Computer Networks and Internet Protocol
Prof. Soumya Kanti Ghosh
Department of Computer Science and Engineering
**Indian Institute of Technology, Kharagpur**

Lecture - 46
Data Link Layer-Overview

Hello. So, we will continue our discussion on Computer Networks and Internet Protocol. Today we will be discussing on Data Link Layer rather will be having a series of lectures discussed on data link layer. So, as we have seen that data link layer is the one of the predominant layer in both ways OSI TCP IP protocol stack, it is in the level 2 or layer 2 in the stack.

And as we are coming in a top down approach, so we have discussed on application layer, then transport related transport layer, network layer then now the data link layer and then we will go for the physical layer. In some of the literature or some of the references you will find that data link layer and the physical layer added together because, there are a lot of specially the I triple E 802 stack consider them together.

So, there is there are both way it is there. So, what we will see we will try to look one after another, but no harm in looking them together also.

(Refer Slide Time: 01:26)
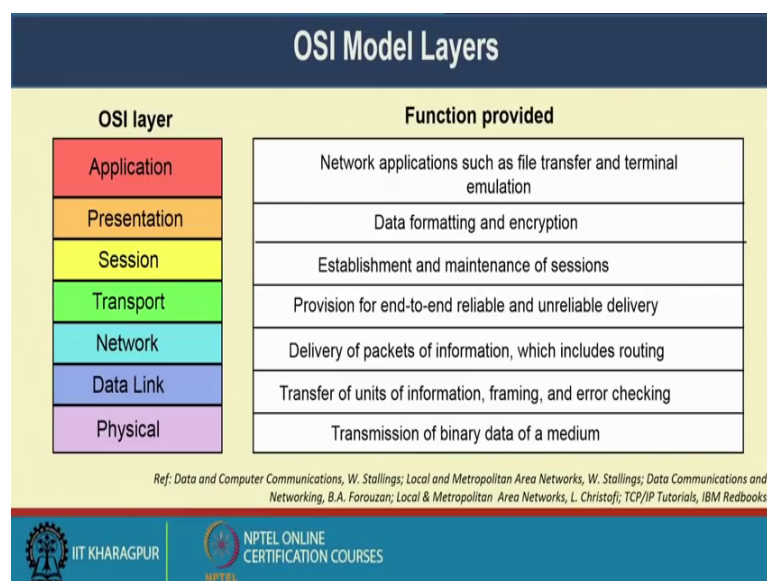
So, we will just come back to our that slides which we have seen much earlier at the beginning of the lecture. So, if you look at the OSI protocol stack, these are the 7 layers and if we refer to this data link layer, the transfer of unit information framing and error checking or error and flow control is one of the major aspects. And down the below is the physical layer which is basically transmission of the binary data through the medium. So, this is our protocol stack ok.

(Refer Slide Time: 02:02)
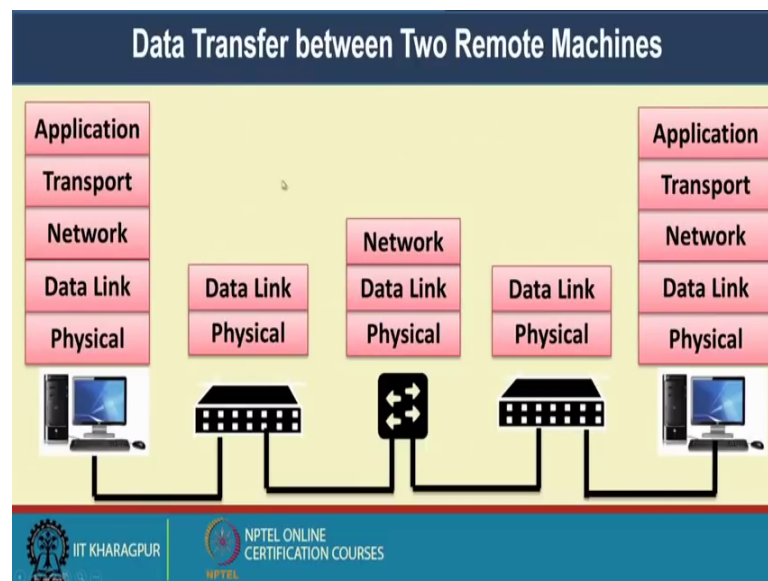
So, and if we again if you recall, so if we see that they if 2 end systems a and b are communicating, so a application say email application or (Refer Time: 02:15) applications when it goes through, it goes through the stack and finally, push through this physical and then goes to this is a layer 2 switch, there is a layer 3 switch or a router again a layer 2 switch and go on.

There can multiple hubs of the things finally, it is another application that if it is the email, there are this email application going on, this PRA applications talks to each other or any applications going on PRA applications over the network talks to applications talks to each other.

Now, one as we know or we have already discussed that intermediate layers, intermediate these devices are open up the layer or the packet up to which it is enabled right. In other sense, this is the whole stack of things like applications data pay load goes to the transport layer as a pay load then the with the header etcetera goes to the network

layer as a payload then, the data link layer physical layer and when it is going coming to the layer two switch which understands of the data link layer it is it opens up to the data link layer and see that where need to be forwarded, goes to the this one and go on so long, it is not reaching the end system right. So, that is allows us to achieve inter operatibility right.

So, we can have intermediate switches and routers of different this is (Refer Time: 03:45) or layer 1 to layer 7 capable devices which open up the packets up to this and check that where things to be which to be moved. Couple of things we want to put into want to discuss or just to recap that when we look at a network layer, so it divides the network right like, IIT Kharagpur is a network then say some other say IIT Bhuvaneshwar, IIT Delhi the other pre universities and type of things if we look at the academic institution these are the different networks and type of things.

So, there is an router which goes on the things right. Also we have discussed about autonomous systems and traffic moving from one autonomous system to other. Nevertheless, if you see where if we want to send some data there should be a physical connectivity; it can be wired, it can be wireless, it can be something line up sight or it can be through satellite or something right, but there should be a medium by which the transmission should be done right.

So, whatever you want to transmit, it need to come to the down level right. So, if we look at that if we look at the last 3 layers, so if we look at the at the network layer it divides the network or in other sense, as we have discussed it divides both the collision domain and the broadcast domain right. The broadcast is not hard by the other side of the network neither the collision things are there.

If you look at the layer 2, it basically in the same broadcast domain, but nevertheless they divides the collision domain. So, it gives us a better efficiency. If we look at the layer 1, then it is in the same collision domain and broadcast domain, so the efficiency is much less. So, what we are trying to primarily focus on this couple of or series of lectures is that what are the different things what we go to the layer 2 type of device.

So, just to again remind you that if a router is sending a packet to another router right, the logically it is in the network they can it has to find out, but nevertheless finally, it has to come to this layer 2, find out that layer two addressing scheme and go push to that

particular other inter phase of the router. So, even 2 layer 3 devices when you have to communicate, it has to come down to layer 2, look for the layer 1 for the physical media and get the things transmitted right.
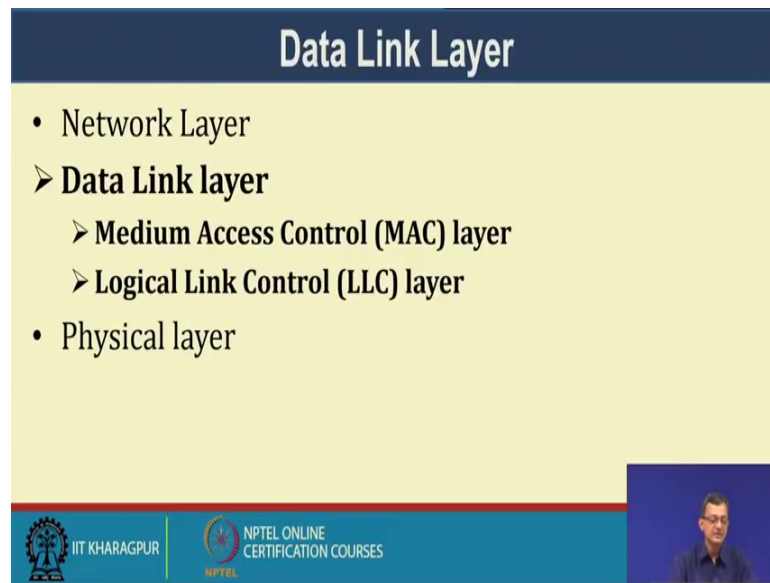
So, it plays data link layer is inevitable as in some references we have told, we will be again discussing those things. There is a protocol called address resolution protocol ARP by which, I this is a intermediate protocol what we say that between a layer 2 and layer 3 which you given a IP address it find out what is the layer 2 address or the MAC address at the MAC address, so that it can be transferred to the next thing right.

(Refer Slide Time: 07:01)
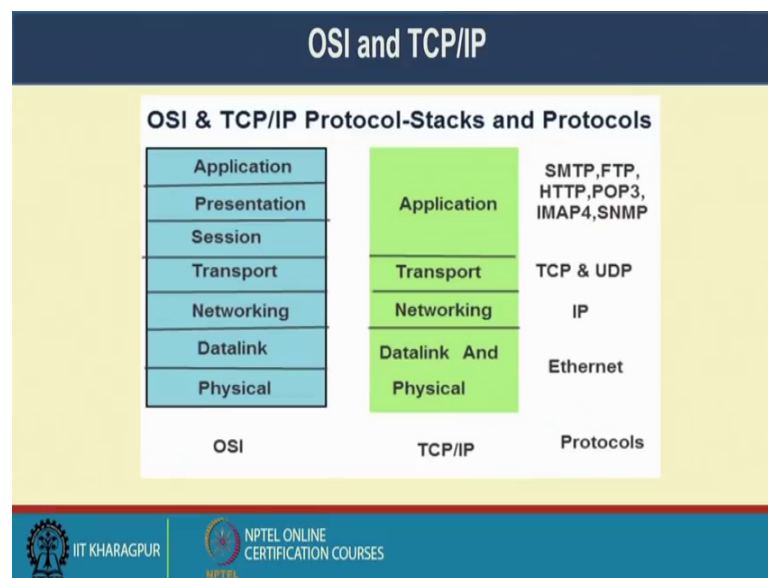
So, if we look at the protocol stack, so this data link layer and physical layer sometimes considered as a combined layer, where the predominant protocol is the Ethernet. There are other protocols, but the predominant protocol here is the Ethernet protocol.

(Refer Slide Time: 07:26)

So, if we see that the data link layer. So, above it is the network layer, down is the physical layer again I am repeating some of the configuration we take that data link and physical layer together. And if we look at the data link layer little deep, so what you see that it has 2 sub layers; one is MAC sub layer another is LLC sub layer, that is Medium Access Control sub layer and Logical Link Control sub layer.

So, one sub layer that MAC is primarily for accessing the media that how the access mechanism should be there and logical link control is more of it defines the service access point with the upper layer. In differentiating these 2 allows the thing that there are different MAC mechanisms or protocols can be used for a given LLC and type of things right. So, this is 2 aspects of the manageability.

(Refer Slide Time: 08:21)
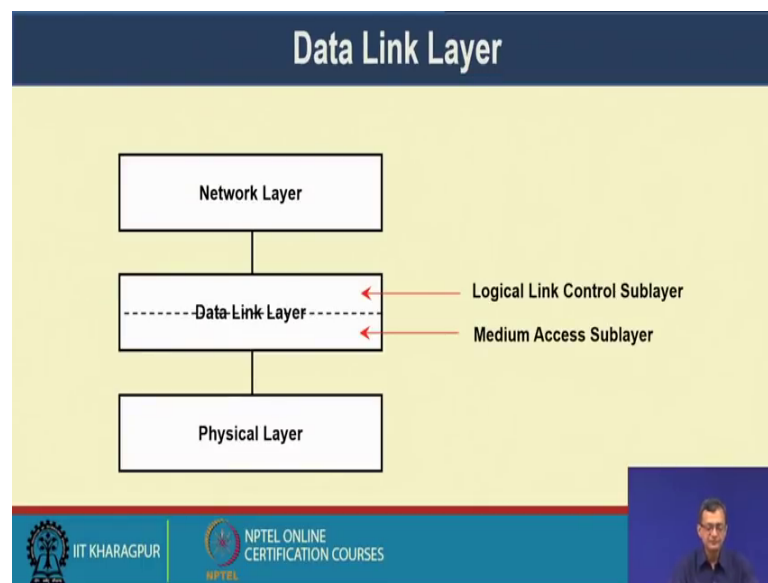
So, like just to pictorially show you, so network layer, so this LLC sub layer and the MAC sub layer right and this is the physical layer. So, they take care of that connectivity with the upper layer and the down layer, means layer at the bottom of the things right. So, again just to repeat, we have 2 applications which at it may be running at different systems of the same systems for our consideration we say that over the network it is running. And then these applications how they will transmitted will be through the transport layer. So, transport layer identifies the process of the 2 things.

So, we require the IP address (Refer Time: 09:05) port, what we have discussed while discussing on the socket forming a socket connections IP address and port. We have then the network layer, which find out the logical connectivity with the help of the IP address.

We have that data link layer, which is a hub to hub connectivity right, that every hub the next data link layer address need to be resolved or the MAC address need to be resolved, packet need to be passed to the things like if I have a n number of routers in my path then every router i to i plus 1, the address of the router i plus 1 need to be resolved. Or find out that what is the MAC address or the layer 2 address or sometimes known as the hardware address use this traffic to the next hub and it goes on the hub by hub connectivities. Or as in commonly say, that it is within that local area network connectivity, it is in the same broadcast domain, but the collision domain where is a different collision domains.
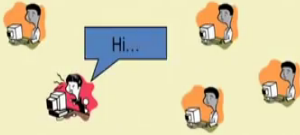
(Refer Slide Time: 10:10)
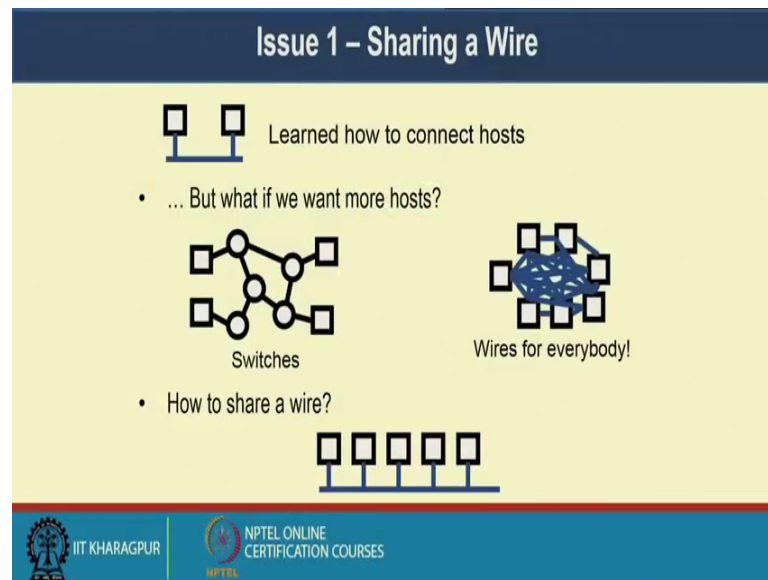
Now, there are some of the issues, challenges, problems what we say like one is the sharing the wire right. So, I can have 2 things to connect a host, one where connecting a host like we will see that if I have two machines which wants to communicate, I may not required so much, so much layers of network. I can have a wire which can physically connect the resource and I can have a say swap of the (Refer Time: 10:42) and it can be connected right. But if I have more host than the connection will be somewhere like that right or it will be everybody is connected to everybody, this is switch network this a type of thing.

So, whether I can how to share on a wire; that means, whether I can have a bus and then go on connecting systems on the bus right. So, I have a sort of a backbone bus and then connectivity on the thing. So, that is one issue.

(Refer Slide Time: 11:12)

Other issue usually what we find that when we talk to when we discuss that somebody talks that listens right. So, listen before you speak or right it can be things.

(Refer Slide Time: 11:29)

But, it may so happen that if you do go on simultaneous speaking right. So, this is the another challenge right. So, there will be collision and requirement we need to speak out what we are talking again, so you have to speak out again and which results in retransmission, if there is a retransmission then there is a loss of bandwidth right.

So, on a particular given time, you how much things you could have transferred, if you are going on retransmitting that is effectively you are delaying or loosing or in effective trans you are losing that (Refer Time: 12:03). So, in other sense, if there are multi party term which is which may be a case when we share a things like this right, when there is a common bus you have number of systems then what we see then that may be a scenario of collision right.

(Refer Slide Time: 12:25)

So, another issue, so there will be a issue of collision, another issue recipient of the packet need to put an address on the packet. So, there should be an addressing scheme right. If I want to transmit from here to here or this fellow transmitting to other fellow other same fellow there should be addressing scheme to identify the identify the destination.
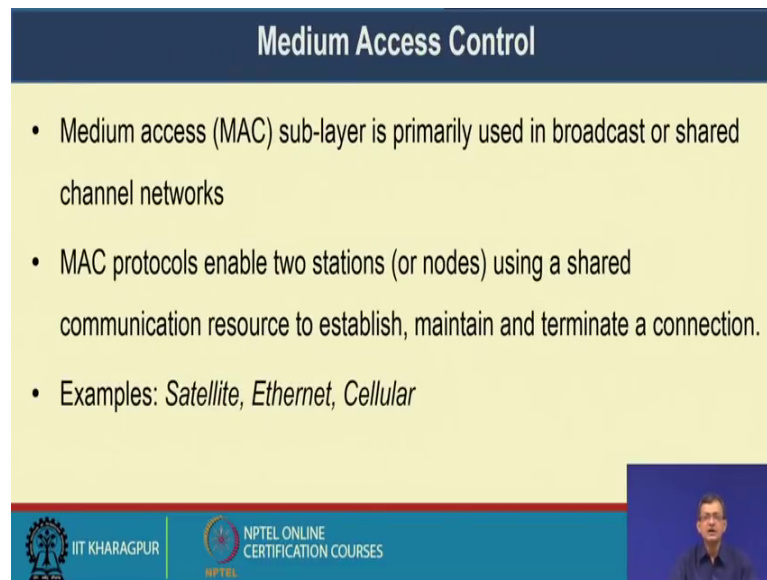
So, need to a address of the packet, so what should be the overall format and type of things that is issue or there is a something to be resolved. How do you know that what address you want to send it to right, I have a logical address right. I know that logically I know that that thing which will be the physical address or which address I need to send those things need to be I need to know right. So, that is this is other challenge.

(Refer Slide Time: 13:32)

So, if you look at the data link layer, they need to resolve these things. So, if we now come to the medium access and medium access medium access control, so MAC sub layer is primarily used in broadcast and shared channel network. If I have a PR to PR network, it may not have that much utility right because, if it is a point to point connectivity, then I do not have that type of utility.

MAC protocol enables to station on nodes using a shared communication resource to establish maintain and terminate connection right. So, it is a protocol which is when 2 nodes or 2 given 2 stations systems once to communicate to each other they shared a media and they want to communicate with each other and then MAC protocol should be able to establish, maintain and terminate a connection.

So, it should have a way to connection establishment, maintenance and terminating. Something analogy you will find in case of our connection oriented service in the transport layer, where also we have this sort of a stuff that need to the connection establishment then maintenance and termination. Also you might have seen or look at the things where you look at the socket type of things, where these things are required.

Those are analogy, but here also we require a things to be communicated right, so things are there. And they are can be different type of scenarios, the predominant is the Ethernet what we are using, it can be through silver connectivity, even it can be through your

satellite connectivity right, so or any type of media which allows you to connect through this through some media.

(Refer Slide Time: 15:24)
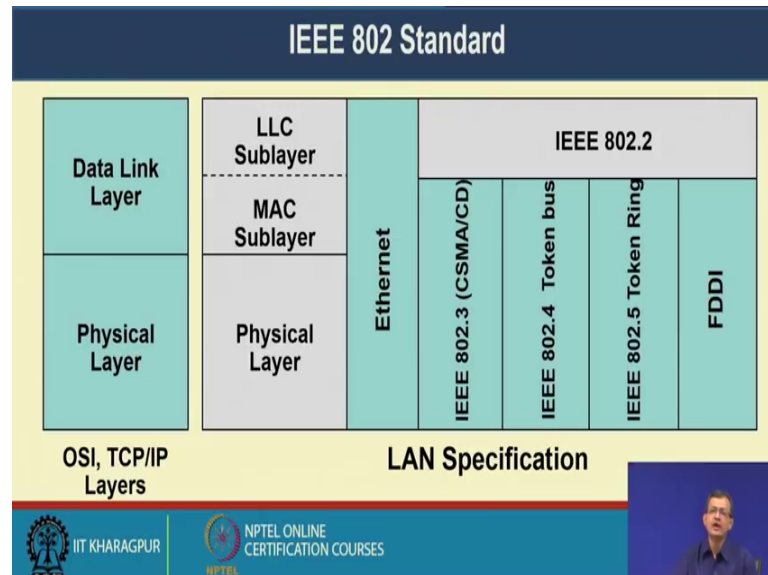
If we look at the standard IEE E 802 is the predominant standard which are which are used or which are practised these days over across the world. And if we look at so, if we look at that OSI or TCP IP layers per say if you look at the physical and data link layer, so the OSI layer, then we have this MAC sub layer and LLC sub layer. And if we have the standard, so Ethernet is the predominant standard here ignore 2.3 and that this is this looked as a CSMA CD or there are standard for 802.4 upto can bus, 802.5 upto token ring or FDDI. So, there are different type of standard, but our again as our predominant standard is CSMA CD will be primarily looking little more deep into this type of in this technology or in this particular protocol right.

So, this is the so what we have we have a standard to support this and any say network device manufacturing following this standards will enable us to connect the devices across the across each other. So, that is inter operatibility between devices from different make or connecting at different layers etcetera are guaranteed or ensured by this use of this standards right.

So, this is a important thing to know. Though this token ring and token bus are not so popular, so most predominant is the Ethernet protocol and we have from 10 mbps 100 mbps and Giga byte Ethernet at the Gbps level.
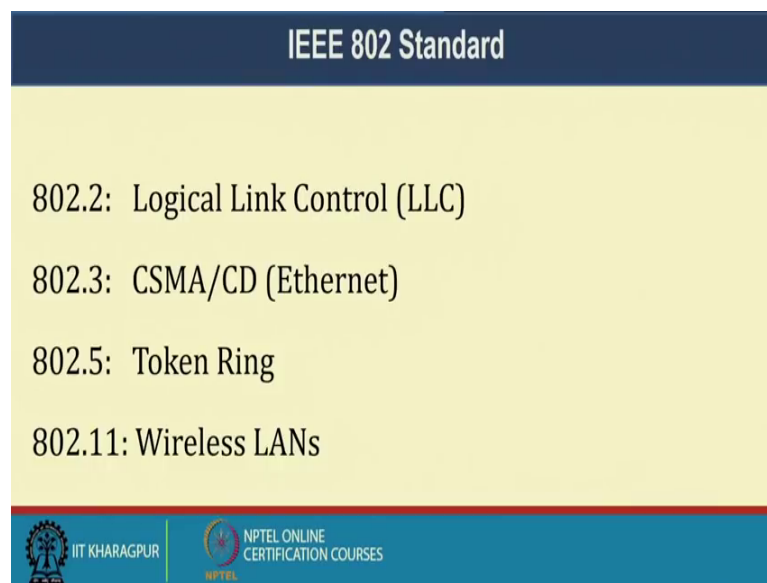
So, if we see that 802.2 is the primarily handled LLC, 802.3 is the CSMA CD or the predominant Ethernet protocol. 802.5 is the token ring and 802.11 series is primarily for wireless lines or wireless connectivity right. So, rather in wireless domain we follow a protocol of CSMA CA will look into those things in our subsequent lectures.
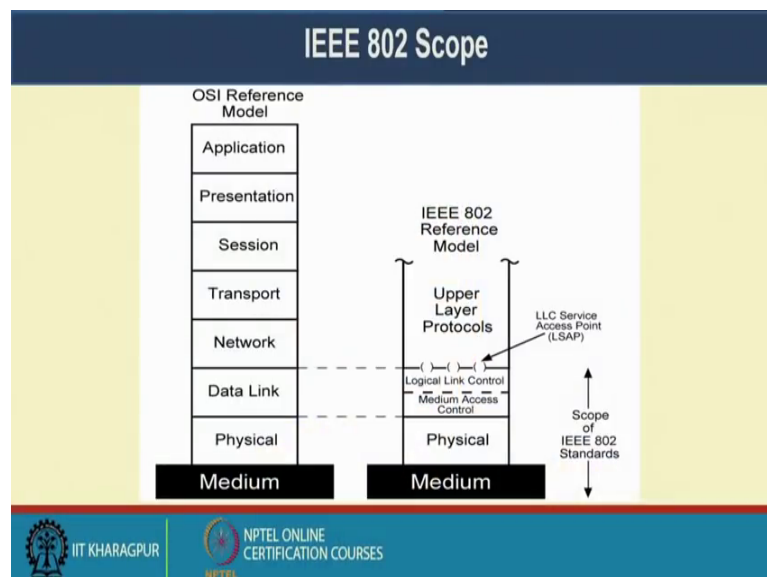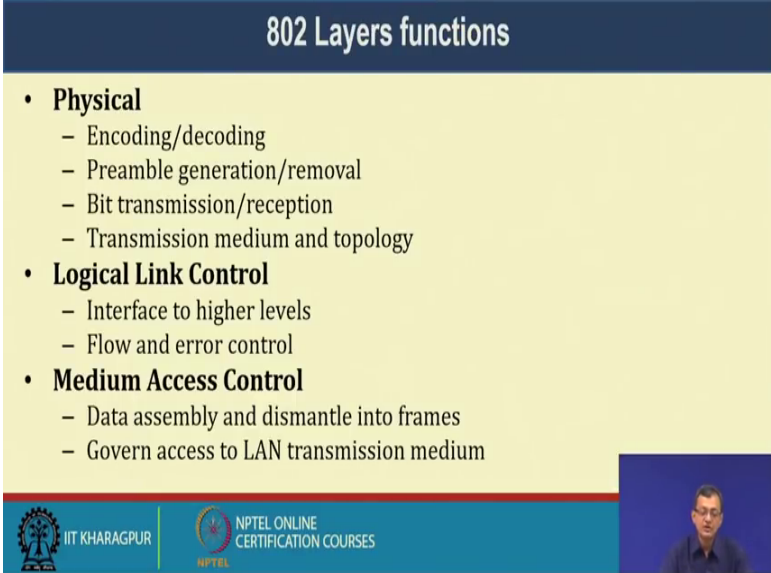
So, if we look at the scope of the 802.802 standards it is if you look at it spans from this data link layer to physical layer. So, those type of things, as we are discussing that LLC as a the different what we say that service access point for different service access point

for the upper layer protocol. And it basically communicate with MAC layer, MAC layer in turns communicates with the physical layer.

So, one sort of thing is that I want to know that which is the MAC layer of the there should be addressing scheme for the MAC layer of the destination mist and also there should be some sort of a addressing. But say for this LLC to talk to the upper layers or in other sense, there should be some sort of a service access point reference type of things. So, these things are needed for while we have to communicate from one system to other system at the data link layer.

(Refer Slide Time: 19:14)

So, if you want to see that 802 dot layers functionality, so at the physical layer portion which will be discussing in sometime little later in this series of lectures. So, physical layer is primarily concerned with encoding and decoding of the data. So, preamble generation or removable as and when it is means as applicable right, so, based on where transmitting or receiving and type of things.

Bit transmission and reception and transmission media and topology how things are there that is the one of the these are some of the primarily functions of physical layer, which is governed by the 802 standards. And in the logical layer control inter phase to the higher level is one of the primary thing and flow and error control is another aspects of LLC whereas, in the MAC these are these are assembly and dismantle into the frames right,

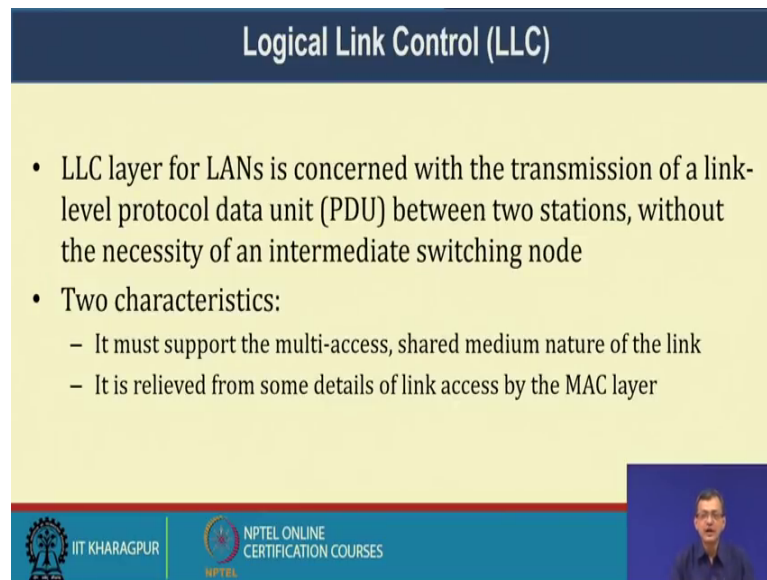govern access to LAN transmission media that how that data to be there into the media right.

So, these are the things which we require. As we are familiar with LAN card or network adapter type of things, that primarily in a pc or laptop or whatever the your device is. So, this network adapter card or LAN card or type this whatever we heard is primarily enables this your functionalities of data link layer and some of the physical layer things. Like, inter phase with the (Refer Time: 21:06) physical layer it may be wire, it may be wireless it may be blue tooth, (Refer Time: 21:11) or anything satellite communication and so on so forth.

(Refer Slide Time: 21:15)
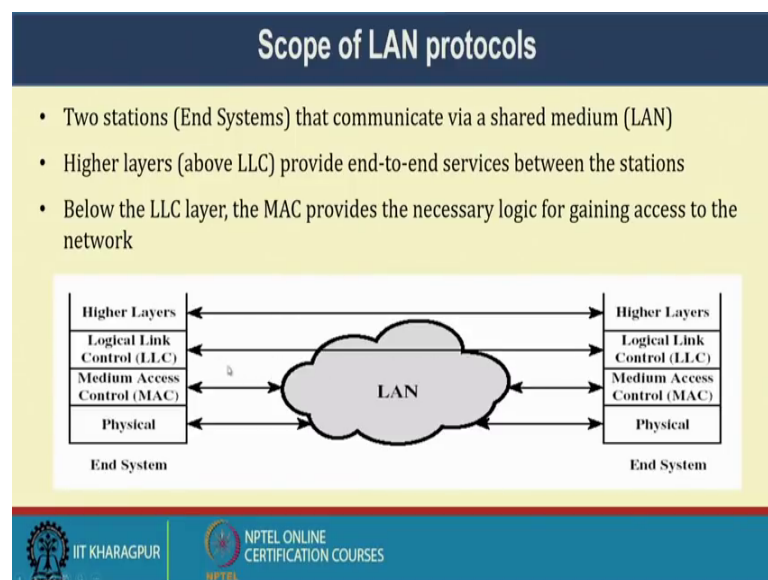
So, if we look at the LAN protocol, so 2 end stations, so end systems that communicate via a shared LAN right. So, higher layer protocol above LLC provide end to end service between the station right, these are the higher layer protocols. So, in case of a logical link also we go through these LAN, but this is also end to end connectivity whereas, the media access and the physical is basically utilize this LAN infrastructure or the connectivity to communicate between each other. So, that is the whole of the thing.

So, if we look at the LLC, so it is a LLC layer for LANs is concerned with the transmission of link level protocol data unit or PDU between the 2 station without the necessity of a intermediate switching right.
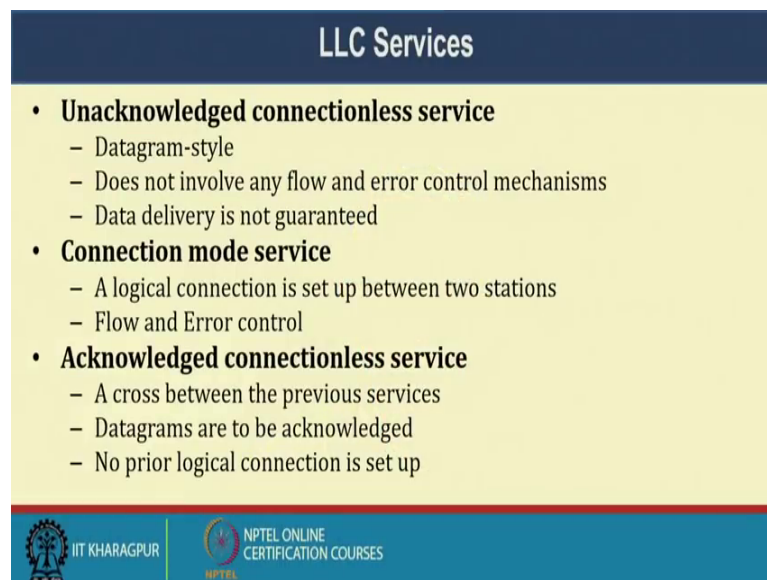
So, the LLC layer of LAN or LLC layer of the data link layer DLL Data Link Layer is concerned with the transmission of the link level at the data link level PDU right or protocol data unit between 2 stations without the necessity of a inter phase of a switching nodes. So it can transmit the things or in other sense, this that protocol data unit will contain the payload what it gets from the higher layers right.

So, it is that the data along with the whatever the network layer header and footer and whatever is there, header and tailor it comes as a payload to the data link layer which transmit to the next device or next hub right by finding that what is the next of address and transmitting the data right. So, that is the basic bottom line of the thing. And there are two characteristics it must support multi access, shared medium nature of link. So, these are the things what we expect from the data LLC or the data link layer protocol. And it is relieved from some details of the link access to the MAC layer.

So, in other sense, LLC some of the things that media access things are pushed into the MAC layer. So, it takes care of the MAC layer. So, if you look at conceptually, so the data link layer is to LLC and that MAC layer, the MAC layer takes care that negotiation or inter phasing with the medium, underlining medium or the physical layer. Whereas,

this LLC is primarily involved or concerned about how it communicate to the higher layer or in this case the network layer how it will concern to the things (Refer Time: 24:13) taken care of the things. Only it needs to be ensured that the medium can be shared right and then and multiple shared means it will be multi access nature of links.

(Refer Slide Time: 24:28)

Now, there are different category of LLC services and may be unacknowledged connectionless service. So, it is something data datagram style what you have looked into the IP, does not involve any flow or error control mechanism and data delivery is not guaranteed. So, it is a some sort of best (Refer Time: 24:43) service what you have seen that in case of a datagram right. Another is the connection mode service, a logical a logical connection is set up between the 2 station, flow and error control are maintained, it is a connection oriented type of service.

Another is acknowledge connectionless service right. A across between the 2 previous services right, so it is a acknowledge connectionless service right. So, some sort of guaranty is ensured. Data grams are to be acknowledged, no prior logical connection set up is required. So, this different mood that LLC type of services can work on fine. So, unacknowledged connection less service, connection mode service and or connection some sort of a connection oriented service, acknowledge connectionless service.

So, if you look at the MAC or the Medium Access Control, so assembly of data into frame with address and error detection fields. So, that is one of the major aspects assembly of data into frames with address and error detection fields and disassembly of frames and performing address recognitions error detection and other types.

So, it is it takes care that i of the MAC at the sender and the receiver. So, we need to put the addressing things of the destination hub along with the frames and the error detection fields etcetera. And on the other hand it sets to extract and also to check that whether there is a error request for retransmission is there and type of things can come into play. Govern access to transmission media that is one of the major or one of the major aspect or major concern that is governs the access to the transmission media.

For the same LLC several MAC option may be available. This is another interesting part. So, you have the 1 LLC, but you can have different type of MAC options right so, or MAC mechanisms for the same LLC. Means, dividing them or into 2 aspects that 1 LLC for the higher layer connectivity and MAC for the physical layer connectivity what we achieve that you can have, now number of solution of this MAC for the same type of LLC.

So, if you look at the medium access layer so all LANs consist of a collection of devices that must share network transmission capacity right. So, whatever LANs at the layer 2

level network we are considering, consist of a collection of devices that must have a network transmission capability.

What we see that if you have a pc it should have a Ethernet inter phase card, if you have a network printer it should have a network inter phase card, anything which has a capability to communicate with the network has to have some way a inter phasing with the things.

(Refer Slide Time: 27:49)

Function of a medium access control protocol is some means of controlling the access to the transmission media in needed for efficient use of the capacity right. So, what is the basic function of the protocol, that there is a some sort of a controlling mechanism so that, it can first of all it can transmit through this shared media or multiple access type of things and the media is maximally used. So, that is; that means, the bandwidth which is available can be used in a maximum terms right.

So, if you look at there are 2 things we are looking for where and how. Where refers to whether the control info is exercised in a centralised or distributed fashion and that means, in case of a centralised we have a controller has a authority to grant access to the network. So, there is a control or centralised controller that who says where things will be how things will be accessed. Who comes after whom and type of things and there is a distributed station collectively perform in MAC function to determine dynamically and the order in which the station stand right.

So, one is centralised, there is a master controller which takes care of that how transmission will be there or that is distributed; that means, there is a some sort of concession protocol or way that the stations transmit to each other. And how is constrained by the topology is a trade off among the competing factors like cost performance, complexity and type of things the how the transmission will be there right.

(Refer Slide Time: 29:36)
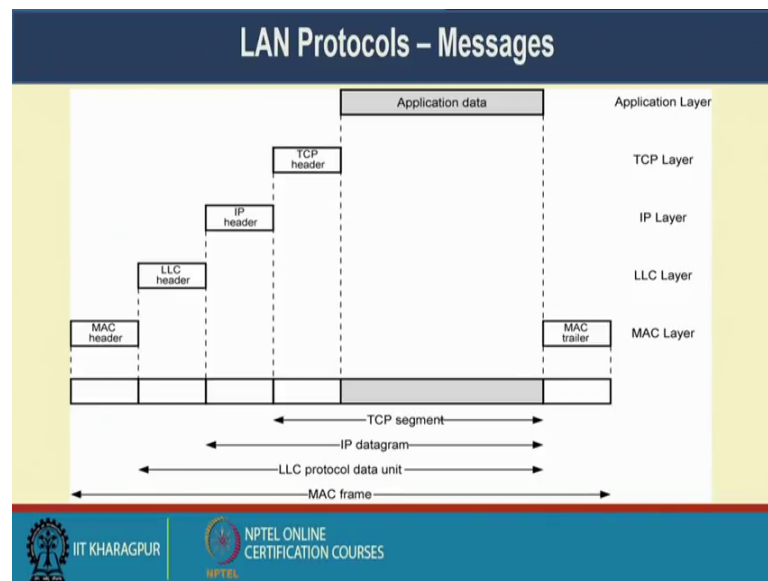
So, overall if we try to look at that again that protocol stack, so we have the application data right, which along with the TCP header at the transport level. So, it accumulates. So, the application data payload application data becomes a payload to this TCP layer, it acts as head or tail or whatever it wants to add. And along with that TCP header, it goes to the as becomes a payload for this IP layer. When the IP layer header is added and then it becomes a payload to this LLC or what we can say over all a data link layer.

And then this MAC along with that whatever is coming with the MAC header and tailor become the MAC layer frame. So, what we say that TCP segment, IP datagram LLC PDU and MAC frame or sometimes we say that layer two frame which consider both LLC and the MAC layer things.

So, just to recompile what we are discussing, so, what we are looking at the data link layer is primarily responsible for hub to hub transmission of the things right like, from one hub to another hub how the data will be communicated right. And so whatever the upper layer things coming up right the data link layer, when you transmit the things, it

opens up at the packets at the data link layer level and try to and find out that, what is the next layer next address to be pushed into and push the data to the next.

So, it goes for a hub to hub layer. It is in the same transmission same what you say broadcast domain, but different collision domain, it allows multiple access to these overall multiple access to the media and also we have seen LLC for the higher level connectivity and the MAC for the medium access type of connectivity right. So, with this let us let us conclude this lecture and we will be continuing our discussion on this data link layer protocols in our subsequent lectures.

Thank you.