Computer Networks and Internet Protocol
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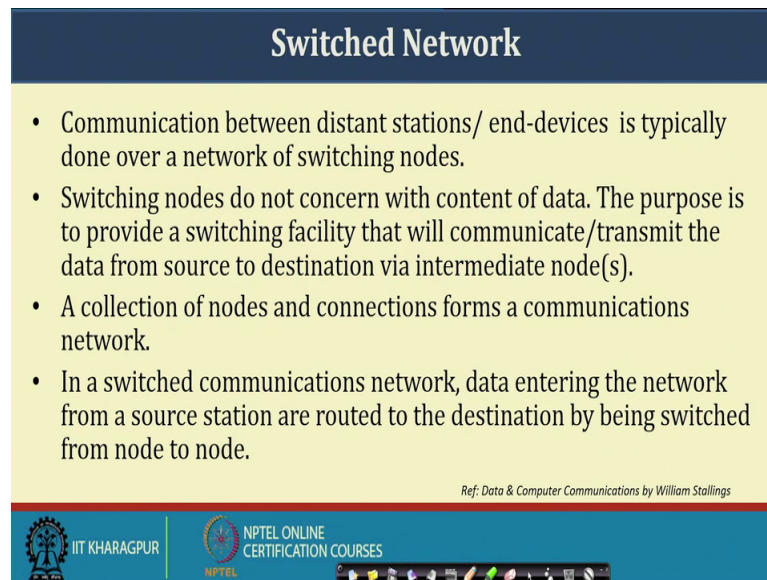**Indian Institute of Technology, Kharagpur**

Lecture – 03
Circuit Switching and Packet Switching

Hello. So, we will be discussing on the course on Computer Networks and Internet Protocol. So, today we will be discussing on the topic of Circuit Switching and Packet Switching, right. So, what we see when we look at a any network or any communication network it is a switch network. That means, if I have two nodes connected directly or two station. If we consider the station that is source station and destination directly connected then they can communicate to each other directly. But however, if they are in the some other network then what I require I need require to switch between different devices right network enable devices.

It is true for our telecom connection also when you are calling somebody it is some other exchange, then there should be some sort of a switching between these exchanges. So, it will be first the first the phone my phone is directly connected to my home exchange then there can be other trunk connection and go and so on so forth, it go on switching to the so long to the end, right. Similarly, for data network also when we look at when two station source and destinations are apart then there they are equal number multiple hob which are being switched, right.

So, what we try to look at is the preliminary of under the switching thing irrespective of what sort of network is there. It can be added a network, it can be a telecom network and type of things. So, what sort of switching techniques are there? So, that is our goal and will try to look more deep into the thing, when we actually see when we discuss about the protocols, right.

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So, what we are discussing about is a switch network. So, communication between distance stations or end devices is typically done over network of switching nodes. So, the so, intermediate nodes are switching nodes which allows me to switch to the things or in other words what we say, we find a path between the source and destination, right. So, from the source to destination we get a path and that is that is that path need to be established or and the your packets or the data or need to be information need to be transmitted from the source station to the destination through this switch network.

So, switching node do not concerned with the content of the data the switching nodes typically not concerned about the data the purpose is to provide a switching facility or a path between the source and the destination. So, they are not what data is being carried, right. Later on we will see that the different data has different type of necessities, right. So, a collection of node and connections forms a communication networks. So, this collection of nodes and intermediate connections forms error. So, the nodes and the errors or the connection between the nodes from the communication network that we already we known.

So, in a switch communication network the data entering the network from the source station are routed to the destination this by a being switch from one node to another, right. So, that is when we natural that if I have two nodes at for a part and intermediate set of connection and nodes. So, the data need to be switched or hop between one node to

another. So, couple of things one is that there can be multiple path, right; there can be no path, right. I cannot able to switch or there can be a path at times while the communication is on there can be one of the node fails or age fails and there can be communication problem right. So, what there can be the several issue; so to for this type of switch network.

Nevertheless, if we keep those challenges and issues little bit apart like will look at those thing that how still reliability whether it can be attained, if at all what are the mechanisms, but what we try to see is that how these a information or data from the source station or destination can go home one up to another.
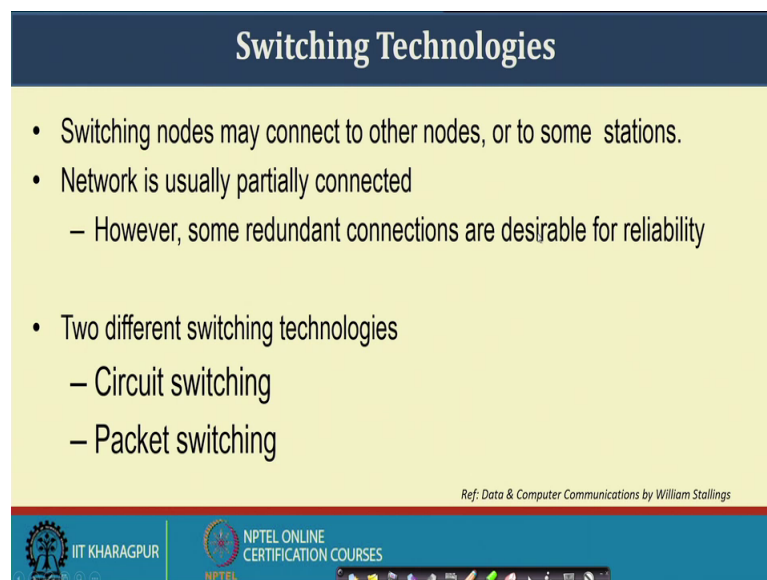
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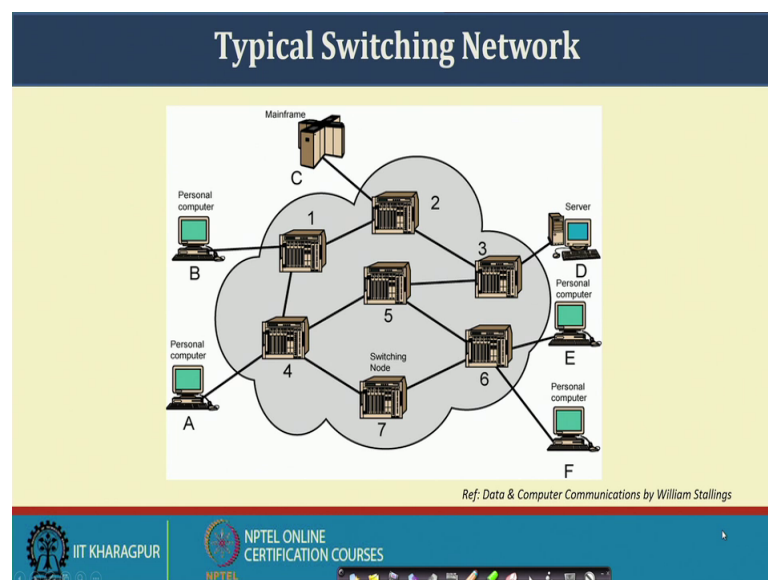
Now, typically this is a example of scenario from the switch network I am you can refer this data communication while Williams which I am also referring in this case. So, this is a switch network if you say, right. So, there are there are end systems right end systems there are there can be mainframe, server, personal computer variety of things, there can be mobile devices and so on so forth. So, if so, for them this is a switching cloud right or so, to say that some way if I am connected I will be able to communicate with the things, right. So, I am not bother about this or I am a user is not bother about this switching things, but if you look try to look in little depend to things.

So, there are different category of switching nodes. So, if a packets come if is want to communicate from B to E, so, B is this is the host or the connected switch or the

connected node in case of telephone we connect our nearest telephone exchange and then it decides in order to go to D which path is should follow, right. It can follow this path, this, this, this, this it can follow this path, sorry.

Or there can be other paths, right this, this, here, here, here and D right B to D. So, there can be different path. So, this intermediate switch is need to decide that which path there should be followed or there can be a predefine path. If I want to go from B to D I need to follow 1 4 5 3 D somebody defined it, right nevertheless this route or path need to be decided or need to be established by this switch network. So, this is the switching network typical switching network thing and there are the external thing which are going.
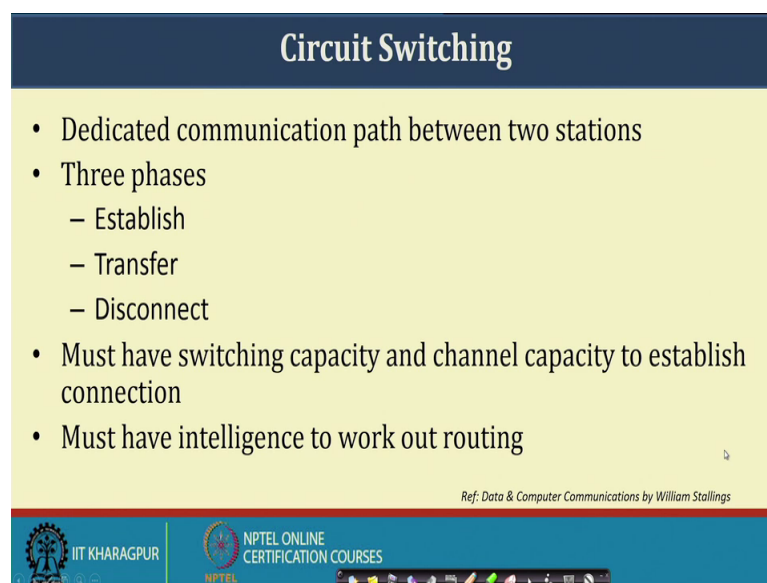
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Now, there are what are the there are different switching technologies? So, switching nodes may connect to other nodes or to some station. So, in this case what we mean to say there are two category of nodes what we say these are switching nodes and these are some other nodes right, these are stations. So, this is a terminology which are being followed here, but you in some places you will find that though all are considered as source node, destination node, it does not matter.

Network is usually partially connected like it is not that all are all routes are established. So, that it is the routes will be established on demand and type of things and however, there can be some redundant connections are desirable for reliability also, right. So, I can

connect that network like I can have only these path only this path could I have been there for B to C, but there can be there can be determinant path. So, that the reliability if 5 goes down in this case I could have gone through 1 2 3 D if 6 4 goes down also this path can be possible, right. So, there can be reliable path there can be multiple paths, right.

So, two predominant switching technologies are there circuit switching one is packet switching, right. At as the name suggest or roughly suggest circuit switching is establishing a circuit or establishing a connectivity between source and destination this is the predominant thing; whereas the packets switching says means that individual in the from the source station data can be divided into different packets which are being transmitted through this switch network to the destinations. We will try to see that both the things quickly.

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Now, circuit switching it is say that there is a dedicated communication path between two station usually there is a three phase things. So, for circuit switching I should have a dedicated path from the source station to the destination right. So, how I how a dedicated path can be established? So, there are how this from communication can be goes on? There are three phases; first one is a path establishment phase, then next is the transfer of data or information inform the source station to destination and the third one is the disconnection phase.
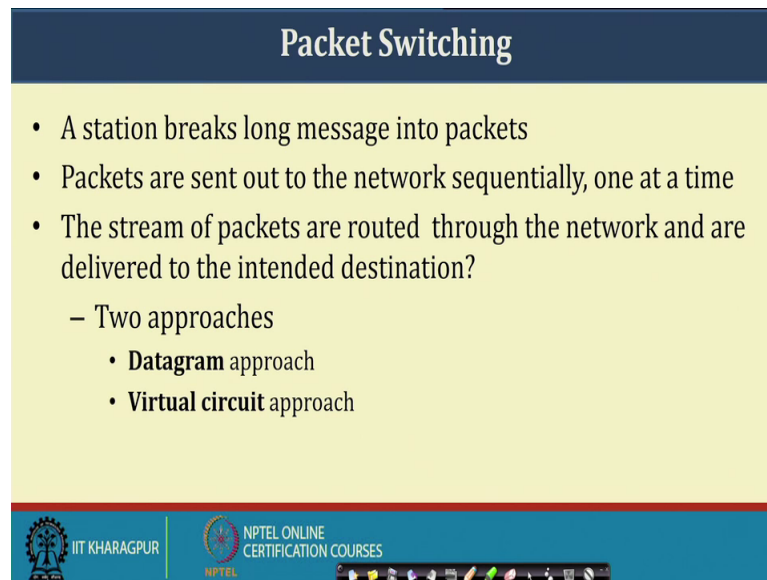
Where, in other words if you try to see this establishment phase is basically acquire the resource right suppose I want to talk to somebody so, I basically some other part of the world. So, I what I am trying to do is allocating the resources from my starting from my telephone connection to my nearest exchange and there are different other intermediate switching nodes. So, I am allocating the resources and interesting and then I can go on communication it can be bi direct communication or full duplex communication and once the communication is over then I tear down the connection or disconnect the thing right, in other sense I release the resources, right.

So, if there are there are possibility of ten connections can be establish if when I am one is already in the communication path. So, one is blocked one is already occupied other nine are available. So, there from there are another type of things come up that is blocking architecture and non-blocking architecture. So, if the connections if the all ten connections are block then we then they are when may not be the eleventh connection will get a that no connection available at this point of time to type of things; that means, it is a blocking things are un unblocking or unblocking means I have an half resources to handled that will look at this.

So, circuits switching must have switching capacity and channel capacity to establish connection, right. So, it should both have switching capability; that means, capacity; that means, that number of paths are free and not only that the data which is being carried by the channel that should have also the capacity to carry the information on the data. So, it should have both channel capacity and switching capability to establish connection must have enough intelligence to work out routing.

So, in some of the cases or many of the cases it should have a typical intelligence to work out the routing. So, if a B wants come to connect to D what should be the path intermediate through the switching node that need to be find out. So, it can be there can be some I will go to them routing algorithm some way of intelligence with work out the routing in some cases there can be dedicated path if B to D this is the path which is there, right. So, there can be dedicated path or algorithm. So, look at it.

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On the other hand, the packet switching try to say that the station if the or source station breaks the message into packets, right typically smaller chunks of packets now packets are now becomes a independent authority, right. Packets are sent out from the network sequentially one at a time, right. So, one packet after another it goes on the stream of packets are routed through the network and are delivered to the intended destination, right. So, these packets are pumped into the network and these go on the network and they are delivered at the destination.
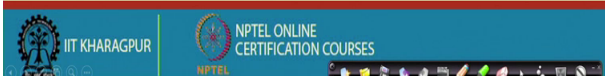
So, there can there are also can two approaches; one is what we say datagram approach where packets moves on independent things, one packet may follow say route 1, one packet may follow the route 2 and so on so forth. Nevertheless, there is the destination and not only that once this type of situation come you cannot guarantee that they will may reach sequentially, because the one say path one or the route one may be more congested then the path 2 so, the delay will be varying and so on so forth. Whereas there is another approach for virtual circuit approach where a virtual circuit is established between the source and destination and the packets moves in that particular path.

So, these are typically in case of a packet switching network.

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Now, again we if we come back to this our circuit switching discussion so, there are predominantly basic four type of thing type of approaches. One is space division switch, another is time division switch, another is TDM bus – the time division multiplexing bus and there can be combination of this type of things, right of these switching things. So, these are the four predominant stuff.

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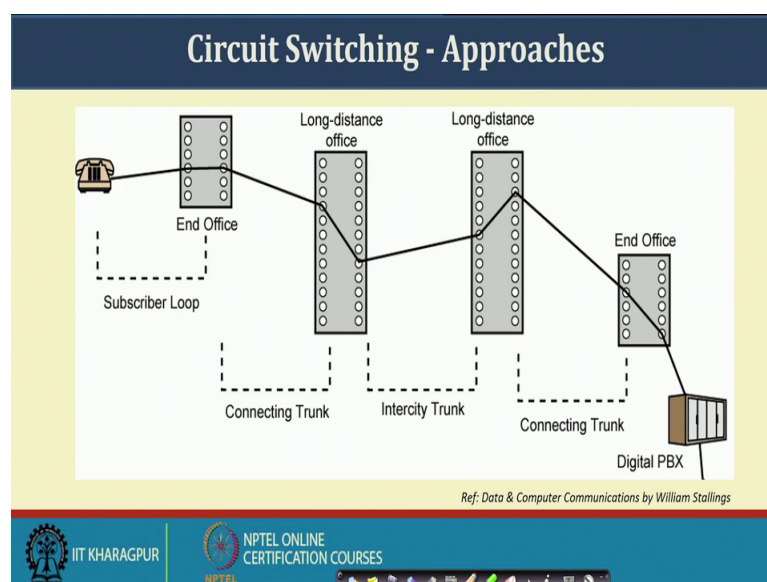
So, like a typical circuit switching network is like these that from the like, which is this is as we know that circuit switching predominantly for that voice type of connectivity. So,

the connectivity is like a telephone. If you consider a telephone then it is this first office or this near a takes change then a switch to that if there is a call from this A to destination B so, it goes on different switching circuit is circuit. So, line things are established. So, a path is established from the source to destination.

Now, this how this connectivity's will be established by at the intermediate things is decided by some protocols or some algorithms or some way intelligent techniques that it how things will be established, once established the this is dedicated for this things. So, that nobody can basically include into this path in other sense this path is reserved or the resources are reserved at different exchanges, at different with different type of what we say resource allocations schemes, right.

So, in this case it is connecting trunk then intercity trunk and then another connecting trunk and going on the things there can be multiple other many other hops based on the things, but nevertheless the whole path is reserved.

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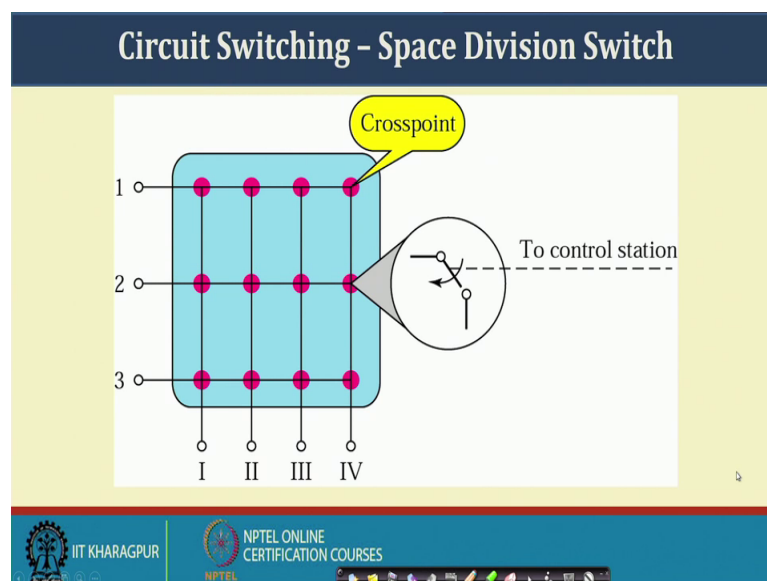
Now, if you just look at the space division multiplexing. So, or in the other sense there is what we say this sort of cross connect or cross points. So, one connects to 4 or 2 once to connects to 4 then I switch on this type of things. So, there is a controller or control station which basically tries to see that that which is connected. So, we have this sort of a matrix type of things. So, anybody can connect to the any other resources.

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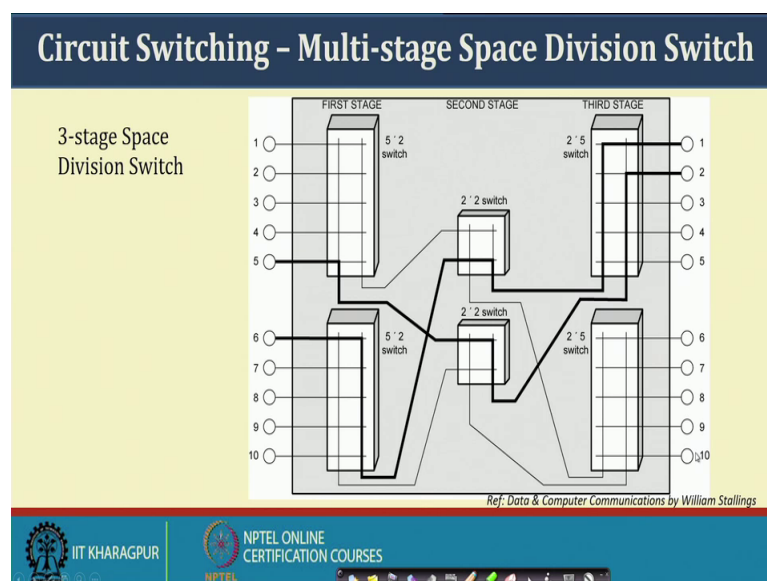
So, it is a that was a single stage it can be a multi stage thing where you have this sort of switches in different multi stage and in doing so, there can be optimization of this type of space division switching otherwise if it is a whole matrix everybody is connected to everybody by this things like here if you see there are 10 to 10 this side 10 node this at 10 nodes. So, in ideally we could have a needed a 10 cross 10 or if this sort of situation was there. So, around means 10 cross 10 or 100 nodes right like 3 cross 4 here we are having 12 nodes; whereas, here the number of points have much less.

So, that we can have multi stage switching and then I can have a we can established here established connectivity into the things, but this still the then we have to looked at to whether it is a becoming a blocking architecture or unblocking architecture, how many cans I am the state of each other and type of things. So, those consideration comes into play. So, there is a need of overall planning when we go for this type of switching strategies.

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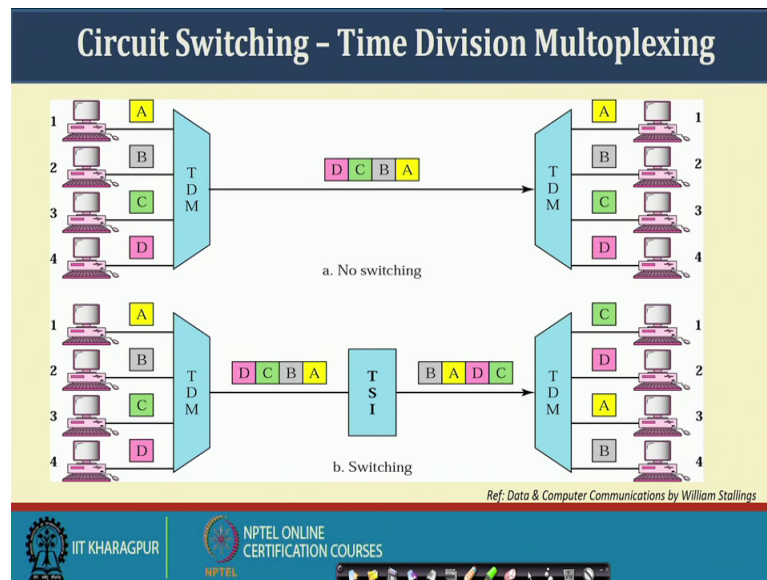
So, in case of time division sorry there was a type of in case of time division multiplexing so what we have? There is so, one is that no switching. So, I send it BCDA and it is received by BCDA, right or there can be some sort of a switching, right. I want to send from d the connectivity is that this has to go for to 4 has to communicating with 2 then I can basically here change this packets sequence. So, that there is a switching. So, BCDA DCBA now become BADC based on that where the packets should go, right.

So, these sort of things are possible there this is a time division multiplexing and instead of these we can have TDM bus or a mix of the different things. Nevertheless for all this purposes what we have there is a resources location a connection establishment is required then the communication and then a connection TDM process required. So, these are these things are required when we look go for a this sort of circuit switching the circuit switching on the other hand is extremely useful or extensively used for our standard telephone connections, right. All our exchanges etcetera are circuit primarily circuit switch network means this our traditional telephone connectivity's.

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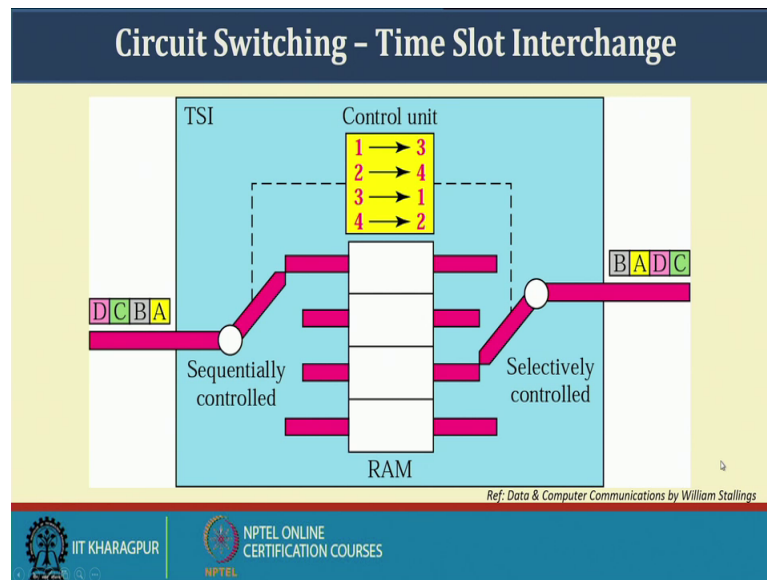
Like we are talking about time slot interchange, so that I can have a particular switching things which basically with a control unit based on the things we can interchange or select so, this is this can we select sequentially control and this can be a selectively control that which data is coming in the thing. So, there is 1 2 3 4 whereas, I can selectively control from where the date has to come out. So, in other sense I have I simulated switching techniques where things will be there.

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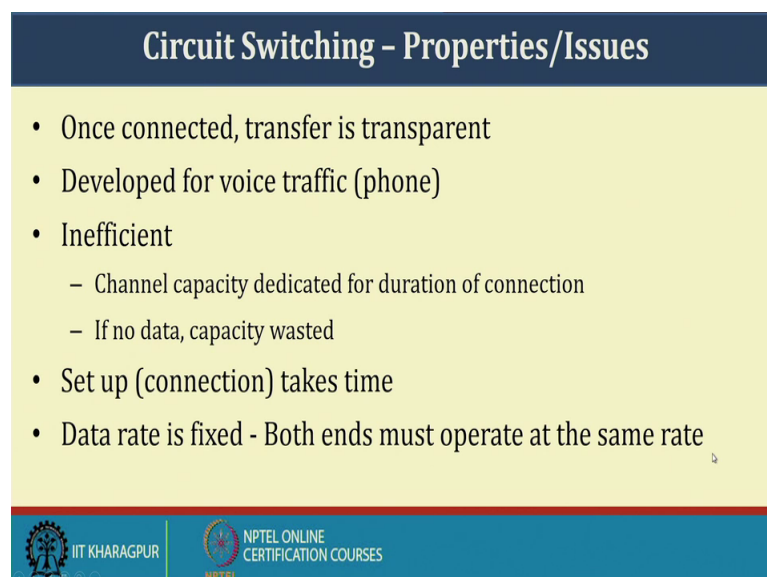
So, if you look at the switching circuit switching properties and issues first of all once connected it is some sort of a transparent, right. So, once connected it is the communication goes on in a transparent mode like what we do in cover telephone connection once it is connected our; I am talking about our traditional telephone connections. So, once it is connected over this exchange and trunks and type of things then it is transparent it is as dedicated line between the source and destination with appropriate resources, so that you can go on communicated with the things, right. So, this is a dedicated connection.

Secondly, what we have primarily develop for voice traffic. So, this was primarily developed for voice traffic or our traditional phone connections, right. In some scenarios or in several scenarios it considered to be not efficient, right. Channel capacity dedicated for a duration of the connection event a whole channel capacity which could have been properly multiplexed right, I could have done a frequency duration multiplex in it is said the or other type of multiplex it is fully dedicated for the things right or if even no data is there, the channel is wasted, right. Even if you are not communicating holding the phone or even not no data communication is not there the channel capacity is wasted no other party can we use the things. So, it is a dedicated the source type of things.

So, other things other issues are there at time there are set up or connection takes time. So, establishment phase takes time to have connectivity, because unless the connection is establish you cannot start communication. The basic assumption or basic condition is that there should be connection between the source and destination a full connection should be established between the source and destination, unless it is established then you can do.

Another things is the data rate is fixed both the ends must operate at the same data rate. As the as it is dedicated path and flowing the data flow is in a particular data rate, so, you source and destination should that it should be fixed and must operated the same date rate otherwise the some there will be accumulation of the data all over flow of data rate is come will come to play which will adversely affect the connection. So, the data rate need to be fixed. So, long as the voice things are concerned with fine right because first of all voice as this own means that communication has its own restriction with the devices at the end, secondly, the human interaction can handled this data rate and type of things, right if there is at all need this.

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Packet Switching – Basics

- Data transmitted in small packets
  - Typically 1000 octets (8 bit byte)
  - Longer messages split into series of packets
  - Each packet contains a portion of user data plus some control info
- Control info
  - Routing (addressing) info
- Packets are received, stored briefly (buffered) and passed on to the next node
 - Store and forward

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On the other hand, which is our primary interest for our data network is the packet switching. So, basically what it tells it is typically small packets the data from the station to station it difficulty source to destination typically broken down into small packet typically it is 1000 octets or one 1000 8 bits 8 bit packet or type of packet. The longer message split into series of packets each packet contains a portion of the data plus some control information. Now, here what is happening as we understand that it is as it is a packet and packets are moving independently so, the packet contains the data and some control information which helps it in get routed to the destination, right. So, there is one information.

So, what is the control information primarily for is basically further routing or addressing informations where I am going type of things. Or where to when I am it is moving and there are other informations which are there in the things when we particularly this discuss about this packets then will be discussing those things right like.

So, packets are received stored briefly or what we say buffered and passed on to the next node. So, once say intermediate node receives a packet it once a packet receive a intermediate switching node it is receive it, store it and forward it. So, typically it is that is store and forward mechanism receive it, store it and forward the packet to the next destination.

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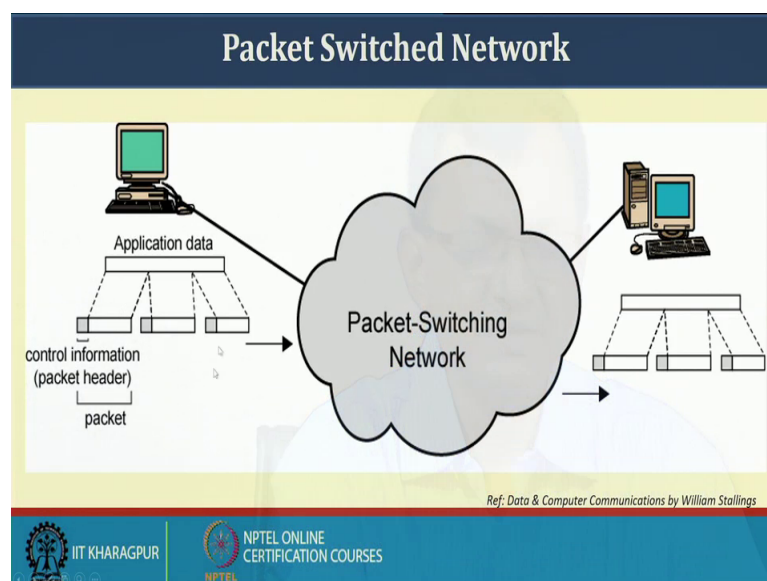
So, like this like the I have a application data from one in that is the packet switch network and I going to communicate to the other end through this packet switching network.

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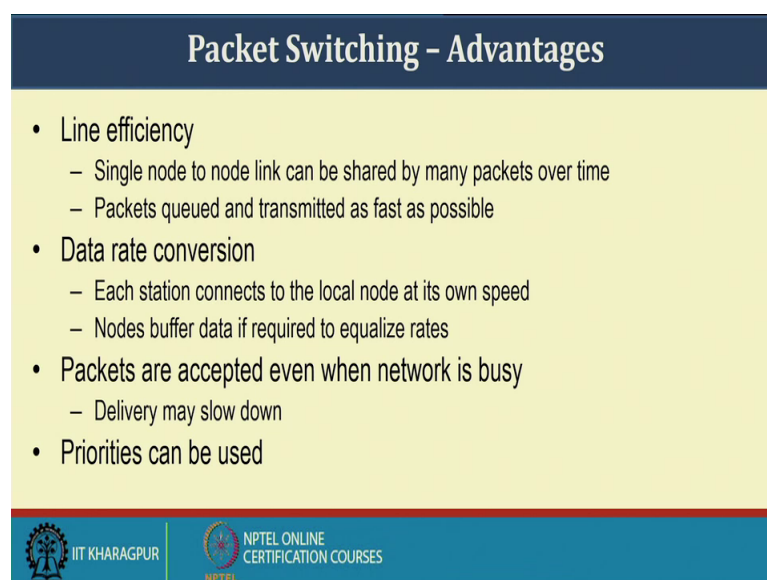
So, there are advantage first of all line efficiency single node single node to node link can be shared by many aspects of the many packets over the time because now it is no dedicated path, I have small packets. So, the single node to node as can be shared by different packets. So, packet queued and transmitted as far as possible, right. So, at

everywhere what we are doing you are receiving storing forwarding. So, it is queuing, queued and pass to the next destination on next hop as far as possible.

There is a there is a possibility or there is a what we say chance of data rate conversion right each station connects to the local node at it is own speed, right. So, nodes buffer the data if require equalize rates. So, as there is a store at forward type of mechanism the node has a option of synchronizing the speed, right. So, different communication between the different ages and different speed of different node may be defined. So, it takes and basically make a rate conversion on the things, right.

So, that is possible because this these are small packets and are handled independently and each other packets are accepted only even when the network is busy even when in the intermediate network is busy that the packets can be accepted and delivery may be slow, right which may be which will be difficult in case by circuit switch things if the network is not there it is basically a dedicated circuit we cannot do anything on the things. But here we can accept the packets and it will be delivered once the things are may be at slower rate or once the availability is there defiantly there are time limits over which we cannot it cannot wait and so on so forth.

Nevertheless, things will be there and another thing is that I can have a priority of the things right I can say that this sort of packets may give an priority or others can wait and type of things. So, privatization of the packets of the communication this is also possible.
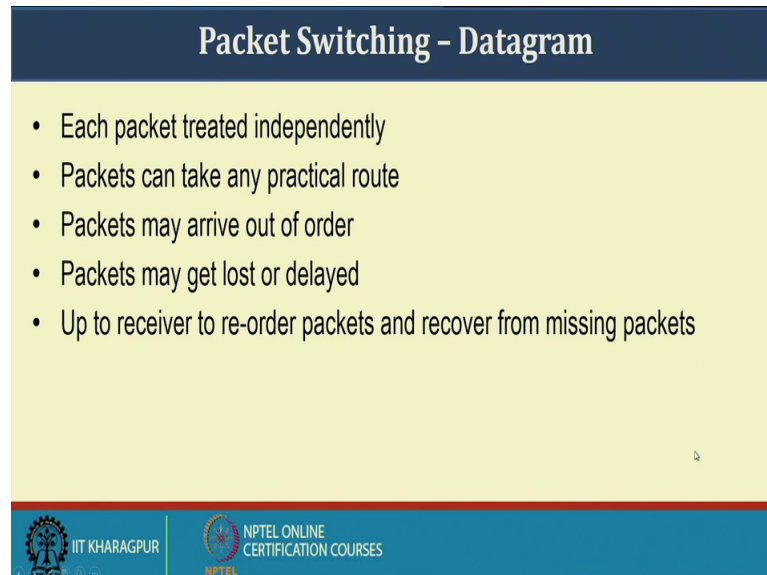
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Packet Switching – Techniques

- Station breaks long message into packets
- Packets sent one at a time to the network
- Packets are handled in two ways
  - Datagram
  - Virtual circuit

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So, again here also what we see there are two predominant techniques or two different ways of packet switch one is datagram another is the virtual circuit.

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Now, in case of a datagram each packet is treated independently. Packets can take any practical route. So, if there are in number of routes or say there are 4 routes 10 packets this anything can packets may arrive out of order it should not arrive it not need say any arrive sequence packet may get lost or delayed. So, once some packet may get dropped or delayed may not reach the things on time or even may not reach at all.

So, there can be other mechanism to look at it, but it there this is possibilities are there up to the receiver to reorder packet and recover from the missing packets. So, the receiver only sequence it and if there is a missing packet receiver can take appropriate mechanism like receive can request for return missing of the packet and so on so forth. So, there can be appropriate mechanism, but there as to be done by the receiver end.

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So, like typically if you look at a packet switch network. So, say 1 2 3 going towards this particular node can follow different paths and go on accumulating a go on this at the receiver end it accumulates or it order the packets in the things in a proper way.

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So, other technique for packet switching is the virtual circuit. So, preplanned route establishment before any packet is same. So, there is some sort of a route establishment is there call request and call accept packet establish connection hand shaking. So, there are there are request and call accept packets and type of things each packet contains a

virtual circuit identifier or VCI instead of the destination address, right. So, it is more decided instead of destination address it goes on locally like if I want to transmit here when an next thing I have to deliver which in turn think will be there right, but my routing is now somewhat table best, right. I at every node I say that if I received packet these VCI received from port number received at port number one will go to that with port number so on so forth.

So, no routing decision required for each packet once the packet is established, right. So, you do not have to individually you do not have to take the routing decision. So, it fallows the things. So, it can be times more efficient clear request to drop circuit. So, if there is a if the once the communication is over circuit may have to drop. So, there can be a some sort of a circuit means tear of request and it may not be truly dedicated path. So, the circuit once they are if there is disruption or some other reason there can be other circuits can be established. So, it is not necessarily truly dedicated path not only that the paths can be said by other virtual circuit also, right.

So, I can have some sort of a multiplexing on the path like here same thing what we are seeing at a thing is established and then it goes on communicating in thus particular sequence right, in case of a virtual circuit.

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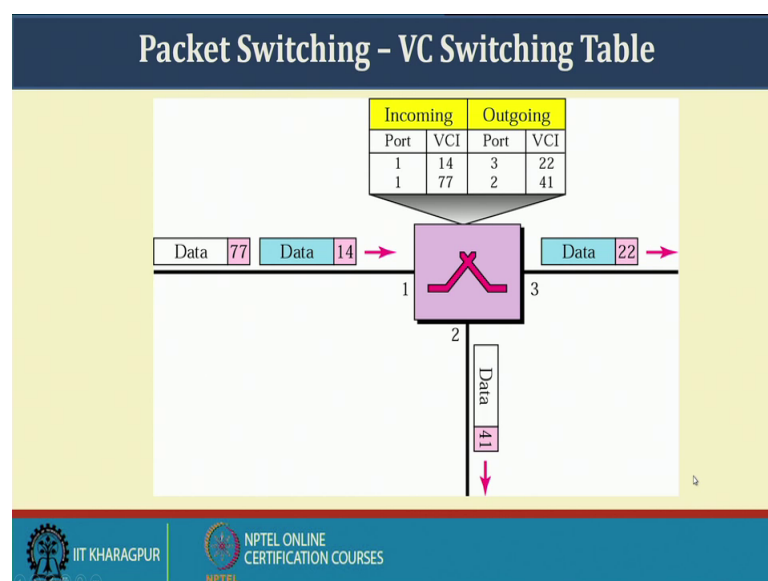
So, as we are discussing that it carries a VCI so, if we see if I have a switch here which receives a data 77 data 14 at port number 1, then it decides that if it receive 14 for one it

will push it to port number 3 with a VCI 22. So, this switching things are there and if you see this is interestingly localized. So, I do not have to have a huge number etcetera also because it is it is only localized like I can have other hops where some other VCI 14 can be there theoretically right. So, this is this way it goes on switching. So, if it is a one port from port 1, VCI 77 it will go to port 2 with VCI 14.

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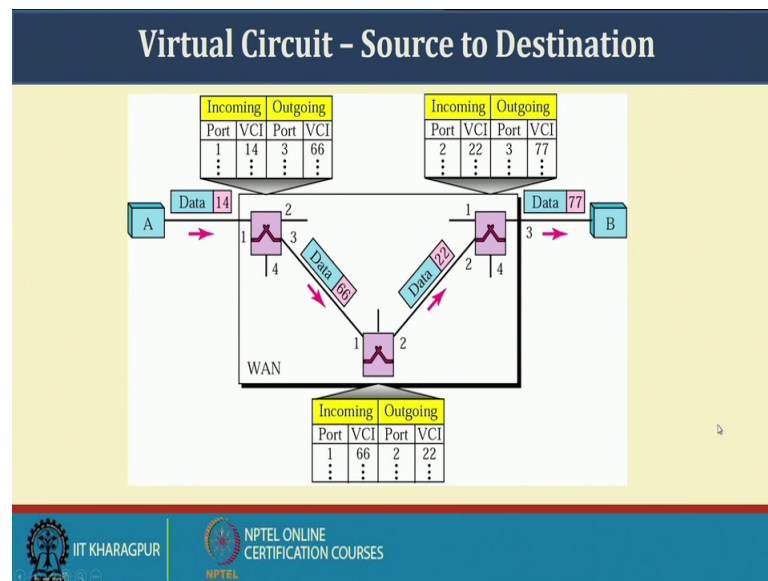
Now, this so, if you if I have a larger scenario. Then I can have something some paths to communicate, right. So, it is for here it is one 14 coming going to three 66, this is port 3 packet VCI 66. If 66 is established at port 1 and then it will be push to port 2 at 22 with VCI 22 it receives at port 2, sorry port 2 with VCI 22 and push it 2 port 3 to this. It goes from source to destination with different type of hops and if you see this table allows me to establish they route between A and B, right.

So, this is a virtual circuit established it data flows in this particular direction.

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So, if you try to look at the packet switching virtual circuit by the datagram. Virtual circuit network and provide sequencing and error control as they are having a establish path. Packets are forwarded more quickly, no routing decision is required for individually at the packet level. Less reliable loss of node loses as the all the circuits to that particular node and because a particular node can have more than one circuit which is established. And if that particular node is faulty or not working then all the circuits to the node is lost it goes for not only reliability it also have extra cost of reestablishing the country circuit and transmitting the things.

Whereas data gram one has these has no call setup. So, each packet moves independently better if the number of packets is less if a use volume of packets are there then there are lot of consider more flexible routing can be used to avoid congested part of the network, right. So, I can we can have different routing things. So, that if there is a congestion then the other packets are routed to some other part of things etcetera. So, that is known effected or better routing strategy is can be there.

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So, if we try to look at circuit switch and packet switched network or packet switching network, right; so in case of circuit switch a bandwidth is guaranteed right. So, that you have a establish connectivity and your data flow through that so, the bandwidth is connected; whereas, in case of a packet switch bandwidth dynamically allocated as needed as need base is right or as and when needed type of things. So, that is that is being allocated as there is a need, right. So, it is not guaranteed bandwidth you may. So, happened that the bandwidth availability is not there or when you need because you are not preoccupying the resources. So, while communication you may face problem of dropping of packet etcetera lose of packets circuit capacity not reduced by other network traffic.

So it is not, as it is a dedicated circuit the circuit capacity once allocated or once establish are dedicated for this source and destination whereas, may have concurrent transmission over physical channels, right. In case of a packet switch is may have concurrent transmission over physical channel so, once physical channel there can be number of things.

Circuit cause independent of the amount of data transmitted right resulting in wastage of bandwidth. So, whether I if I established a connectivity whether I transmit or not it is a dedicated connection. So, I pay for it, right. So, in other sense there can be effectively there is a waste of bandwidth whereas, there is more effective and better performance

because there is no such sort of a blocking the channel even if you not communicating, but they may have some delay and congestion because of its typical characteristics and at we see that this type of circuit switch network is more amicable for voice communication, right.

So, it is more amicable for voice communication where as this sorry this circuit switch network and where as the packet switch network are more amicable for data communication or how data is communicate between the things for our computing this particular course for computer network and internet protocols; we will be primarily looking at this sort of a packet switch network, right where this nodes or the packets are independently moving from the source to destination and in number of cases this is a unreliable, best of our service, it depends on how things are there.

If you want to have a liability on the things you should have a different mechanism of the things that we will gradually study on in this particular course when we go on more depend to the things and specifically look at different protocols, their characteristics and type of things. So, what the primary objectives of this particular lecture is to that to bus up that already most of you may be knowing that packets switching or circuit switch network. There are several other things we means and here. So, we have overview of the things, but we primarily now look at that packet switched base things what we go on subsequent things, right.

So with this, let us stop today and we will continue our discussion in subsequent lecture.

Thank you.