Communication Networks
Prof. Goutam Das
G. S. Sanyal School of Telecommunication
Indian Institute of Technology, Kharagpur

Module - 07
Data Networks
Lecture - 32
Layered Architecture - contd

So, we have so far started our Layered Architecture discussion in Data Networks. So, we will continue on that same discussion that how a particular layered architecture that we have just discussed TCP IP layered architecture. So, how does that actually facilitate the whole communication, and how the task has been modularized and subdivided into different layers?

And what are the functionalities of each layer we will talk about very briefly, and then we probably we will probably continue discussing a specific layer one by one.

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So, if you see over the few courses of our lecture. So, what will be mostly covering this TCP IP layer is the first thing that will be covered. So, which will be the primary focus of today's discussion? Then we will go to layer 1, layer 1 is the physical layer most probably in this particular course we do not want to discuss that, it is a point-of-point link and the physical layer of whatever we do.

But layer two onwards is the most important part. So, there we will try to understand how layer two is being facilitated mostly it is part of the access or where the network gets interfaced with the user which is where it is being used. So, we will give a brief history of this basic broadband access which has been traditionally done which is dial-up ADSL. So, that was just the bridging between the circuit switch network towards the packet switch network.

And then we will come to more advanced means functionality of layer 2, one of them is media access control, we will talk about that and then start talking about some typical protocol that has been historically developed like Aloha, Slotted Aloha then we will go to CSMA CA, CSMA CD and all kinds of things. So, that should be our brief outline of discussion that will be happening over next 2-3 lectures ok.

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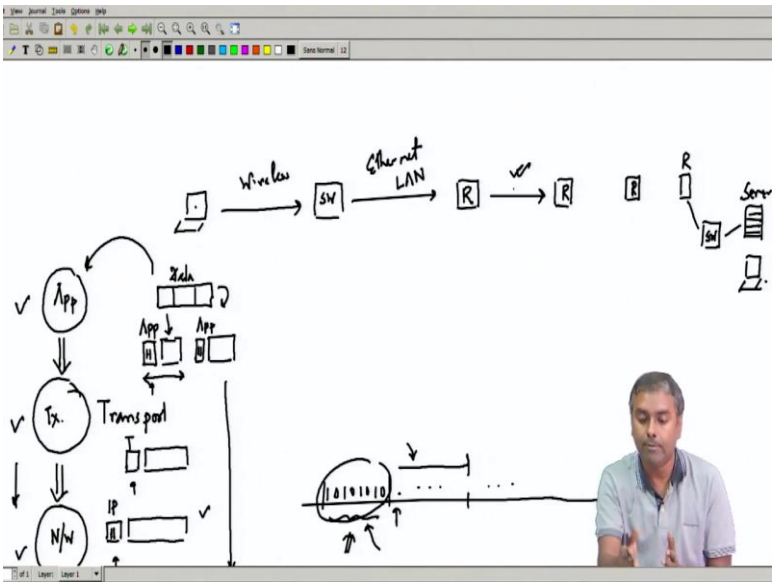

Let us try to see what we have been doing. So, basically what we have told it should be something like this. So, there is a station through which you are probably accessing these things. So, from there it tries to access a common media let us say or the access network part ok. So, and then it goes to particular we will try to appreciate these parts so a switch ok which is the local switch probably where it goes from here to here, then from switch probably it might go to multiple other switches high higher aggregation switches.

Almost similar like our circuit switch network. So, there will be from switch to another switch it might connect and so on. Finally, it will go to some router ok. So, which might

be the access gateway of let us say I am in a campus and I am trying to access. So, first I go to the next switch and then from that switch I go further multiple switches and then aggregation switches and then finally, go to the access router probably or aggregation router or gateway.

So, this is the age router I should say and from there, it hops through multiple routers of different capabilities, and then finally, it goes to the other end access router or age router similar to that, then from there to a switch, and then to the user ok, this the connectivity generally happens ok. It might also happen that this is not another user, this might be a server, so that is also possible. So, instead of that, it goes to a server back ok.

But that server also will be locally connected to some local switch and then connected to an access router and then via multiple routers it goes to the other end ok. So, this is the full picture of the connectivity. Now, let us see how the actual connectivity goes on. So, basically over here whatever the user is trying to do he will be having application layer things, whereas here he is actually putting the actual data ok.

So, let us say it might be your HTTP this www web page browser where you are actually inserting something or you are clicking somewhere you are trying to type something ok or you are typing just the address. So, something like that whatever you are doing. So, that is actually the application layer actual data you are providing. So, you get raw data, so it is a; it is a data chunk. So, which you actually give it to the application layer.

So, this will be having an application layer sitting over here in the machine and this data will be submitted to the application layer. What the application layer will do? He will first packetize this data because we have already seen it is a packet switch network. So, he has to packetize the data he might have some restrictions on the size of the data so he will accordingly, so he will decide to packetize the data.

So, he will subdivided into multiple chunks. So, data will be subdivided into multiple chunks. And then what he will do? He will actually add a header which is called the application header to this data and for each data, he will be putting his own application header and they might differ in some aspect.

We will talk about this aspect and what are the aspects of this header. So, the header will have some field-specific field according to the protocol which has to be properly,

which means this application layer has the task of putting those headers or making that header.

So basically, he has few tasks one of the task is take the application data chunk, you subdivide it into multiple segments packet segments ok. So, that packet segment which we call the data segment is being appended with a header which is prepared by the application layer. What are the functionality of those header, what each bit specifies, how you actually put those things according to your visual operation. So, that will discuss later.

But this is what application layer does. After doing this what it does it actually releases that data, towards the next layer. Let us call that in TCP IP it's actually the transport layer, that is the transport layer ok. So, the transport layer what it does? For him this is the whole packet. So, this is how the layers actually means function with each other. So, the upper layer just gives the data plus header to the next layer, next layer takes that as if his own data is the whole thing, and the data plus application layer is his data ok.

So, he takes that whole thing and then he starts appending his own transport header ok. So, a specific transport layer for TCP IP is TCP or UDP ok. So, they will put their own header, we will also when we will be discussing this particular layer we will be discussing what exactly it does. So basically, he will add his header in that header all the functionality he will be putting according to his jobs that he has to do.

So, basically all the jobs of networking has been now segregated into layers and they have been segregated in such a fashion that one after another it comes. So, there is a layered structure and the application layer does its things and then it handles or gives the handling to the handling of the data to the transport layer, The transport layer is oblivious of what the application layer has done.

So, the entire thing he takes as data, and then he appends his own header according to his functionality. Similar things will happen next layer also. So, from the transport layer, it goes to the network layer which is IP for our discussion. So, the IP layer will take this entire thing as a packet and he will add his header which is the IP header ok and so on it goes on like this.

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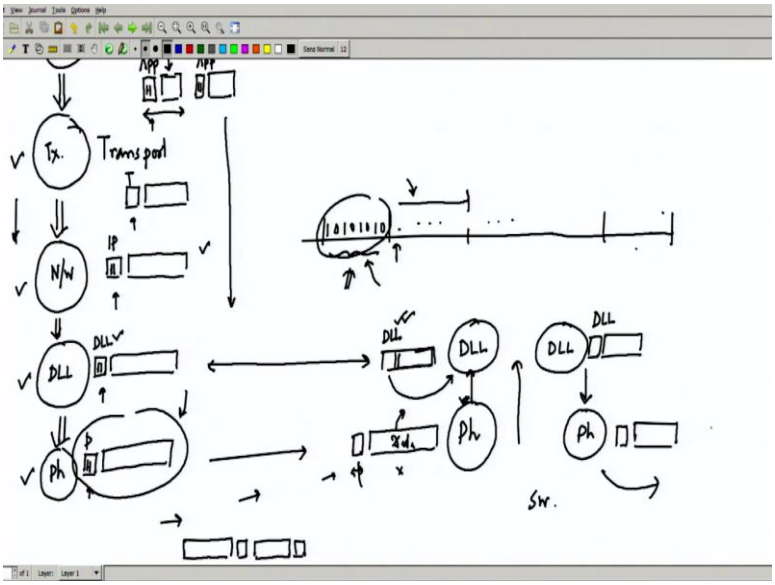

So, from the network layer, the next layer will be if we can demonstrate the next layer will be, so from over here if it goes. So, the next layer will be the data link layer. The same thing will be happening again he will take the entire thing and he will put his DLL header ok and so on, the last layer which is the physical layer.

So, he will also take this whole thing and he will add his physical layer header treat ok. So everybody, all these layers starting from application to transport to network to DLL to physical layer actually one after another takes the data given by the above layer and then encodes it with, not encode it actually appends it with its own header according to its own functionality.

So, this is how it operates. So, basically, the data will be given to the application layer whatever you do in your machine always all the layers are set. So, whenever you are accessing suppose let us say a http browser or whatever network functionality you want to do suppose you want to send the email. So, basically, all you do is whatever you type that is given to you have an interface which is the application layer interface.

So, if it is your Gmail account, so it is the mail interface ok. So, application is called the email service whereas, if you go to some let us say Google search engine. So, it is that search engines interface. So, you have this application interface where you submit your data. Now, what they do? This application layer first layer will be the application layer

with some functionality it will try to it will first segregate the data make a packet and then append its header according to its own understanding of what he needs to do.

All the application layer whatever he has to do on that data to transfer the data from one end to another end he will be doing those things, that functionality, and those functionalities are encoded by the means of header and associated protocol, we will discuss that later on. Similarly, after the application layer goes to the transport layer, the transport layer does the same thing and they keep on doing it.

So, this is the communication which will be happening in any station ok? So, in any station where the initialization of the communication is happening all 5 layers or if it is the OSI layer all 7 layers should be there including session presentation in between. So, all layers should be there, it should pass through all layers every layer will be adding its own header, it is like when you post letter what the post office does, actually post office gives you a envelope, you put your data inside the envelope think about that or you put your letter inside the envelope.

So, think about that letter to be the data and you actually put it inside the envelope this envelope is the header, in the header you specify something. So, the addresses and all those things right, address, pin code, in address also there are separate segregated things. The state, the district, then the city, then probably the road, the number of the house, or all those things you specify are actually the things extra things that you put to encode it such that this letter is properly delivered to the destination. So, as you can see from the letter analogy that addressing is one of the important part.

So, you will see later on when we will be discussing specific headers of each of the layers and their associated protocol addressing is one of the most important schemes which is there and it comes from that letter analogy actually if you see. So, basically, you put that, and then what happens, seeing those addresses later on whatever other post office will be taking that they will not call you, the users are no longer important. It is all given in the letter, which means in the address field of the header or the letter where it has to be delivered.

They understand that and they will be exactly taking it. So, first they will see which country it has to go. So, it will go to the first half of that country suppose it has to be posted from some other country let us say the US to India. So, first it comes to India the

first hub either Bombay or Delhi ok, so from there it tries to see which particular state it has to go, suppose it is written as West Bengal, so it comes to West Bengal next. So, it comes to Kolkata, then it tries to see which city it is specified. So, if it is specified that it is in Kharagpur it first tries to see which means district it has to go.

So, its specified that its West Bindapur ok. So, you go to that district and then there it will be specified the city then you go to that city, then the post office, then the street address, then the house number. So, accordingly seeing each one of them you decode one by one, and then the data gets delivered, the same thing happens over here.

So, there will be addressing we will also talk about those addressing scheme in terms of IP layer or even in the other layer. We will start means seeing how those address actually these addresses are so important and how seeing those address like the letter analogy or the letter delivery analogy this data are being delivered, always remember we have talked about this also.

All these things has been taken from our daily life analogy. So, the way we do things, the way we transmit things, we communicate messages we used to do communicate messages through post office and through all other schemes. So, that has been just copied or borrowed, those ideas are borrowed over here. So, headers are serving those purposes only ok. So, let us now try to see how this things actually, this entire protocol actually is being functional in the network.

So, this is only one end of the network I have seen, that is one user is trying to transmit data. So, what will happen? His data chunk will be keep on appended by the corresponding layers header and they have a sequence also. The first application layer headers will be added next transport, the next network, the next DLL, and the next physical layer and the processing also will be done in this sequence only from top to bottom.

So, first application layer will handle the data then it will actually give the handle to the next layer which is your transport layer, then transport layer will handle the data and so on, they will just do that. Then when it comes to the physical layer this entire chunk of data including the physical layer header will be launched to the media ok. So, whatever the media might be, the media might be an ethernet connectivity, a LAN connectivity. It

might mean wireless connectivity like your 5G mobile connectivity or it might be Wi-Fi connectivity that you are having or it might be satellite connectivity.

Whatever the media is the user's physical layer is responsible for launching the data in the physical media and accordingly he will do his physical layer encoding. So, if he has to do modulation, if he has to do any other channel coding, source coding so all those things he will do.

So, that he can combat the channel. So, his target is just to facilitate the data transmission from this point to the next point ok. So, let us say as we have demonstrated, that this will be this data goes to the next switch. So, what will happen to the next switch let us try to see.

So, this data now gets transferred to the next switch. What the next switch will see next switch will see this data appended with a physical layer header. So, now, it will be delivered to his physical layer, the switch physical layer which is interfaced with this particular physical layer.

So, therefore, he absolutely understand this particular physical layer so if it is a wireless interface Wi-Fi. So, you are going to the next a let us say your Wi-Fi access point the access point that interface he knows exactly what to do with this physical layer. So, he has a full understanding of that, if it is an ethernet switch so the switch port where you are transferring this data.

So, that switch port knows exactly with this physical layer what he has to do, what kind of data transmission is being done, what kind of modulation has been done, what kind of channel coding source coding and all those things are well aware of, ok in that switch interface. So, that interface physical layer corresponding physical layer will receive this data.

What he will do? For him this part which is the data part of him he does not care about this part, he will just be caring about the header. So, he reads that header and accordingly he does things ok. So, whatever things he has to do, he only takes information from that header. So, how he does do that? Let me give you one example of this physical layer task and how the header helps it.

So, the physical layer he will be getting keeps on getting packets, every packet he will be adding this physical layer data. So, basically, when he is transmitting he will be transmitting a series of such packets, every packet is followed by a physical layer header and then the next packet is followed by a physical layer header, and so on. So, for the channel, it is just like a bit stream, it cannot be a header or a data it is all data, right it is all means it is all binary sequences.

So, basically on the other end when the physical layer receives it, he sees continuous streams of bits coming, so it is a bit stream which is coming to him. Now, how does he know that where one packet ends and where the next packet actually starts and where the header location is? This particular thing is being facilitated by the header. So, basically, what will happen in the header is there is something called this identification of frame, frame identification or it called the packet delimiter.

So, that is actually what says that it is the starting point of the packet, it is a bit stream, but what will happen there will be a unique bit stream that will be encoded, let us say 8 bit or something, some particular unique stream will be encoded and none other bit stream will be having that same encoding and from there he will be able to identify. So, let us say if the bit streams are being transmitted.

So, I have something like let us say 1 0 1 0 1 0 1 0 that is the header initial bits which are transmitted, after that whatever I will be encoding I will do my channel coding and sources coding in such a fashion that never this particular part is being repeated. So, if that is happening then after that all these things, all these bits will be there, but never this signature will be repeated if this happens then I can identify this signature and can tell ok this is probably the boundary of a packet.

And then again in the next packet I will be having same signature over here. So, that signature will identify next packets first bit ok. So, he will identify that this is some redundant bit and this is the first bit of the next packet. So, from here up to some number of bits there will be there which will be identified as the header, what is the length of that also will be encoded over here and that bit position also will be given, so that is the functionality of the header as you can see.

By reading the header you will be able to or you will be facilitated to do all these things. So, when the bit stream from the channel is coming you do not know exactly where the

packet is located, but this particular things actually facilitate you and that is the redundant part which should be already part of physical layer header because it's helping you to identify where the data ends and where the next data starts.

So, he will help you to identify these thing. So, these are the functionalities as you can see, that is just one functionality I have talked about ok, of course, he has to know some more things. In physical layer you need to know the channel, you need to know what kind of modulation schemes he has applied, you need to also know how to means cancel out the effect of channel. So, all those things are facilitated by the physical layer header and how that is being done that is specified in the header and associated protocol.

When we will be discussing, of course, the physical layer we will not be discussing it in detail, but all other layers will be discussed and it is similar to that. So, we will see that. But this is just to give one example to you how this is being, means how the functionalities are being performed with the help of the header. So, ok what physical layer will do? Once he identifies where the header lies, he will take out that header according to that header specification and do the processing on the data.

So, if he has to demodulate the data whatever channel encoding has been employed he has to reverse that. So, all those things he will do and then the raw data he will supply to the next layer. So, this data after some modification will be given to the DLL layer, corresponding DLL layer. Now, what happens? Now, DLL layer after getting the data he knows that what is his header. So, he will be concerned about his header, he will take that header ok.

So, he will take that header and along with that header only his entire processing will be done we will discuss about that when we will be discussing DLL layer. But he will take that header, he will now understand what this guy has put. So, basically virtually he is communicating to his own other side DLL layer, accordingly they can fix things.

So, whatever he will be putting in header over here he will be able to read over here that is the communication intermediate communication or the control channel is being set up through this communication. So, basically you will see always layer to layer peer communication happens through the header and all layers actually gives its subsequent layer, either in this direction when the data is being received and being further processed.

So, it will be going from bottom up. So, from physical layer it will be given to the DLL layer he will take his header and rest of the things he will deliver to the next layer if it is required ok. If not required that is where they will end ok. So, like this it will be happening, if the data is means being to be transferred then it goes in the in reverse direction. So, basically from the top layer one by one everybody will be appending header and delivering the appended data to the next layer, the next layer will be doing that.

And this is how layer to layer means peer to peer they communicate among each other, like over here as you can see DLL layer communicate to the next DLL layer ok suppose this is a switch ok as described over here. So, this is a switch. So, in the switch generally it goes up to data link layer only, it does not go any farther. So, basically what he will do? He will keep this data intact and he will do nothing, on the other interface. So, switch has two interface as you can see, switch is connected to the user and switch is also on the other side connected to the router ok.

So, in that other interface he has another DLL, layer it might be a different technology. So, over here it might be wireless, over here it might be a ethernet LAN ok. So, on the other side it might be a ethernet LAN. So, if that is the case then it needs to have a different because ethernet will have a different DLL protocol, different physical layer whereas, wireless LAN will have a different physical layer and different protocol.

So, of course, what he has to do? He has to transfer to the other interface DLL layer. What he will do? He will just give that same data that same data will be given, only now he will put his on DLL header. So, if it is ethernet protocol that he will be putting ethernet LAN header ok.

So, he will put that and then similarly like over here whatever has happened. So, he will transfer it to the other sides physical layer or other interfaces physical layer, he will then add his physical layer on top of this and transfer it to the ethernet LAN. This will then go to the next router let us say, in router it goes up to again same thing will be happening.

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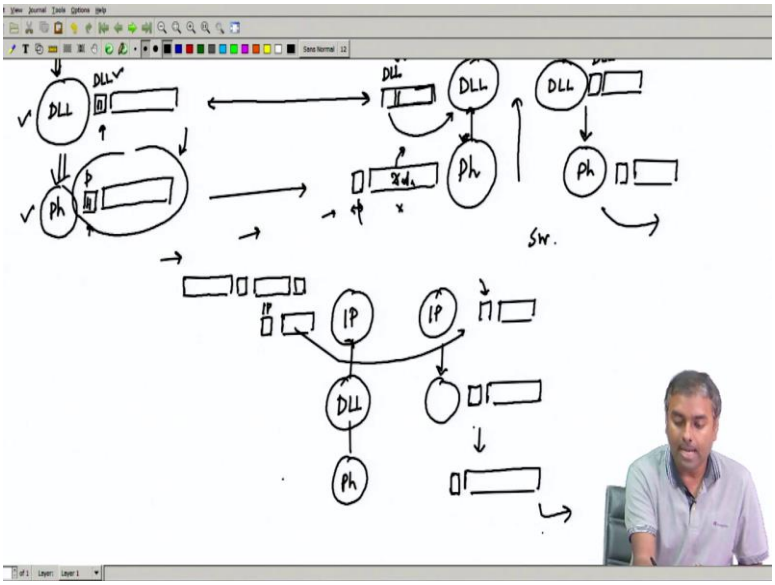

So, if it goes to the next router so if you just construct that. So, in the router what will happen this data comes to the router physical layer. So, router physical layer will strip off the physical header, it will give to his own DLL layer then DLL layer will give to the next layer, which is the IP layer where IP does the routing functionality ok.

So, it will take the header to do the routing functionality; that means, which port to forward to reach the destination he will do that functionality, and he will give it to the other interface wherever it is transferring. So, from one router, see the router is connected to ethernet switch on the other side it is connected to another router.

So, on that side he will put another DLL because this might have a different LAN functionality or different kind of access functionality or different DLL layer functionality. So, that might be a token ring let us say or it might be a some other kind of point of point protocol. So, if that is the case, then accordingly that DLL functionality will be at it.

So, basically this IP layer, so whatever packet he gets over here stripping off the IP header, the other IP will take that same packet the packet will remain the same, but the header might be changed if it is required, not always it will be changed he might also put the same IP header over here. If it has to be changed, he will modify that he will add that then he will supply this to his DLL layer. Now his DLL layer will put his own DLL header.

And then his physical layer will put his physical layer header and that will be further transferred. So, on it goes on, up to whichever layer intermediate up to whichever layer functionalities are required, up to that they will go ok this IP layer then actually as you can see through this header, he talks to the IP layer of this source. The next IP layer will talk to the next IP switch or router whatever will be there his IP layer.

So, peer to peer there is a communication and then there is a communication vertically up to down and down to up depending on if you are transmitting the data or if you are receiving the data. So, this functionality in the overall network goes on and all the functionalities are accordingly being processed, you will see each of the layer what they do. So, we will talk about that in the next class ok.

Thank you.