to node and internal means from node-to-node so in both the cases it can be virtual circuit or datagram so there are two dimensions of the problem. At the interface between a station and a network node we may have connection oriented or connectionless service. Internally the network may use virtual circuits or datagram. This will lead to four different scenarios. Let us explain each of them one after the other.

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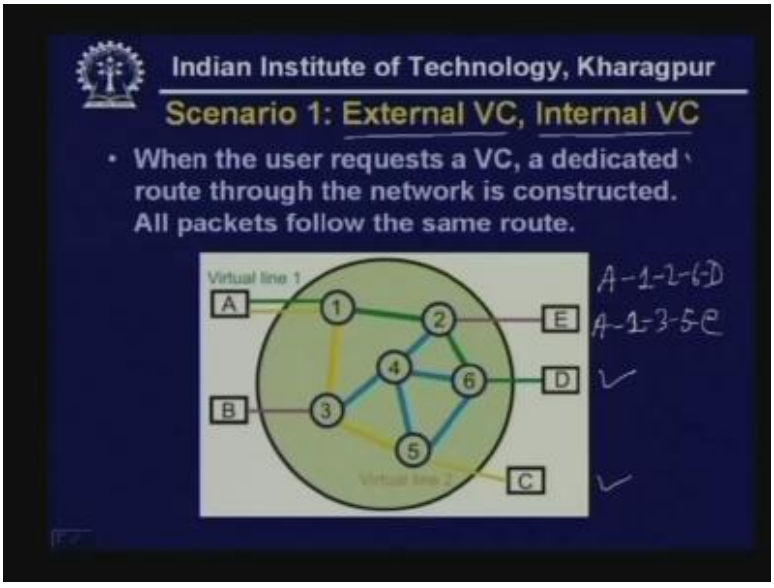

First one is the external VC and the internal VC. So in both cases it is virtual circuit. Whenever it is external VC and internal VC a virtual line or virtual path is created for example we are sending from 1 to D and 1 to C so virtual circuit is A to 1 to 2 to 6 to D. On the other hand another virtual circuit is A to 3 to 1 to 3 to 5 to C so these are the virtual circuits. It can be the other way also, say 1 to 2 to 6 to 5 to C that is also possible so there can be overlapping but here incidentally these are not overlapped.

Therefore we find this virtual circuit is created from end-to-end that is station to station so in such a case all the packets are originating from A for C and D. Obviously they will be having some sequence number. We will follow this route that the packets with destination D will go from A to 1 to 2 to 6 to D on the other hand all the packets with destination address C will go from A to 1 to 3 to 5 to C so follow the same route depending on the destination. Hence this is your external VC and internal VC.

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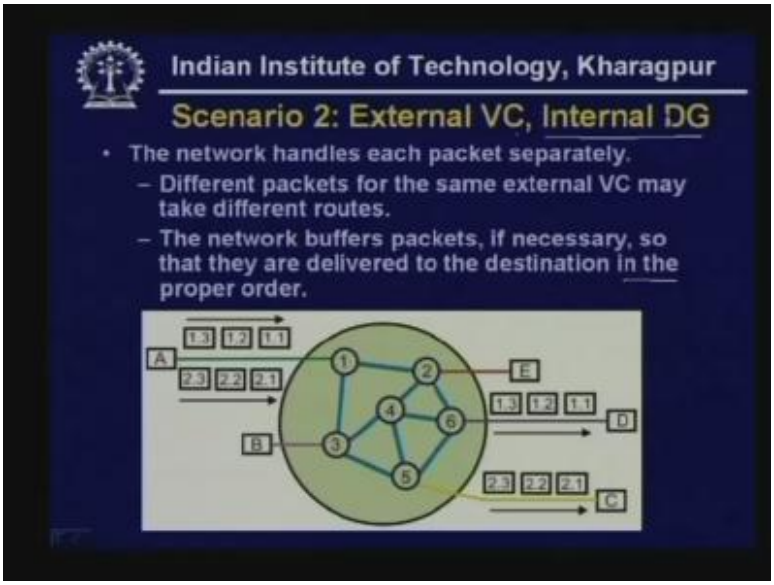

Then comes the second scenario. In this the network handles each packet independently. That means external virtual circuit and internal datagram. So the network handles each packet separately. Since the internal is datagram here the internal is a virtual circuit and since it is a virtual circuit it will be given in this order. However, since internally it is virtual circuit here at one point this packet can go in this route, the other packet can go in the other route and the third packet can go in a different other route. Similarly this 2.2, 2.2, 2.3 as it enters the switched communication network then it may follow different routes. However, the network buffers packets if necessary so that they are delivered to the destination in the proper order.

That means in this node these packets are buffered although within the network it comes in different sequence then they are delivered in order. As you can see in the same order it was sent from A and has reached the destination D 1.1, 1.2 and 1.3 because it was stored

in this node 6 and it was buffered here and then they had been ordered in the proper sequence. Similarly, the packets with the destination at C have been stored in node 5 and they have been ordered properly with the number 2.1, 2.2, and 2.3 although it may come from different routes. Hence this is your external VC and your internal datagram.

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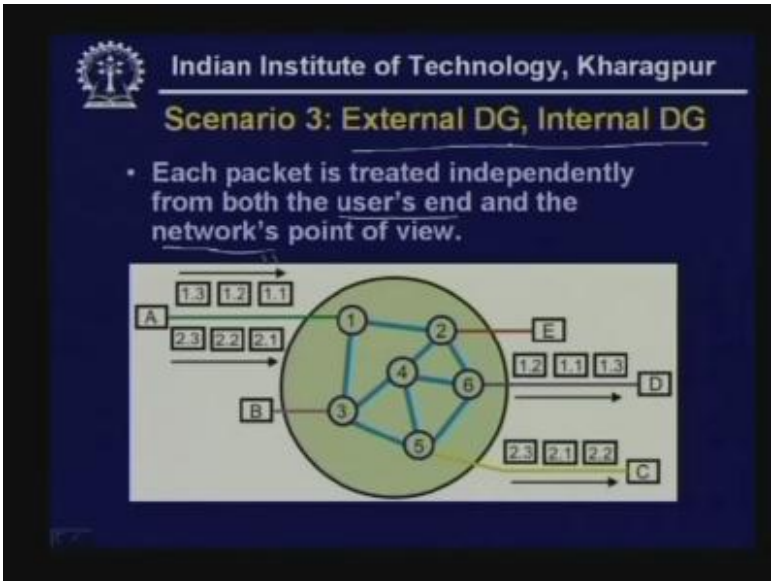

Coming to scenario three where it is external DG and internal DG, here the packets can be delivered out of order and once it is enters the network inside the network also it may go through different routes. Since it is external datagram the nodes do not buffer the packets or arrange the packets in proper order. The way it is received here is sent to the destination because it is external datagram. And as a consequence we find that the packets have reached the destination out of order. Although 1.3 was sent at the end it has reached the destination earlier then 1.1 and 1.2. Similarly 2.2 has reached earlier than 2.1 although it was given to the node one earlier than 2.2.

Therefore in both the cases the packets have reached out of order which is possible in case of external datagram and internal datagram. In both the cases we are using the datagram so each packet is treated independently both from users end and the networks point of view that is why the packets are reaching out of order from the destination.

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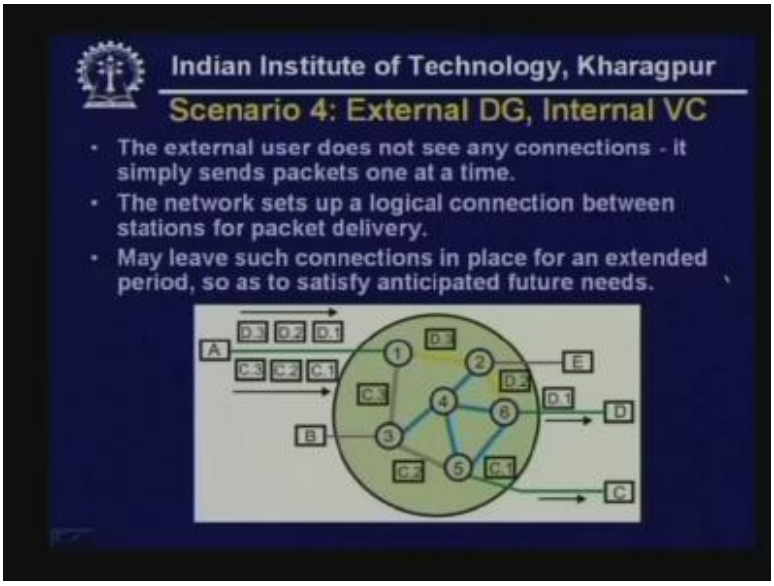

Now let us come to scenario four. Here it is external datagram and internal virtual circuit. So here you will find external datagram means here it can be given in any order, however as it is given in a particular order inside the switched communication network there is a virtual circuit and since the packet is given in order D.1, D.2 and D.3 As you can see (Refer Slide Time: 42:48) they are going through the network in the same path and following the same sequence through the same virtual circuit. So here also the order in which the packets are provided to the node in the same order it goes because inside it is a virtual circuit.

Similarly, if A to C also you will find that the C1, C2 and C3 have been presented in the same order to node A and you can see here that C1 has reached earlier than C2 than C3 and so on. Therefore this is the route that is being followed through the virtual circuit that is being created between node 1 and node 5 however externally it is datagram.

Therefore in all the four situations we have the external datagram and the internal datagram. We have seen how internal paths are created and the packets are delivered at the destination using external datagram.

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Now we have come to the conclusion part of the lecture where we are comparing the three techniques; circuit switching, datagram packet switching and virtual circuit packet switching because these three techniques have been merged as the key techniques used in switched communication network. Hence in circuit switching we have seen that a dedicated path is created from source to destination and that path remains valid and is used for sending the message.

In case of datagram packet switching no dedicated path is created and as we have seen each packet is treated independently. In virtual circuit packet switching also no dedicated path is created because in both these cases the paths can be shared by other packets or other source destination pairs. In circuit switching as we have seen the path is established for entire conversation. As I mentioned in case of circuit switching just like your telephone network whenever you dial and after you get the receiver successfully then the link is established and for the entire conversation the link remains established whether somebody talks or not.

On the other hand in datagram packet switching routes are established for each packet. We have seen that each packet is treated independently in case of datagram packet switching and as a result the route is established for each packet separately. In case of virtual circuit route is established for entire conversation that means for all the packets of the same message. These are the differences between these three.

Now let us come to the call set up delay. We have seen that the circuit switching has call set up delay. Call set up delay is necessary for establishing the path before any data transfer. In datagram packet switching there is packet transmission delay there is no call set up delay. In datagram packet switching we have seen that the packets are stored and then forwarded. If there is a big queue then there may be delay in transmission so packet

transmission delay is present. In virtual packet switching also there is call set up delay and packet transmission delay.

Then coming to the fourth point which is overload we see that in case of circuit switching overload may block call set up. That means if the circuit switched network is blocking type, if there is heavy traffic, for example, whenever it is implemented with the help of multistage cross bar switches in this case it can be of blocking type so in such a case when there is heavy load it is not possible to set up the link. Hence here even the path cannot be set up so data transfer is not possible.

But in datagram packet switching even when there is overload only the delay will increase but packets will be accepted by the network nodes and they will be stored in queue. However, in case of overload there may be long delay. In case of virtual packet switching overload may block call set up. Just like circuit switching there may be blocking in call set up. If path is not available then call set up cannot be done and also it increases the packet delay.

So if we can see here in the context of overload (Refer Slide Time: 48:06) the virtual circuit packet switching is not really very good because it may lead to blocking of call set up and also there is delay.

In circuit switching there is no speed or code conversion. Since all the data has to go through the same path the guaranteed bandwidth is provided big or small and there is no conversion in between, it is not possible. So if the sender is sending at the rate of 64 Kbps to the entire path then the data will go at the rate of 64 Kbps. On the other hand in case of datagram packet switching speed or code conversion is possible.

As I mentioned from the station to the node if it is an analog line using modem you can use suitable modulation technique. On the other hand from one node to another node it can be time division multiplexing and data transfer can take place at a much higher rate and code conversion is possible. So various encoding techniques and different speeds are possible in intermediate nodes which is true not only for datagram packet switching but also true for virtual packet switching.

Then the circuit switching technique gives you fixed bandwidth. Fixed bandwidth means once the network is set up it gives you the fixed bandwidth in circuit switch. On the other hand in virtual circuit packet switching or datagram packet switching in both cases the bandwidth can be dynamic because in different path you can have different speed and conversion times so it is possible to have dynamic bandwidth in datagram and virtual circuit packet switching. The only thing possible is since it is being shared that bandwidth will be dependent on the load.

In case of circuit switching we have seen there are no overhead bits after call set up. After the path is set up, for example, in case of telephone connection once the connection is established you can simply talk or sing and do whatever you want and there is no extra overhead.

On the other hand in datagram packet switching or virtual circuit packet switching, that is in datagram packet switching you have to do routing so you have to provide the source address, destination address, sequence number for control purposes and for using error detection and control you have to use CRC. Similarly that is true in case of virtual packet switching. in both the cases overhead bits are present in each packet not only in call set up delay but subsequently.

Therefore this gives you the comparison of the three switching techniques that we have discussed. One circuit switching we have discussed in the last lecture and in this lecture we have discussed the datagram packet switching and virtual circuit packet switching. So now it is time to review the review questions.

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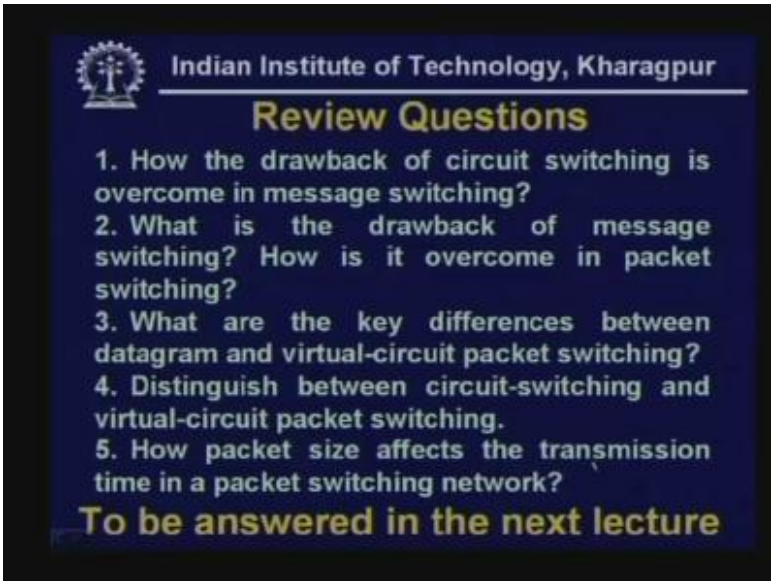

1) How the drawback of circuit switching is overcome in message switching?
2) What is the drawback of message switching how is it overcome in packet switching?
3) What are the key differences between datagram and virtual circuit packet switching?
4) Distinguish between circuit switching and virtual circuit packet switching
5) How packet size affects the transmission time in a packet switching network?

These are the five questions which will be answered in the next lecture.

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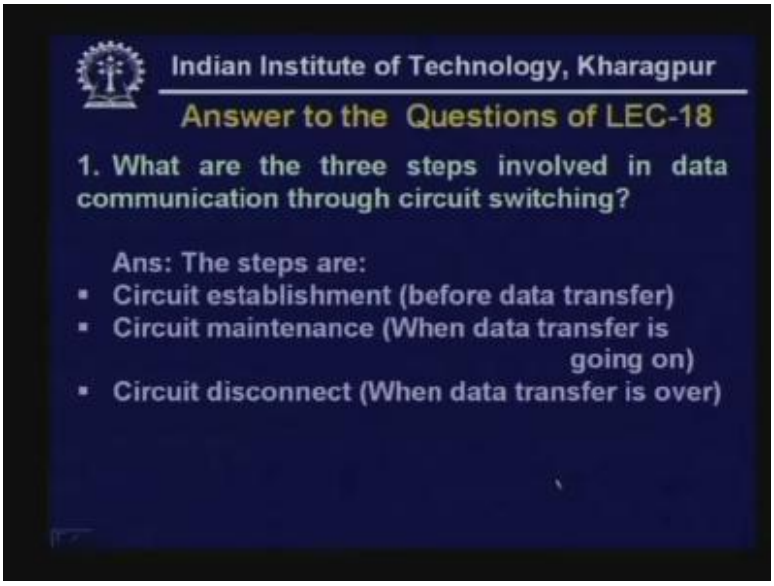

Let us see the answers of the questions lecture minus 18.

1) What are the three steps involved in data communications through circuit switching?
As we have there are three basic steps. First step is circuit establishment that means with the help of call request and call acknowledgement. So, with the help of call request and call acknowledgement circuit establishment is performed. Then we have the circuit maintenance. That is, during the data transfer when the data transfer is going on that circuit has to be maintained. Since the circuit has to be maintained for the entire duration the circuit maintenance operation has to be performed by using suitable signals. Then comes the third state that is circuit disconnect. When the data transfer is over that circuit has to be disconnected. So these are the three steps in circuit switching as we have discussed in detail.

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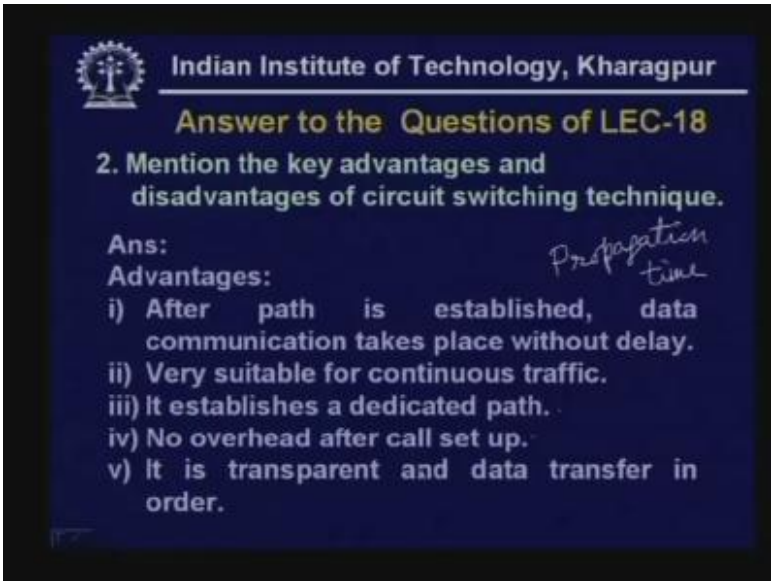

2) Mention the key advantages and disadvantages of circuit switching technique.

The advantages of circuit switching techniques I emphasized many times. The advantages are after path is established, data communication takes place without delay. Only delay involved is the propagation time. It is very suitable for continuous traffic. Obviously circuit switching is very suitable when there is a stream traffic continuous traffic is being sent from source to destination. Then it establishes dedicated path and there is no overhead after call set up. Also, it is transparent and data transfer is in order.

As I mentioned whenever a circuit switched network is established then whatever is sent reaches the destination in the same order. So if you send data for packet then the packets will reach in order, this is the advantage of circuit switching technique.

The disadvantages are it provides initial delay for setting up the call and as I mentioned it is inefficient for bursty traffic. Third disadvantage is data rate should be same because of fixed bandwidth. Fifth disadvantage is when load increases some calls may be blocked that means it may not possible to set up the link.

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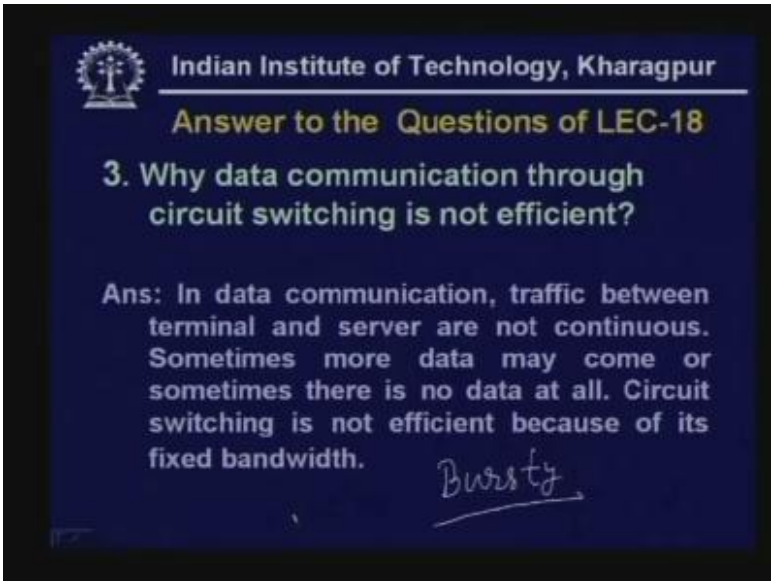

3) Why data communication through circuit switching is not efficient?

In data communication traffic between terminal and server are not continuous. Sometimes more data may come and sometimes there is no data at all. Circuit switching is not efficient because of its fixed bandwidth. Circuit switching provides you fixed bandwidth but in data communication because of the burst in nature or traffic this fixed bandwidth is not suitable rather dynamic bandwidth is suitable which cannot be provided by circuit switching that is why it is not efficient.

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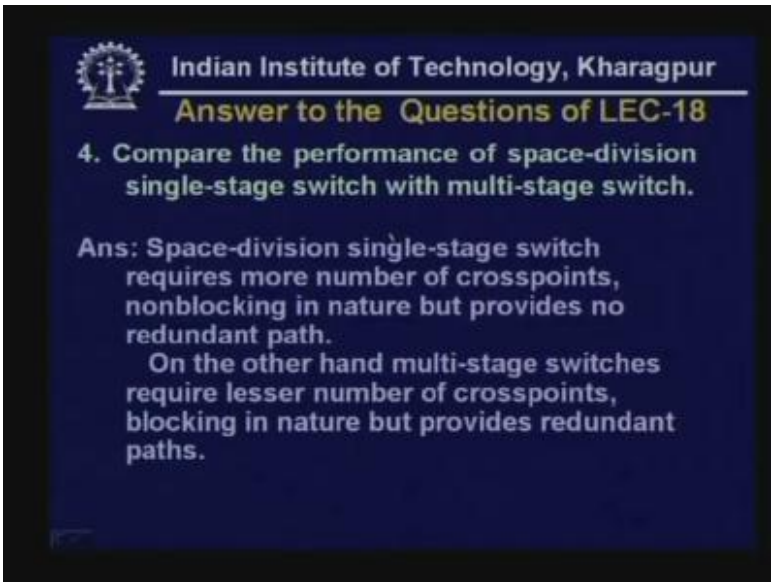

4) Compare the performance of space-division single-stage switch with multi-stage switch.
Space-division stage switch requires more number of crosspoints as we have seen. It is nonblocking in nature but provides no redundant path.

On the other hand multi-stage switches require lesser number of crosspoints, they are blocking in nature, and the multi-stage switches can be blocking in nature but provides redundant paths. Here you have got more crosspoints, (Refer Slide Time: 56:42) here the number of crosspoint is less, here it is nonblocking, here is blocking, here there is redundant path, here there is no redundant path. Thus there are advantages and disadvantages in both the cases.

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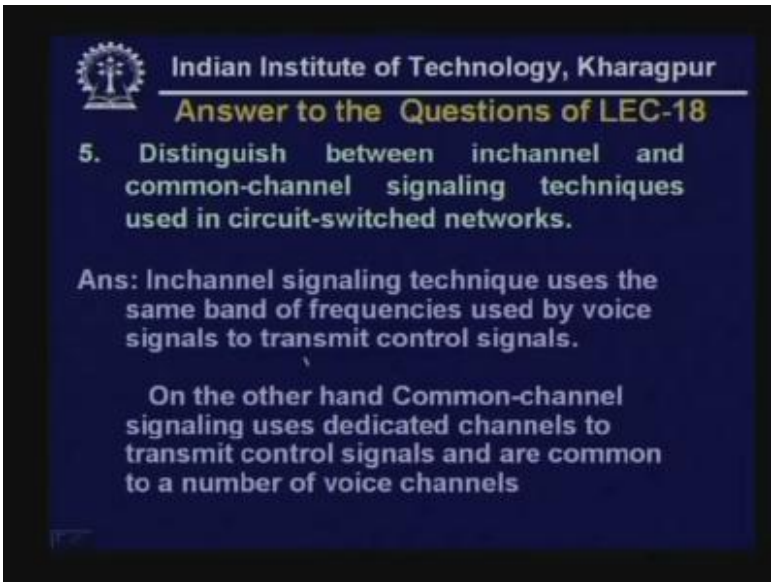

5) Distinguish between inchannel and common channel signaling techniques used in circuit switched network.

Inchannel signaling technique uses the same band of frequencies used by voice signals to transmit control signals. That means the signals can reach wherever the voice can reach. On the other hand common channel signaling uses dedicated channels to transmit control signals and this dedicated channel is common to a number of voice channels.

So with this we come to end of today's lecture. In the next lecture we shall discuss about the routing in um packet switch network, thank you.