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

Lecture – 04
Protocal Stacks – Layered Services

Hello. So, we will be continuing our discussion on Computer Network and Internet Protocols series of lectures to be. Today we will have a quick overview of the different services at the different Protocol Stack. So, if you recollect in our previous talks or discussion what we tried to look at it that how this inter networking is possible and primarily the concept is a layered architecture. So, that intermediate networking devices are enabled up to the layer which is upon which is it suppose to look at like what we see that if it is a simple hub or a repeater.

So, it can look an up to the physical layer all other layer things will be a below to this physical layer or if we look at a; on the other hand if we look at a router, so it has a network layer. So, it can look at the packets at the level of the network layer or sometimes called IPDR or internetworking layer and type of this right. So, these protocol stacks allows us to design different devices and also allows to inter operate between heterogeneous devices and services. So, what today's talk what we will bit looking at is that what are the different typical services provided a different level layers of part say TCP IP protocol stack or which is which will be some or true for OSI stack only. We will just look at it. So, that in our subsequent lectures we will go on looking at this stack individually like that how they behave.

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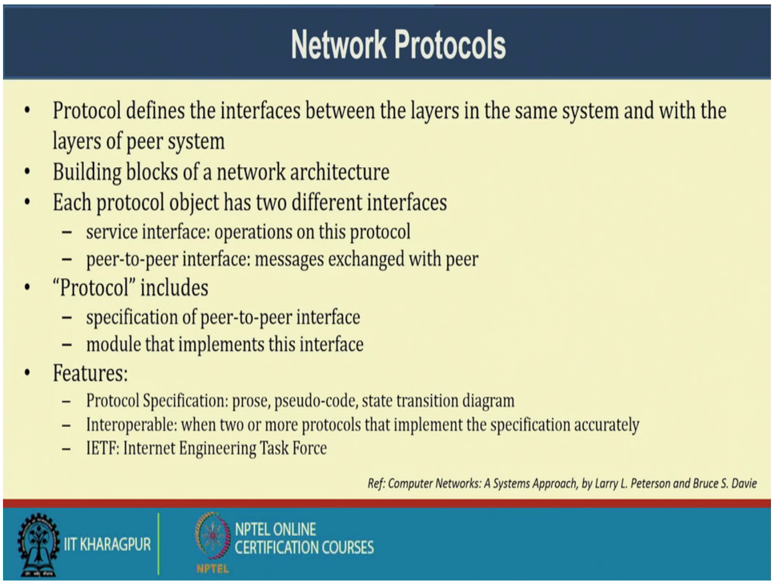

So, just to have a quick recap; so, again if when we talk about network protocols; so what type of protocol says protocol defines the interface between the layers in the same system and with the layers of peer system.

So, it is a set of a rules, set of a guidelines or what that by which the different we the different applications or the different services in the same system or with the peer system things can interchange. So, protocol basically allows us to inter operate right. So, buildings blocks of any network architecture that we have already seen each protocol object has two different interface.

So, broadly two different interface one is service interface operations on this particular protocol that is it keeps some interface that which explores the services which can operate on this protocols or peer-to-peer interface message exchange with the peer. So, one is allowing it some interface the services can be exploited or executed or can be done or another is that how I can say in message pass between the peers of the two protocol a two particular protocol say.

So, it includes specification of peer-to-peer interfaces if I want to communicate with peers, then I should include the specification for peer-to-peer that what way the message will be there, what will be the particular size of the message, what will be the structure of message and what you expect when whether you expecting an acknowledgement; if at all how things will be there, how will be even and so on so forth right. So, other things is that the module it implements this interfaces. So, there should be so, modules which implement this particular interfaces right at the things.

So, typical features are like that can there are there are prose pseudo-code, state transition diagram and it allows interoperable when two or more protocol that implement the specification accurately and overall it is guided by IETF right Internet Engineering Task Force. Otherwise the standardization will be a major challenge. So, if you see these like any other systems here also what we see this protocols provides a guideline how to interoperate between two peers and how to basically provide a interface with the services which are provided by that protocol right.

So, this makes or this appropriate definition or appropriate guideline tells us to inter correct this whole networking or what we say that making this internetworking possible right.

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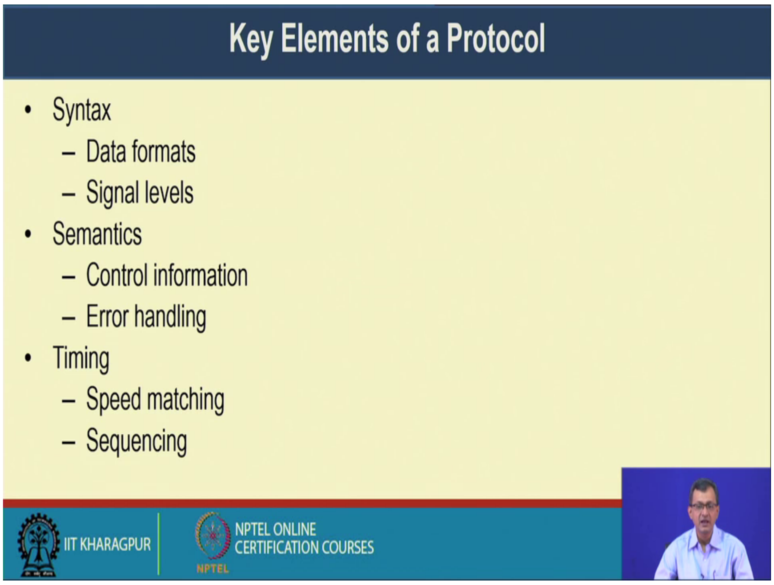

So, if we again little bit look at the key elements of the protocol when we when we look at individual protocol stack like when we look at the application layers or the protocols in the application layer, protocols in the transport layer, protocol in IP or network layer or data link layer though physical layer protocols are there, but physical layer based on the communication network in some of the cases we segregate we will try to give a overview of the physical layer protocol. But if you look at that that this link layer, network layer, transport layer, application layer; these are the major contribution of this internetworking things, definitely there should be a physical layer and there are physical layer constraint things at that will discussed.

So, when we discuss at the individual protocol level we will see that what is their different what we say specifications right. So, if you like to like to look at the key elements of a protocol of any event protocol, so one is the syntax right or what we say syntactical specification that is data formats, signal levels and type of things right. So, this keeps the overall syntax at the protocol. If we come to the other side or the next level is the semantics right; what are the control information's or error handling capability whether the at all the protocol has this error handling capability or not what sort of the control information or control structure is there in the protocol that comes in the things which is more of the semantics.

So, given a syntactical frame work how this my how this protocol still works like I say that when I keeping apart the networking say I my protocol that I send a message in a particular things, when I when I send a message like voice message at some other part it interrupt interprets. So, that is a particular format right. So, I send a message in a particular format and it respond in a particular format right like I say, I in order to knowing the result of a particular things I send a SMS number and some reference number and so on so forth. So, three-four fields I send a things. On that I expect a response on the things right. So, within that it will respond either by OS or send me back some other message and type of things.

And if there is a fault in that over all things, if there is a packet draw or the failure in the transmission line; so what is the error handling? One is that there can there may be totally no error handling mechanism. If you do not get a response with a simulated time, you think that the message is lost you resend or whatever things you want to do you do, otherwise if there is a error handling mechanism. If it is there a loss there is a specific mechanism to indicate that if it does not say receive acknowledgement, it will resend or retransmit the signal in the things right.

So, that all depends on that how this protocol is specified and there is in order to happen all those things we require a timing relationship right. So, there can be a speed matching issue right like what we say that the interfaces your pushing in say, usually what we do in case of our say when we have push message along the network typically it follows the store and forward store and then forward the things.

In order to do what is one of the things what is tries to do, it tries to match this incoming and outgoing stream right. So, there should be a synchronization appropriate synchronization of the thing, there is a speed matching thing, because there are independent devices working at different speed or different frequency rate whereas I need to have a appropriate speed matching otherwise the communication may not be possible. So, that also need to be somewhere looked into a within that particular protocols specify somewhere.

Another in some cases we require sequencing of the things right, I send message one, two, three and it should be reached as a one, two, three right. So, that and as we have seen in a packet switched network where a particular message is look and down into a different packets or data grams and they are sent independently over the network. So, it is not necessarily that always the datagram will follow the same path and at the end the datagram need to be appropriately sequenced right.

So, the sequencing mechanisms need to be ensured in somewhere other right. So, that either the it follows the same path or there is a sequence number which allows it to reconstruct and so and so forth, but nevertheless there should be sequencing mechanism in replace. So, that if you look at the protocol as a whole at any layer of this network layer or for that for that matter any systems which communicate with one another, I need to look at this different aspects syntax semantics and this timing relationships right. So, this is this is pretty important for to have the in realization of the protocol. So, whenever a protocol is designed, so these aspects are looked into right that how things will work.

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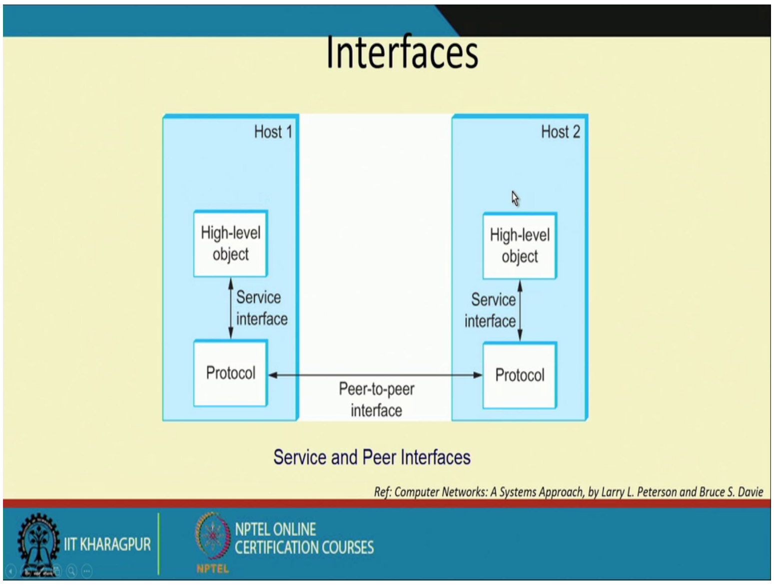

Now, so if you look at the very broad view interfaces. So, if you see there are some higher level objects right at the both ends. So, this is host 1, host 2; it can be directly connected or it can be at any level of the internet right. It can be machine to machines directly connected or two machines connected through different are different network and frame.

Nevertheless, it has a higher level object at which is say messaging or something which is going on and it has a service interface to this protocol, right. I put a service interface and this protocol carries the things and go on at the other service interfaces like if I vary broadly try to say I am writing a letter to somebody with our standard postal system or courier systems or what we see that we write a particular letter or write a particular form for a application for something. And then, I push it to envelop then write the address etcetera and then I put it in somewhere either I put it to that letter box or I registered or put through a courier system to that desk etcetera.

So, there is the interface to take that and there is a separate way of carrying those things to the other end right. So, that is a that two protocols how to carry something from IIT Kharagpur to something say Kolkata is there is a interface for the protocol end. Now one day once it is there then the again there are interfaces to go to this higher level things. So, this is. So, what we try to see that every protocol this interfaces should be properly defined that how need to talk to this interfaces.

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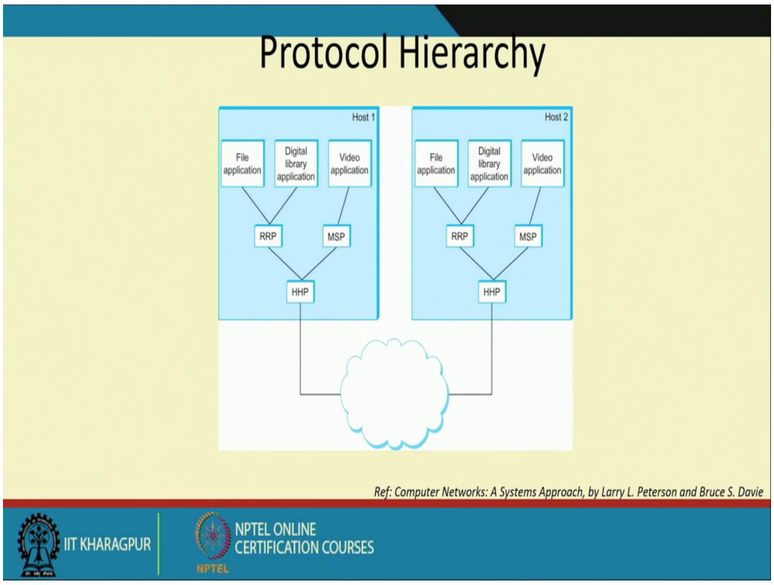

And if you look at it there is a inherent hierarchy in the protocol itself right like if we see these are at the upper application layer, then the next layer of protocols should be there and then there is a another level of things and go on going to the things. So, if you look at so, there is a appropriate hierarchy of these protocol stack; if you look at the networking things.

So, what we what we trying discuss is that these are the different features of a protocol stack and we will we will be going deep into the things once we look at the individual layers.

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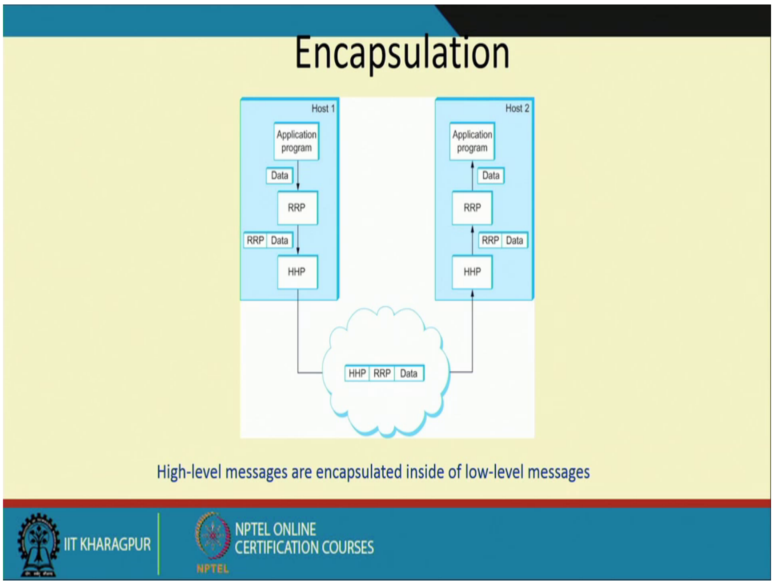

And then another things what we have already discussed in some form is that encapsulation right like if I have say application layer, transport layer, network layer, data link layer and physical layer then things are encapsulated. That means, the data generated at the application layer becomes a preload for this next layer becomes that along with its own header and other information, it becomes a preload for n the next header. So, what we that a data generated at a higher level get encapsulated in some form of other and at the end, it is carried through this physical media to the other end where it is again been exploded or extracted out from this particular bundle at the different level.

So, this there is a distinct beauty of the thing like intermediate layer which is looking at it opens up the packet up to the layer it needs to look at right like as we are saying that a network interface, a router interface will open up the things at the up to the network layer. It is not opening up the so, at the higher layer that is why we say these are layer 1 devices, layer 2 devices, layer 3 devices, layer 4 devices and so and so on right up to layer 7 devices; if we follow that protocol TC OSI or we say layer 5 device and type of things; that means it opens up the packet up to that layer right.

So, layer 1 device we will open up to the data link layer and so on and so forth right. So, that keeps a beauty that I need to open up to look at take it is enough to up that level, it is rest of the things is belong to me. So, open system interconnect as if we if we try to revisit, so that is the OSI model says there are 7 layers like physical, data link, network, transport, session, presentation, application and intermediate hubs they are the layers are may be like if there are intermediate router. So, they are up to the network layer.

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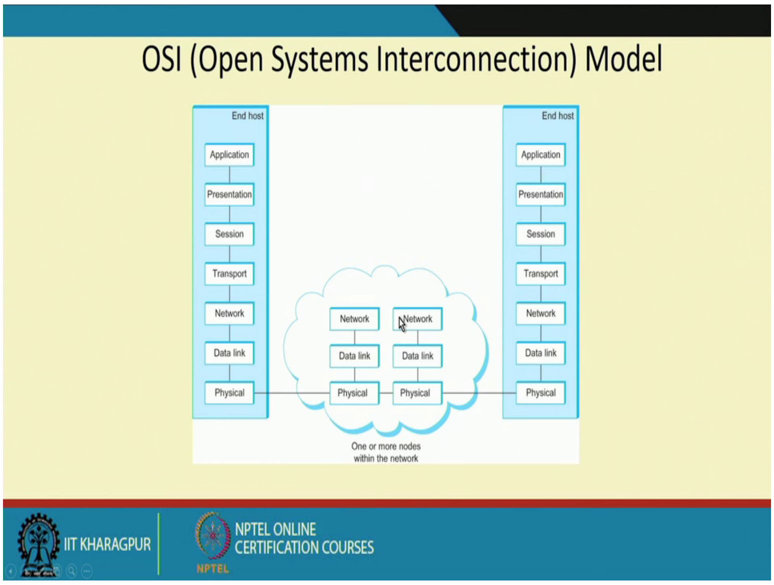

So, what we say this peers are in some sort of a virtual connection or virtually connected I should not say virtual connection. So, this network layer whatever is there can be open up by this network layer and this network layer and go on doing that right and rest of the things at the up to this is become a preload for the network layer. So, it carries that data as a preload for this network layer right. So, this goes on. So, if there is a layer two device in between, then it will can it could have seen only up to this data link layer. If there is a hub or simple repeater, then it could have been the physical thing which is only re generating the signal and transmitting the signal right.

So, this if we so if there can be one or more nodes within the networks which allows it to hub to the destination. So, if it is to end host or the remote host, so it will go on looking at it.

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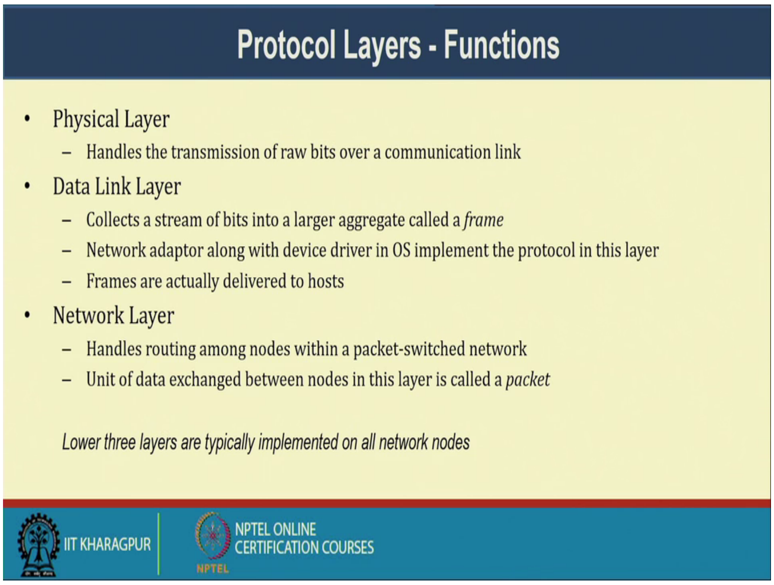

So, if we look at that protocol layers typical functionalities. So, we have physical layers which handles transmission of raw bits over a communication link right. So, physical layer is concerned to the things. If it is receives it is a data how this bits can be transmitted to the through the communication link. As one of the predominant thing is that these are transmitted as most in analog signal there are provision for detail transmissions the analog signals; so, that the data case converted transmitted and regenerated at the things right.

So, as long as the physical layer is concerned, it is not bothered about what is going on the upper layer things right. So, this is the one there is the functionality of the physical layer is to transmit to the other end in a error free manner. So, that it can be reconstructed in the things right and does it individually without bothering that where the upper layer things are doing. If we look at the data link layer or the layer 2, it collects a stream of bits into a larger aggregate call frame. So, it collects a stream of bits call frame and so, what we say that if we say row bits and the physical layer then, what we say if say aggregation of this bits into frames.

Network adapter along with device driver in the OS is implement in the protocol in the layer right like all of you know all of us know that any of our devices like laptop or desktop or even our mobile devices with Wi-Fi connectivity, it needs a network interface card or it needs a interface card to collect it to the what we say to the transmission lines.

So, to say right like it can be wire, it can be wireless and type of things. So, those who are using wire connection like RJ 45. So, there is interface card which takes the signals or the data from the systems and interface to the RJ 45 to this our copper cable right.

If you have a fiber connect, then it converts to that particular things. So, that the interface card is responsible to convert this data to that appropriate signal level. So, that it can be transmitted right. So, that is the basic property one of the major functionalities of these data link layer and data link layer also what we what we what we see that it mention maintains a hub to hub connectivity like a what will be the next hub see this hub to hub connectivity has to be at the data link layer level. Data link layer also has a property of a having a hardware address or mac address what we popularly known as; so, that is address which is which comes along with this interface card right. So, it goes to the hub to hub.

So, even there is a network connectivity like or between several hubs of routers things are going on, it has to has to come to that particular hub. And then find out that particular what is the data link layer, then the hub to hub connectivity is established data is transmitted to this particular signal right; a particular transmission line whatever under line transmission line is there.

Network layer handles routing among nodes within the packet switched network. So, network layer handles this routing along the nodes. So, if there are if there are two devices or two stations then this network layer gets takes care of the routing, it basically responsible to finding out the path between the source to the destination source node to the destination node source network to the destination network and so and so forth. So, it finds a path or route or it helps in routing right.

So, even if finds the path going to one hub to hub by hub, it has to come back it come down to this data link layer to go to the hub to hub. In order to come to the data link layer again transmission the thing, it has to come to the physical layer to find out that appropriate media to transmit the things right. So, data link network layer is much higher, it cares about this how this path will be there.

So, unit of data exchanged between nodes in this layer are call packets. So, what we say bits then the frames then the packets. So, these are different nomenclature which are commonly looped into the things. So, this if we in some of the literature or some of the books we refer this 3 layers at the lower 3 layers at typically implemented in all network mostly implemented in all network nodes. So, these layers are mostly available in all network nodes which allows routing right. So, it is all what we are thinking that all intermediate networking node are having at least routing things. So, it allows routing on the thing.

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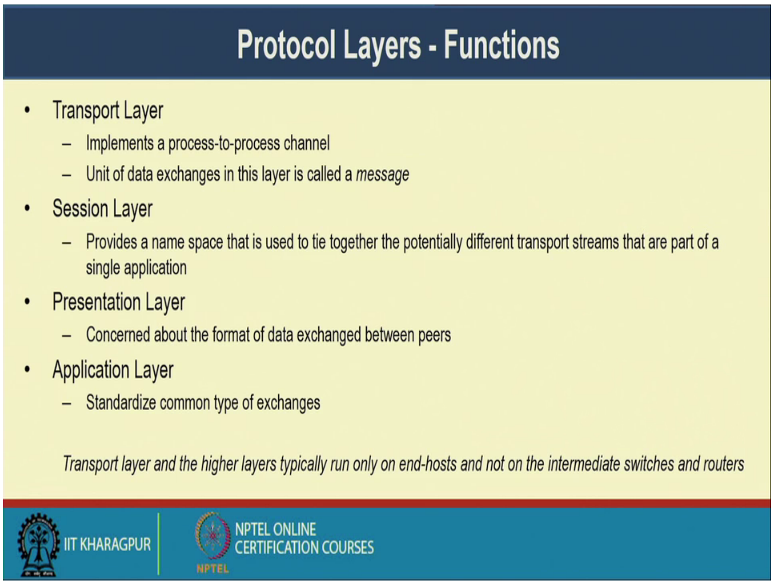

So, protocol layers functionality continues the transport layer implements process to process communication right. So, network layer this what is the path and transport layer process to process communication unit of data exchange in this case what we say message right. So, this is typically called message. There are in case of OSI, we have two more layers like session layer that provides name space that is used to tie together potentiality different transport stream that are part of the single application. So, session is basically maintaining a session which gives a some sort of a name for that session which allows to have transport stream of transport things which are at transport layer to having the same session right. So, it is session to session communication.

Similarly, then the present to presentation layer concerned about the format of exchange data format that format of the data exchange between the peers. So, what should be the exchange format and support? And application is basically the application where the end user are interested. So, it is standardize common types of exchangers using this network stack. So, I have some applications like it can be file transport application, remote logging application and so and so forth. This layer in a allows us that how this application can be transmitted or can be standardized. So, that it can goes over this network.

So, transport layer and higher layers typically run on the end host right and not in the intermediate switches or router. So, this is typically if we see this transport layer functionalities or higher layer like session presentation etcetera that are the n devices right

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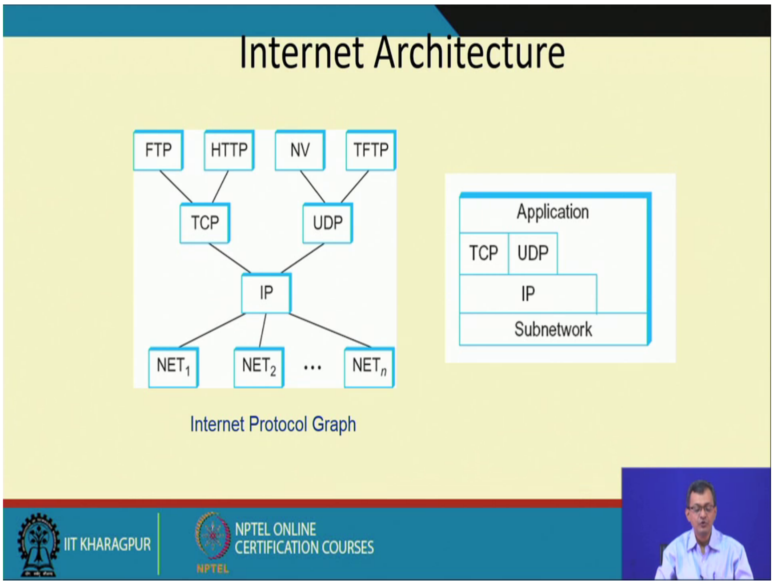

So, if we look at the network architecture to revisit the thing. So, one way that we have upper layer things, then we have this transport layer, then IP which allows me to connect to the thing. Other way of looking at this there are an applications which uses this transport layer which instead IP and the sub network is rest of the network what we say that last thing network and there can be application which directly talk with the IP. There are can be application which directly talk to this sub network right. So, there are things which are other way of so, different way of looking at the things what it allows it a large scale inter operation.

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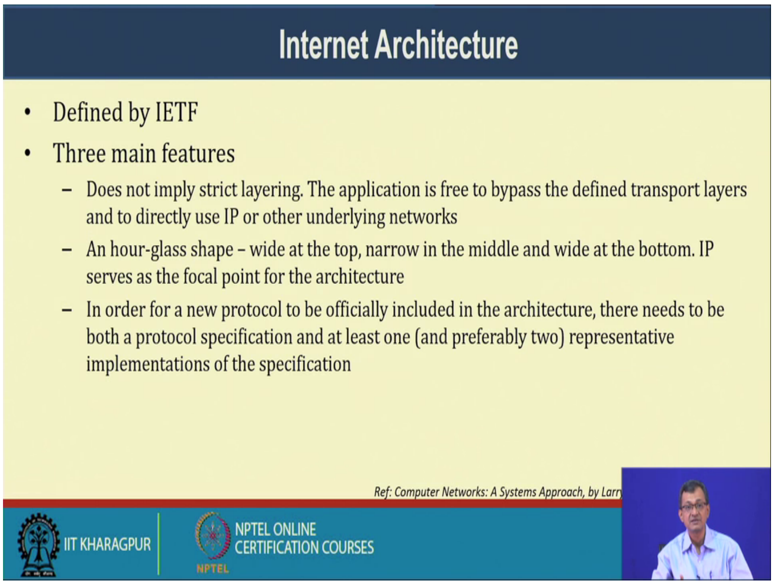

And if we look at the internet architecture which is defined by IE TF what this say does not imply strict layering right. This application is free to bypass different transport layer different transport layers and to strictly use IP and other thing. So, what it says that IETF is not very stringent on this type of things right. It may be good to have a standardize things so that you can receive you can interoperate in better way. And if you see the model is some way hour glass right you have very at the thin at the things and then explode at both the side right; wide on the top, narrow in the middle and wide of the things right.

If you look at the network, I have different networks and then, it boils down to the things even if you see the telecom type of structure you have telecom circle etcetera, then you have the trunk line which connects them. So, it is some sort of a hour glass. So, in order for a new protocol to officially included in the architecture; they are needs to be both protocol specification at least one preferably two representation in the implementations. So, that how you can include the thing we will come to that thing that how a new protocol can be included in the architecture when we go on different discussion on the network.

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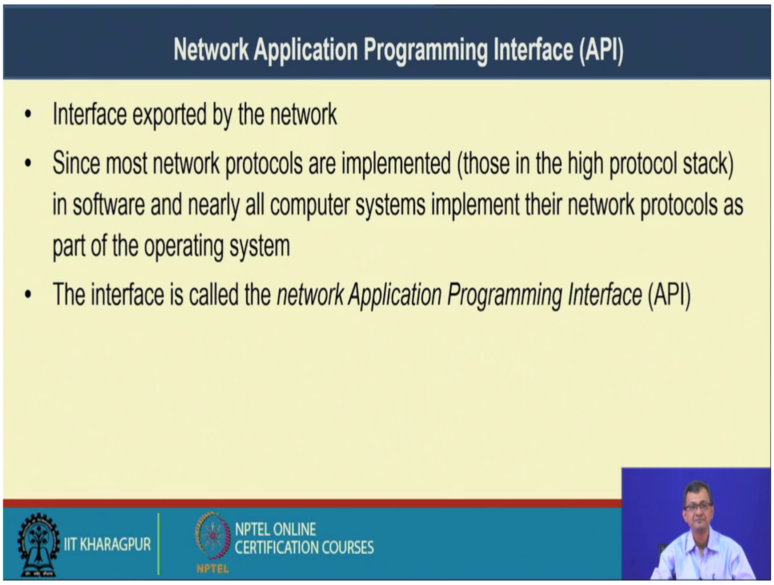

And there is concept of a Application Program Interface. So, interface exported by the networks in most network protocols and implemented those in the high protocol stack is in software right; what we see that num at the higher level things are mostly on the software and nearly all computer system implement their network protocols a part of the operating systems itself like if you see any operating system, they have that protocol stack implemented. You have a interface card and rest of the things in your protocol, all the thing are there available in to the thing.

So, this is the interface this sort of interface is called network API or Application Program Interface. So, that is important. So, that it can allows you to talk application to application and at different level of the things. So, we will we will be again taking up this API's at different context when we will talk about that different application layer things.

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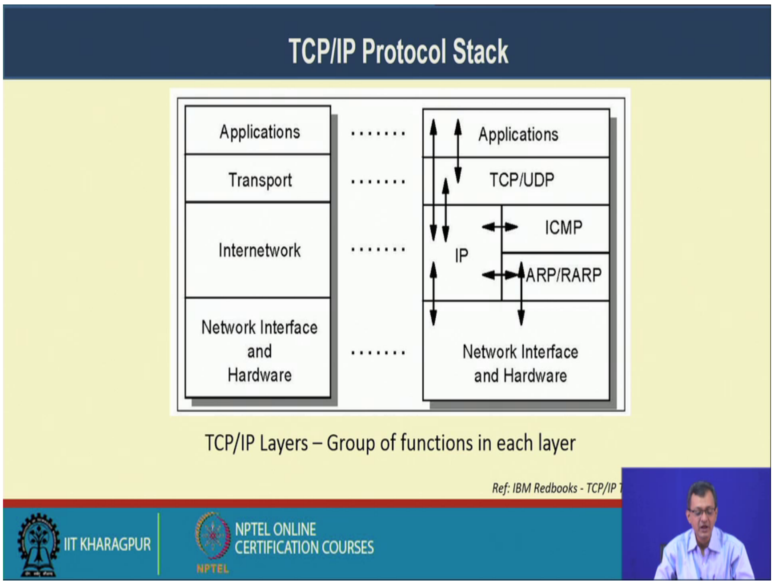

So, when you took at the TCP IP protocols stack visa v OSI, so, is same more or less the same functionalities or more or less the same functionalities. Here it has been shown as a 4 layer, but it you can look it as a 5 layer in several references books and etcetera. So, application transport internetwork and there are data link and physical in this case it has been network interface and hardware are clubbed together.

So, it is a some sort of four layer, but typically we will discuss the things as a in interchangeably had 5 layer where the data link at physical things are suppurate out as physical connectivity of communication have lot of complicates and integrity we need to look at those type things in a separate way. And if you have that at the top level application, this predominant protocol here is TCP UDP, then we have here the IP dominant protocol is IP, there are company and protocol which is ICMP. We will look at to those ARP RARP ARP RARP again allows interface with the lower layers right data link layer and so and so forth.

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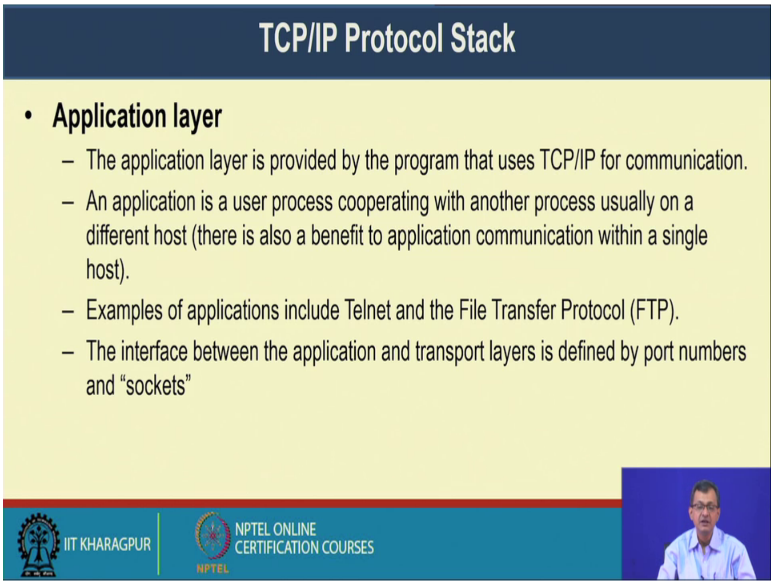

So, if we quickly try to visit these TCP IP protocol search. So, there are application layer application layer of the TCP IP provides by the program uses TCP IP communication and application is a user process right cooperating with another process usually on the different host right. So, it is a application like one popularize thing is ftp file transfer protocol. So, I have FTP client somewhere FTP server is running. So, I can basically connect to the things. How do I identify a particular application? It is a typically identified by the IP where the application is running and the port where is the interface where you need to connect.

So, we come to a concept call socket. So, in this particular course we will have some socket programming doing. We will be detailing little more on the socket when we talk about this socket programming aspects. So, socket is allows us to connect to applications.

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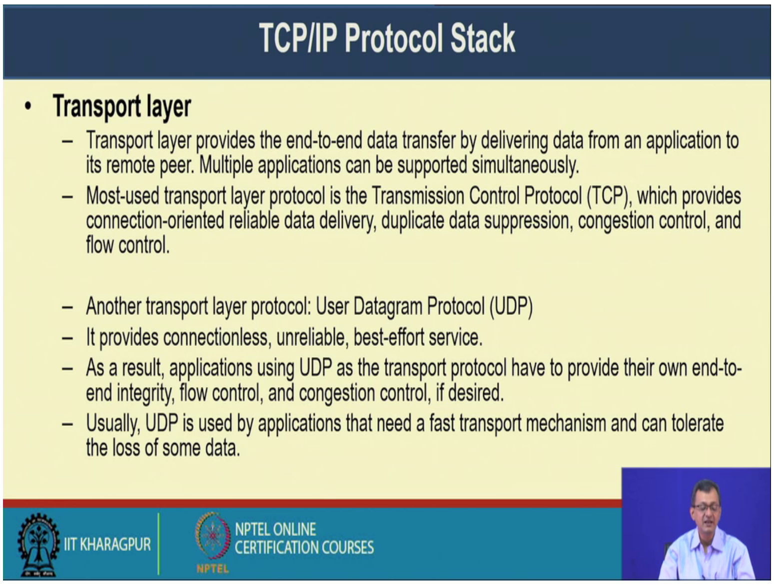

Similarly, in case of a transport layer, so it is it identifies a, it is a process to it basically helps in process to process communication so; that means, it looks at that port of the thing. So, transport layer provide the end-to-end data transfer by delivering data from the application to its remotes peer right; so two application by at the port level. Multiple operation can be supported simultaneously, There it concurrent application that we will see. The predominant protocol is TCP or transmission control protocol which provides connection orientated reliable data recovery, duplicate data suppression, congestion control flow control and so on so forth. There is another protocol which is also very popularly use its UDP, User Datagram Protocol. So, it is connection less, unreliable, best effort service right.

So, in some cases what will see that so, if you require this other type of things error control pro control etcetera, then this has to be handled by at the upper layers right. So, usually UDP is used for application that need a fast transport mechanism and can tolerate some loss of data right. We will see that in where which type of applications which where this UDP will be useful and where we use this type of thing.

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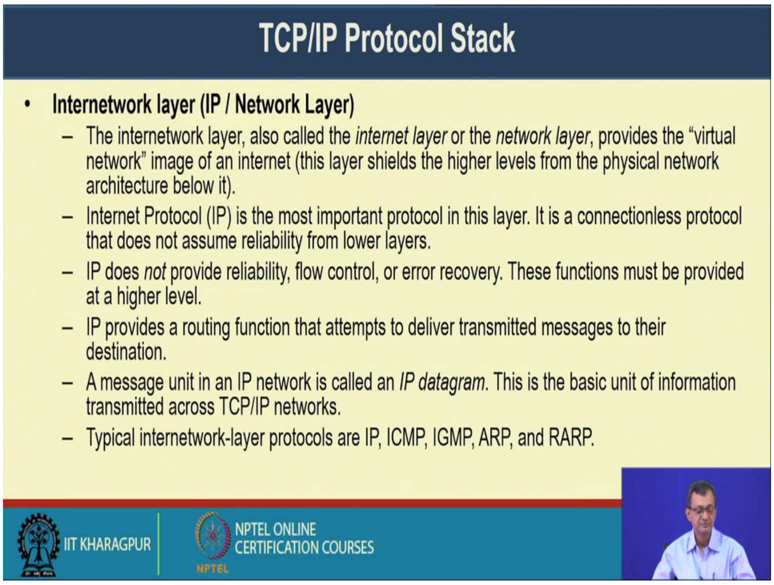

Next come that Internetworking Layer or IP layer or network layer what we say different type of things. It allows us to route packets from one network to another. So, it connects network right. So, it is a most important protocol in this layer, it is the IP is the most important and it is a connection less protocol that does not assume in reliability. So, it is connection less best effort service right. So, there is the predominant protocol is the IP protocol which allows to that connectivity of the network between the two networks right.

There are and we will see little on the once we discuss. So, does not provide reliability, no flow control, no error recovery and this function can be provided by the higher layer. So, predominant protocol in this is the IP, ICMP, IGMP, ARP, RARP and we will discuss those in we discuss at the RARP what are the different, but the major protocol is the IP protocol.

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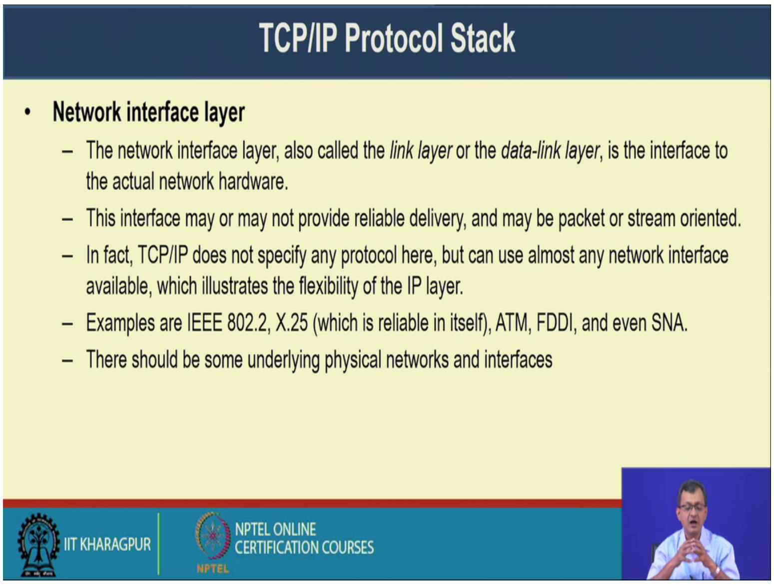

Then we have internet interface layer what we say data link layer and rest of the physical layer type of things. So, this is this provides the data link layer. So, predominant protocol here are IEEE 802.2 to 03 which are that we have the Ethernet protocol there are X.25 ATM, FDDI, SNA and different type of protocols. And what we assume there is a underlining communication path which allows to which this particular frames is the data link layer and pushed as a bits into that particular physical layer connectivity.

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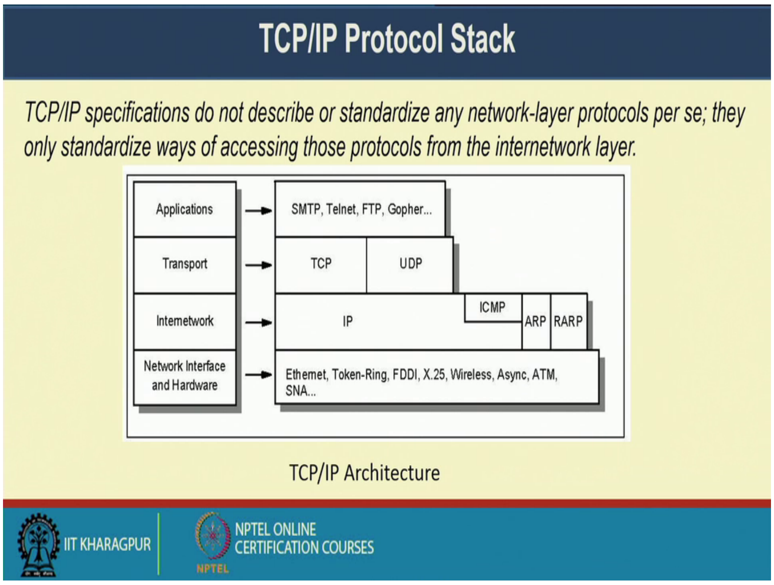

So, if we look at a again come back and try to look at. So, we have this different type of layer application where this are the predominant some of the application protocols, transport layer, internetwork layer and there are interfaces which combines both your data link and physical we can have different data link I am repeatedly telling that these some references in several references. There are at reference it does not matter here it is shown as a single stack.

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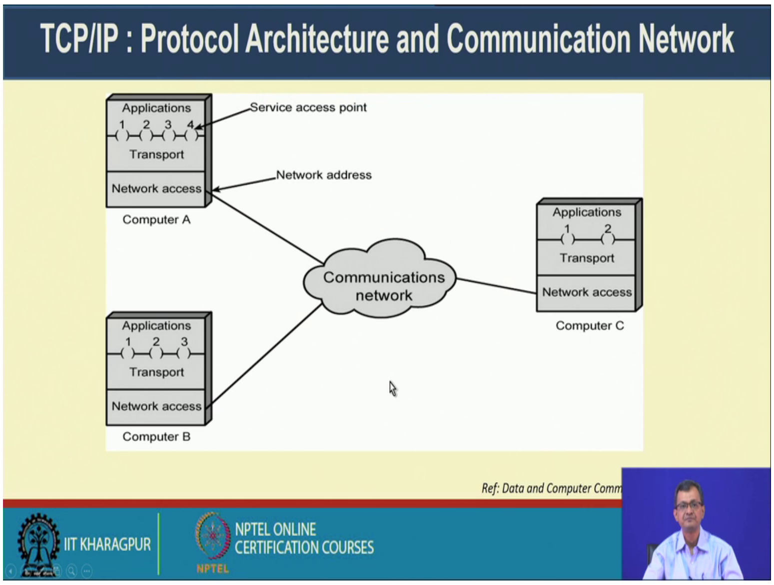

So, that single stack; that means, underlining physical layer physical communication path is there which takes care by these type of protocol. So, if we have a big picture. So, we have different computers where this applications through this transport service access point and there is network access. And we have a underling communication path which allows me to connect to this different devices across this internet.

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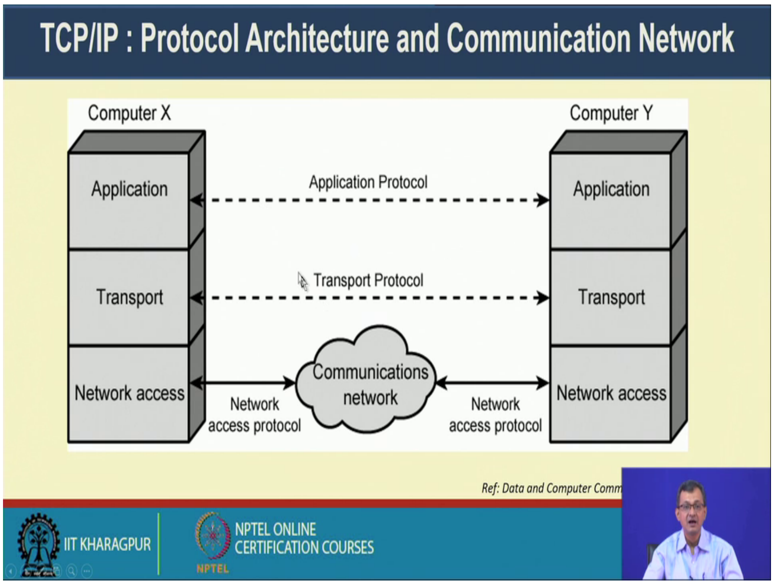

And if we look at the same thing in a little different way, so there are peer-to-peer application understand application; FTP client understand FTP server, HTTP client understand HTTP server. How thing goes on? It is transparent to that application right. So, it goes to the transport if the TCP is the basic thing, then it connects to the TCP or UDP it goes to the network access IP, IP routes the packets form one to another and it goes to data link, then it goes to the physical and being communicated through the communication network right. So, that goes in a ubiquitous way right.

So, what we try to see in this particular talk is that how a communication between two host anywhere across the internet is possible by the, or different type of services are provided into the things. And in the subsequent lecture slowly what will start we will look at different layers individually right that how different layers individually what are the different properties, what are the predominant protocols, how they work and so on and so forth right. And also, we will try to, as I mentioning that we look at little bit of programming like socket programming; how you can how two things works and etcetera right.

So, with this let us stop today’s discussion.

Thank you.