Computer Networks and Internet Protocol
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Lecture – 55
Layer 1: Physical Layer

Hello. So, we are discussing on Computer Network and Internet Protocols, today we will be looking at the our level layer 1 of the OSI or in TCP IP model that is the physical layer. So, rather couple of lectures we will be discussing on physical layer phenomena though in some of the literature on in several standard some of the standards they considered physical and data link as a single layer like if you put the NIC card it comes with the both things.

And though again the physical layer as we will see is more related to the so, to say quote unquote electronics and communication perspective, nevertheless we need to try we need to understand that physical layer basic philosophy, which allows me to carry the traffic from one network to another network and type of things.

So, as we discuss several times that, any upper layer phenomena need say lower layer to communicate; that means, unless the lower layer is there it is not able to do it not able to communicate and end of the thing is the physical layer. That should be a physical connectivity between the source and the destination or in our cases the physical connect between two hubs. So, whether it is wired, wireless it based on the technology, nevertheless or fibre or whatever, but nevertheless I require a physical connectivity.

And there are several consideration like what should be the encoding scheme because finally, whatever we are doing with the system or at the end systems are generated digital signals right, but your communication path may not be suitable to carry that digital signals right. So, in that case you need to convert this digital to some sort of analogue and then communicate and do a other way around who will do that right. Who will provide the physical infrastructure to work on the thing work on this communicate path right. I buy a laptop I want to communicate with the rest of the world right through say mail, chat, browsing and type of things right. Either in a interactive mode or either I read or write type of things right.

Now in order to do that, I need to a connection to the overall networking cloud right or overall this internet; how do I connect? So, one the best way at the home what we are using is using the mobile data network. So, what you are doing? You are using the mobile as a hub right or hotspot or Wi-Fi hotspots or a type of things, then you connect to the mobile your device mobile device from your laptop and that interns use the backend data network to connect to the internet right.

So, this is something which is need to be connected or physically connected whatever your protocol and whatever you are working at the upper layer, this thing is needed right or you can connect your PC or laptop through a cable if you are having a connection in your office with RJ 45 through a cable. So, there is a physical connectivity in turn that point it is connected to a switch in turn to the backbone network and so and so forth right.

So, what we require at our end at the device end is a network interface card the NIC typically takes care of both your data link layer phenomena for more to say MAC layer phenomena and the physical layer standard, whether it is having a wireless connectivity, whether it is having a fibre connectivity whether it is having a coaxial connectivity or a RJ 45 Ethernet cable connectivity that is decided by your NIC card. So, NIC card has those interfaces right and then you can connect to the rest of the world the physical connectivity will be there.

So, there is the physical connections what is there lot of things goes on and its a very complicated not only complicated its a very complex communication procedure which goes on which is another purview of communication. So, it would not be possible to deal with all communication phenomenon, but we will try to hit on those important stuff. So, today we are trying to see that what makes this overall process works together and then slowly in next 1 or 2 lectures we will see that what are the basic features which we need to understand when you will when we are looking at a computer network or protocol stack in a following some standards. Now, the picture which is available in several literature also we are seen in at the beginning of this lecture series.

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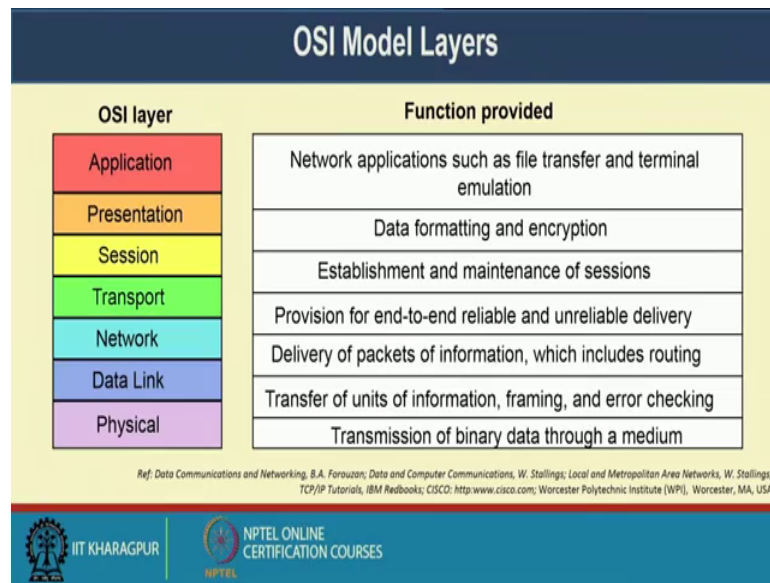
So, what we see at the end we have this physical layer, which is mostly responsible for transmission of binary data through a medium right very straight forward and simple right. So, if we go up, you have transfer of unit frames etcetera then delivery model for network layer and so and so forth right.

So, physical layer is concentrated with the things medium maybe wired wireless or any medium which allows to communicate right. So, this is the down the layer OSI again I am repeating in case of TCP IP, some of the cases we considered this two as a single thing in some cases the physical layer is kept apart because this is more of a communication phenomena, nevertheless it requires for to communicate.

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Now, two things are coming whenever we are discussing two stuff is coming one is communication, let us put it as a data communication because we are looking as, we are trying to look at data where we will communicate another aspect is a networking right or other time is what we do once the communication is there. So, data communication as we see transmission of signals in a reliable effective manner.

So, want to transform one node to another node. So, that is the way what we do get the data communication and it involves signal transmission, transmission media, signal encoding inter facing with different transmission media and interfacing with the NIC card with the transmission media and type of things and multiplexing and so and so forth.

So, these are the different aspects which are there with the data communication whereas, the networking it mostly deals with technology, architecture, protocols, protocol of communication network used to inter connect communicating device or entities or end points or intermediate points per say. So, its the technology, the other should be a architecture and the protocol or what we say standards so, that the two devices can communicate right. Here mostly what we have seen topic like LAN WAN networking protocols of different levels say routing and at the network level that a transport level communication TCP or UDP there are communication at the and finally, we have network applications which talk to peer to peer communication right.

So, these are mostly concentrated in the networking. What it tries to; what it assumes in when we will worked on the network? We assume that the underlining media is there right when you try to browse a particular site or do some networking do some network related operations with your system PC or laptop, what we assume that the as if the physical media is there right or there is a physical communication is there.

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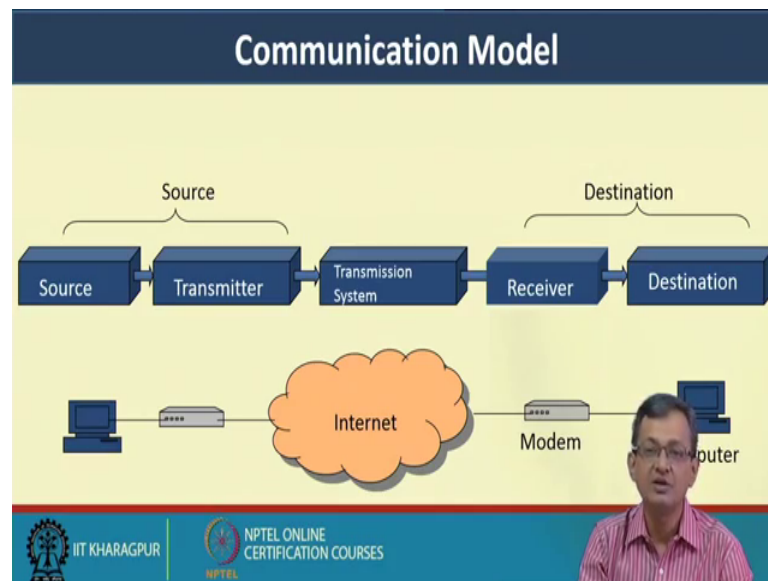
So, these are the two aspects and again in the literature, we will find that when we see. So, we have a source where the data is generated, there should be a something which is a transmitter then a transmitter carries the thing to a transmission systems right then at the other end I have a receiver and the destination which are there right.

So, this way source to destination is there, if it is a full duplex or both way communication and there should be a communication path when the destination source when it acts as a source and this is the distance. So, what we have this thing one is the source like typically PC or laptop can be a source a transmitter that some devices which allows me to transmit to the backbone of the network.

Then the transmission systems it can be internet or it can be a rather I should say that it can be a some sort of a communication system like the most prevalent communication system what we are having is the telecom network right; so, the internet with the backbone as the telecom network and then we have other things right. There is a what

call modem come into coming into picture we will seen coming one or two slides that what is there and that the other end of the computer.

So, I have some way to communicate with the things right, it can be a mobile device, by this systems connect to this say particular mobile device and then this interns at the data network at the backbone and then it the data traffic goes out. It can be like this, this system my system can have a RJ particular Ethernet cable, which is connected to the wall mounted socket which is in turn connected to the backbone layer to network, a back backbone layer to switch or the layer to switch off our IIT Kharagpur network which in turn connect to the hierarchy of switches finally, goes to the gateway to go out of that particular network right.

If it is required or if it is within that the same switch network, then it as whatever is there to be do in a layer to switch right. So, that is the way is here. So, there is some devices which allows me to push the network thing.

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And if you look at the communication task, there is a variety of things, some of them I list transmission system utilization, interfacing or rather than utilization if you say transmission system utilization is definitely another aspect transmission system utilization, interfacing, signal generation, synchronization of the things. Once we communicate there should be a way of synchronisation there is a exchange management

or there should be a when we exchange the thing there should be a inner in management things like I send a data I get acknowledgement and type of thing.

Error detection and correction mechanisms, if there is error how to recover from the error addressing and routing how to the route packets, recovery from a particular field situation, message formatting. Another aspects which come into play though it not directly may not be possible to do cover those things, but what we plan that at least one if possible two lectures we will talk on network security aspect right.

Become this is becoming extremely important so, what are the different aspects of network security that we will take which is so, that is also a thing, and then we have a network management overall network management process to handle that things. So, these are the different aspects of communicate task or so to say computer data communication components right. So, it is a when you do looking at the data communication aspects of it.
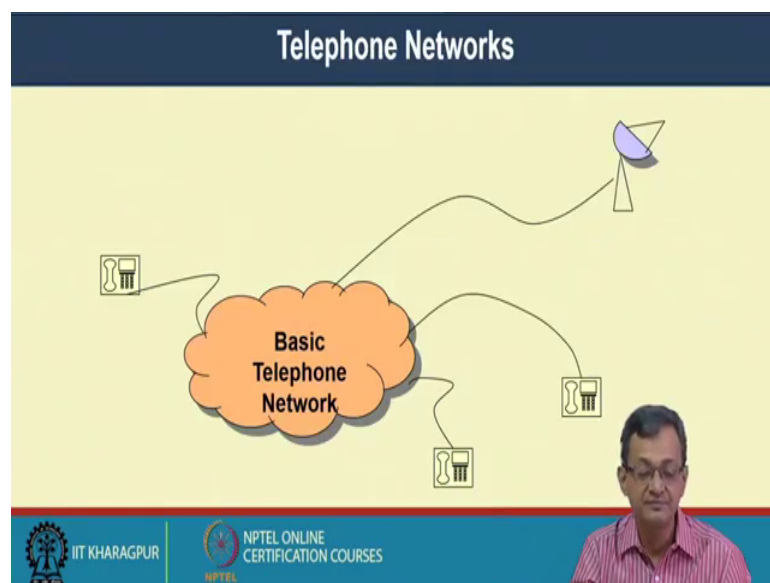
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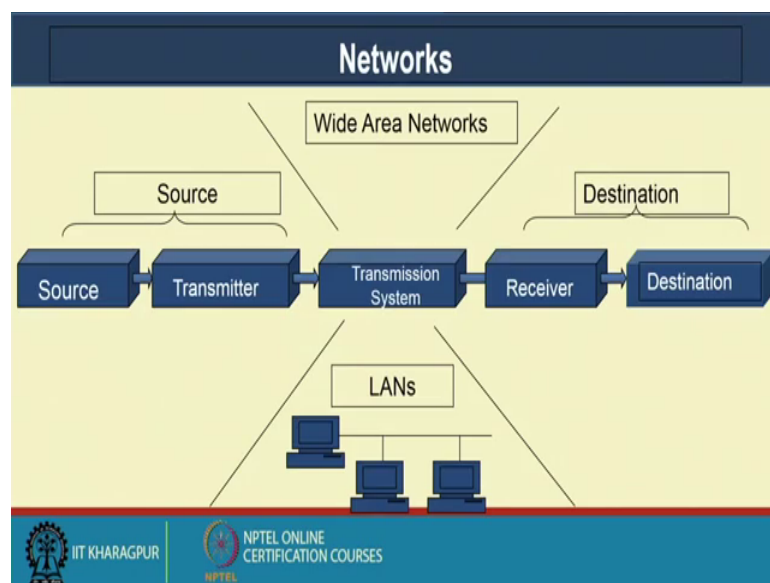
So, we have two type of things one is a Local Area Network or LANs right. So, there are several protocols which are predominantly for the LANs, we will see that there is a basic consideration for LAN another category is a WAN Wide Area Network which is connect to the internet. Typically what we say this LANs are pretty high speed thing, like you get a backbone of a connectivity of one Gbps connection etcetera through your system

provided your NIC card supports that right 100 Mbps is very common is the defecto things or communicating in the things.

Whereas, if you look at your other side of the router, getting 8 Gbps links is pretty costly right so, even means to that tune of order of 100 Mbps as also costly to maintain. So; that means, in other sense the LAN connectivity is much higher than the backbone or the internet router level connectivity. So, and if you look at the source and transmitter at together we put in the sources like your NIC card is sitting on your system itself. So, the both the transmitting and the typically the source of the data are together.

So, out of what we typically see you have the source which is having source data source and the transmitter, you have the destination which has the receiver and the destination for the data right an intermediate thing is that transmitted media and we will we will try to see that what are the different consideration for this transmission media for in one or two lectures.

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So, what is the predominant things what you are having is the telephone network right. So, that is the something which is omnipresent when the communication network coming into play.

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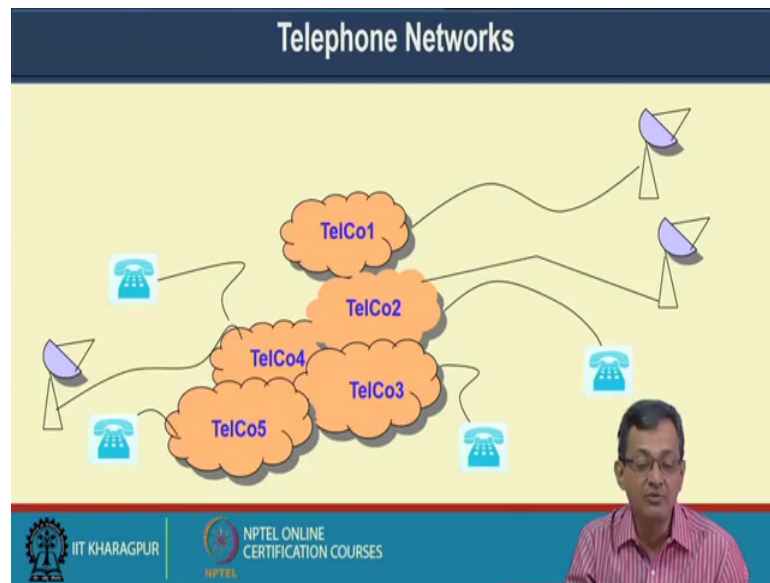
So, this is very much there this telephone network and what we see rather it is what is see basic telephone network. What rather we see there are not only there, there can be different parties which are there right, there are different telecom companies Telco's which are in your serving in your area or serving in your region state country and type of things right.

So, these telecom operators are primarily initially started or primarily started for voice communication, but now they graduated to a scenario of to data communication rather streaming data type of thing. So, voice data multimedia along with mobility right. So, this sort of communication are happening into the things right definitely we have devices which can talk to each other using these things.

There are one thing come into play immediately that this different Telco's should be able to communicate with each other; that means, there should be interoperability between different telecom company right or if you look at our things that mobile service providers or there should be some way, how they communicate with each other. So, that is one important aspect, now if I can put somewhere other my data network or my data communication paradine into this enter this telecom cloud, then at least the backbone communication I can ensure with their data communication right. And if you practically see its a huge infrastructural investment when you go for this sort of thing; its a huge infrastructure investment when to when things are there right if you look at.

So, we can utilize the things; what we require? We require some connectivity with this thing with your system or your network or your organisation network to the nearest telecom centre or what we say nearest exchange right, if you are a organisation by. When we use as individual then my system should be able to communicate to my network suppose I have a BSNL or Airtel or Vodafone or something Reliance and etcetera etcetera connections what I require is the how I communicate to the system to the they are backbone telecom network. Once it is there then the connectivity everybody is connected things are there right.

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So, another thing as we are discussing so there is a the usually our communication path are analog right wire or wireless audio tones info conveyed through a signal amplitude frequency phase or analog signal right where as the working of our system etcetera are primarily digital or 1's and 0's. So, what is the problem happening? You are basically generating a series of 0's and 1's needs to communicate through a media, which understand that analog signal.

So, you a generating a digital signal, but need to be pump through a media which understands a analog signal right. Consider a wire that previously how used to communicate, there is a many of you might have not seen that. So, there was landline still it is there through the landline phone cables, there is a device used to connect and

that device connects to this system or the computer, when I used to we used to communicate we communicate this through this.

So, this device is typically a modem right or what we say a modulator and demodulator. So, the modem at the source end or one end is does that modulation signal getting a binary set, it modulate and pumped into the analog by this; analog backbone which understand the analog, that is carried to the other end of the signal and then it is again demodulated and push it to the end system. So, the two system talks each other at the physical layer itself they communicate that one is modulation another is demodulation at the other end right so that two terms we is called it is modem.

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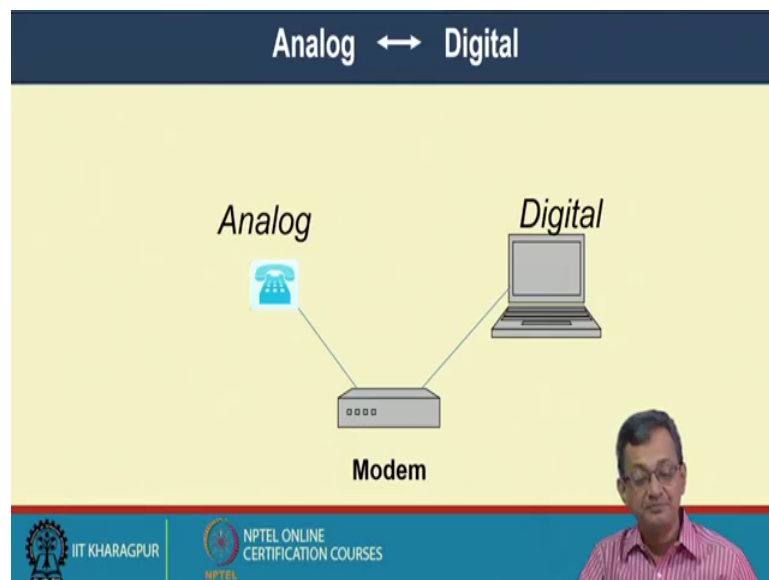
So, it is like this I have a analog network, it's can be a phone or type of the cloud itself. So, the digital signal through the modem goes to this analog and goes out right. So, this analog to the another end while at the in system it is the other way around right. So, that is a very effective device and we could able to easily connect it is not there are lot of other hindrance as like your call drops like it goes can disconnected say the nevertheless the phenomena is at straight forward. You need to have a modem at your disposal, which connects to the rest of the network where at the other end also somebody who is communicating as having another modem so and so forth.

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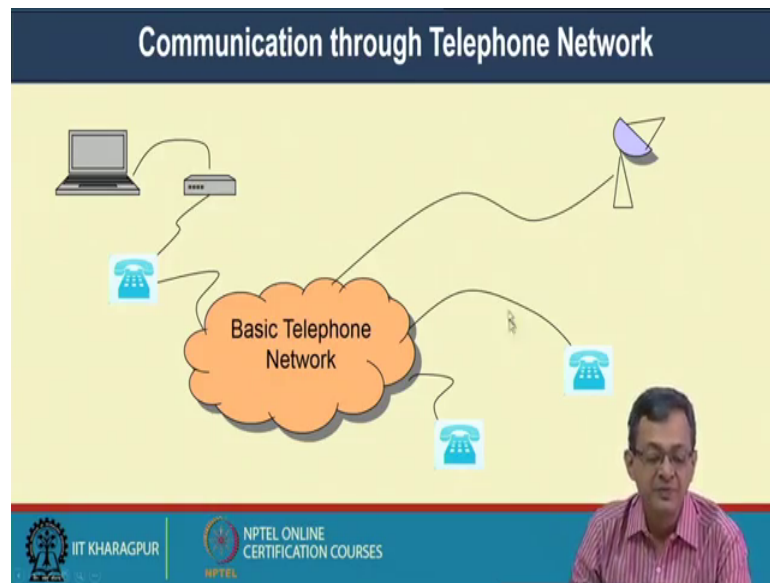
So, what we do effectively? So, we have a system through a modem, it communicates through this basic network and communicates here again a modem and a basic system right and a computing system. So, I can use these backbone network or the backbone telcom network to communicate with the two systems right so using modulator and demodulator or modem.

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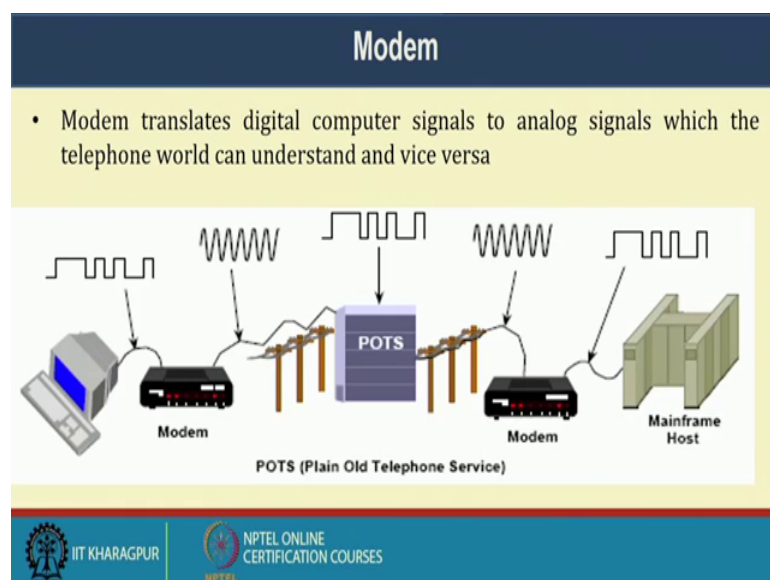
Now if you look at the modem, modem translate the digital computer signal to analog signal which is the telecom network or the telephone backbone understands and carry it

to the destination and vice versa right. So, that is the things are there and there is a like what we have that plain old telephone systems or the pots. So, what telephone service there is a pot, and then what this modem allow is to communicate with this things right. So, that is the way we communicate.

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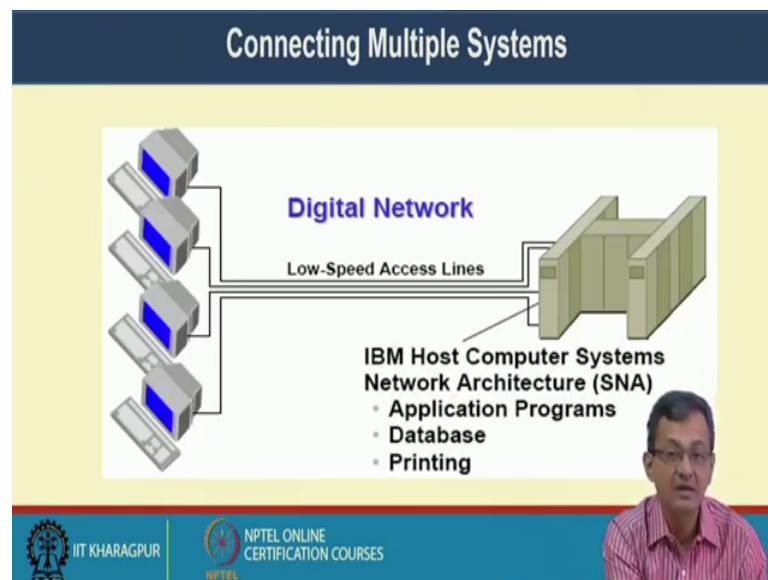
So, what we see if there are multiple systems need to communicate with the other system; like there is a bunch of system out here, which wants to communicate with this say this is the server at the other end right. So, there can be read of the server, application server different type of different type of clients which wants to communicate with this server; and for that what we require? We require individual lines to communicate with the things right. So, to say if I am communicating distance where modem 1, modem 2, modem 3, modem 4 and communicating with the things or even it is communicating with a wired miss to connect if means a wired connectivity from the source and destination.

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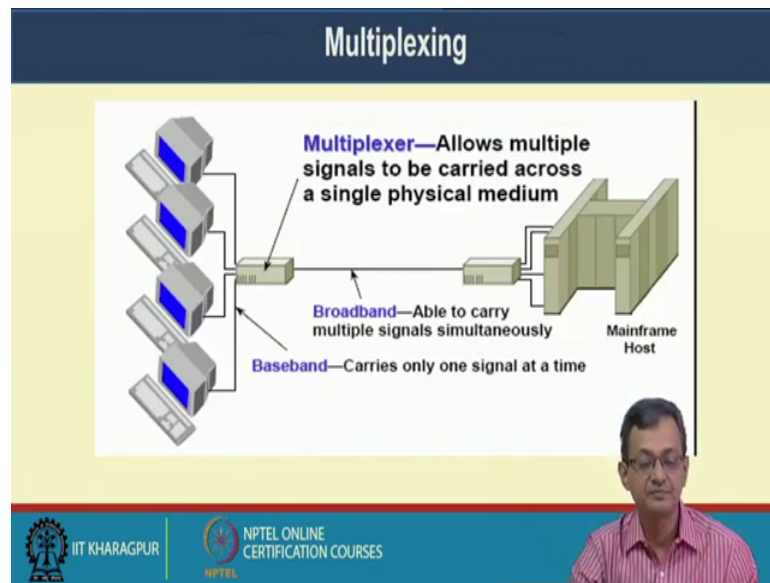
Now this becomes a combustion process if multiple things are there. So, we have a there is a concept in the communication called multiplexer or multiplexing where a allows multiple signals to be carried across the single physical dimension so, that is the multiplexing. And if you look at these are there can be different type of things we will discuss in our subsequent lectures, that is one is time division multiplexing or TDM frequency division multiplexing and so and so forth. So, these are through popular things and we will see that different variance of the things.

Now so I have different signals which are generated by this different systems and then we have a multiplexer which multiplex this things and usually this when the signal things are communicated these are through baseband communication whereas, these are through broadband communication. So, apply able to carry single multiple signals simultaneously, in a baseband it carries only one signal right. So, this is the way it is there. So, I have broadband because there are multiple signals. So, there are multiple. So, those are multiplex using some technology and that has be communicated to a broadband signal.

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So, just to quickly do the letters are pretty little small in size, but nevertheless we just have a quick look at the baseband and broadband. What the baseband said? Baseband transmissions typically use digital signalling over a single wire right so; that means, the transmission themselves take the form of either electrical pulse or light the thing. So, whether it is a what sort of media is there, that digital signal used in baseband transmission occupies the entire bandwidth of the network. Band to the network media and transmit a as a single data signal right. So, typically the baseband multiplexing is the TDM.

Whereas in case of a broadband uses the analog signal in the form of a optical and electromagnetic wave over multiple transmission frequency. So, I have multiple transmission frequencies or carriers by which this signals are carried. For signal to be both send and received the transmission media must be split into two channels. If I have a send receive type of path then we have a things that is true for they are also that if you have to both send and receive data using single cable, then that type some sort of a mechanism that with (Refer Time: 25:54). However, the sending and receive can occur on the same whereas, the same time. So, either I to have a separate two separate cables can receives or some arrangement of doing some sort of a time division multiplexing, where multiple things can be share.

So, in case of a broadband also multiple channels are created by the broadband system for multiplexing technique, known as using some a approach for frequency division multiplexing, we will just see those things for in subsequent lecture.

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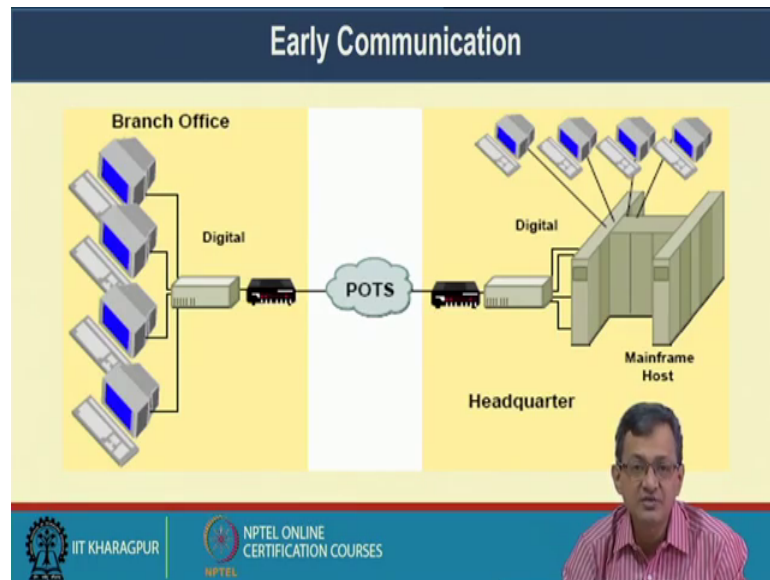
So, early communication so there is a pots and it able to communicate. So, there is a branch office or head quarter or a location 1 and location 2. So, it has some multiplexer, then if I have a multiplex a modem which communicate to the plain (Refer Time: 26:59) telephone service, which in turns communicate to other modem to or this is for modulation one end, this is demodulation and then if there is a multiplexing. So, there is a demarks and the signals are formed into the at the server end or the other end.
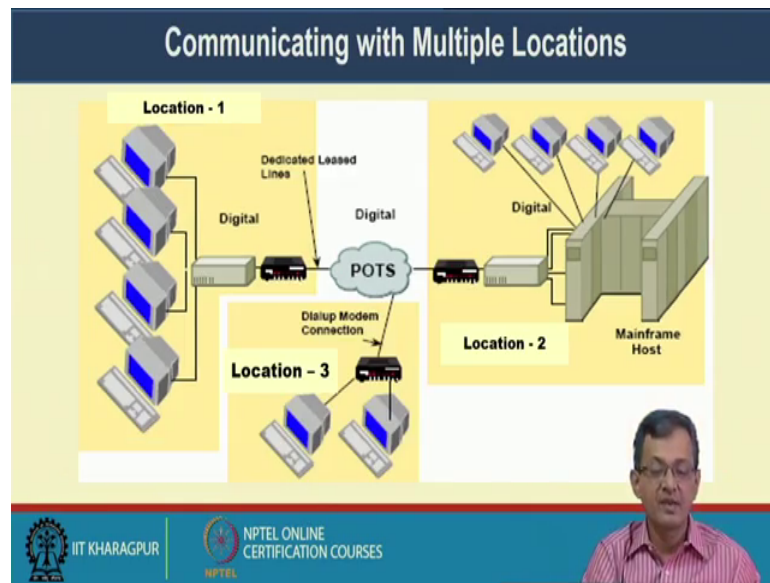
Now, with if the multiple locations are there, then we have multiple modem connections where say and so and so forth. So, with these things also its works fine do the achievable speed is not that high secondly, the management etcetera also challenging right. So, there are different architecture, different protocols of managing them and type of things right though there are lot of standardizations will occur. So, these are three locations where these are communicating with the modem and then it is communicate into the plain old telephone services or pots framework or pots backbone.
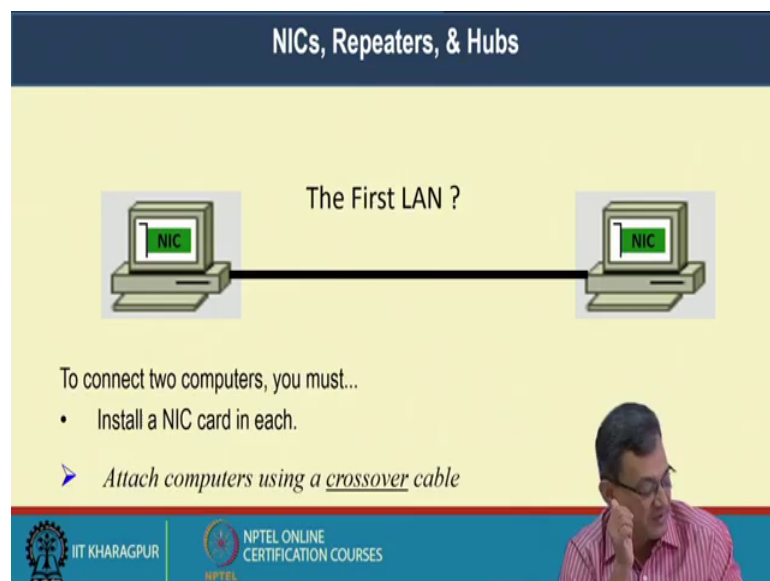
So, what we are looking and that if we look at the physical layer consideration one is your NIC or Network Interface Card as we discussed. So, NIC provides both this MAC and the physical layer as we are discussing it gives a connect a way to connect through a RJ 45 cable or through a wireless media or even through your say COX cable if it is like there coaxial cable is there is prevent. So, two systems, we to connect two computers what I need to do? Suppose I have two computers how do I connect? Install NIC at each right and then connect the thing right? I can have a single cable to connect to the two systems because I if my networking is based on these two system, I do not require something to do that.

But it is how, there is a small catch that we need to do using a crossover cable; that means, crossover means distance of this sources receive of other things and tense of the b in the receive cable of the thing. So, it is cross over to the thing. So, that is a crossover cable or popularly what we say cross cable right we require a cross cable means there is. So, two system can communicate so it is consider at the thing. So, this physical connectivity is that through a say RJ 45 cable.

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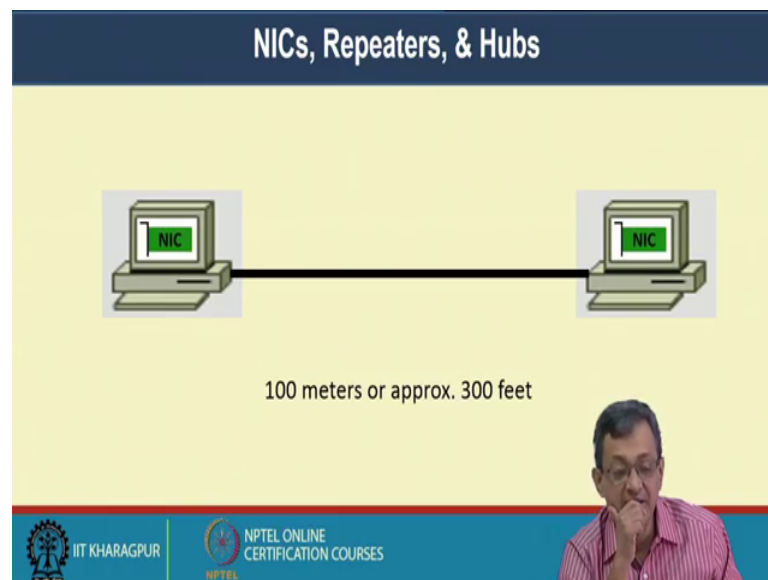
So, typically this cable can be stretched up to 100 metres or 300 feet that for say fully construction of things, but in reality we may not able to go that path it is little less than the 100 metres considered as a, otherwise signal degradation will be much higher to handle that.

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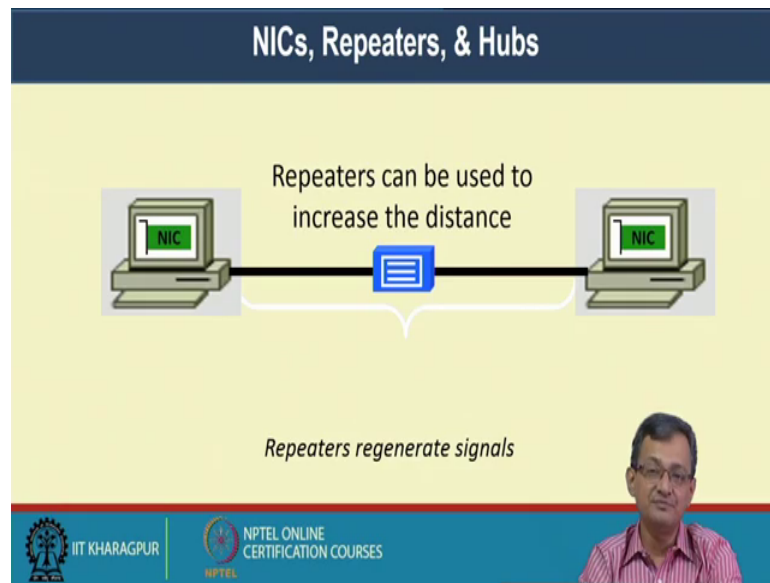
If it is more then we require something call every repeater right. So, a repeater which regenerates the signal right so that is a repeater can be used to increase the distance. So, if I have repeater, again the distance is increase there right. So, repeater regenerates the signal.

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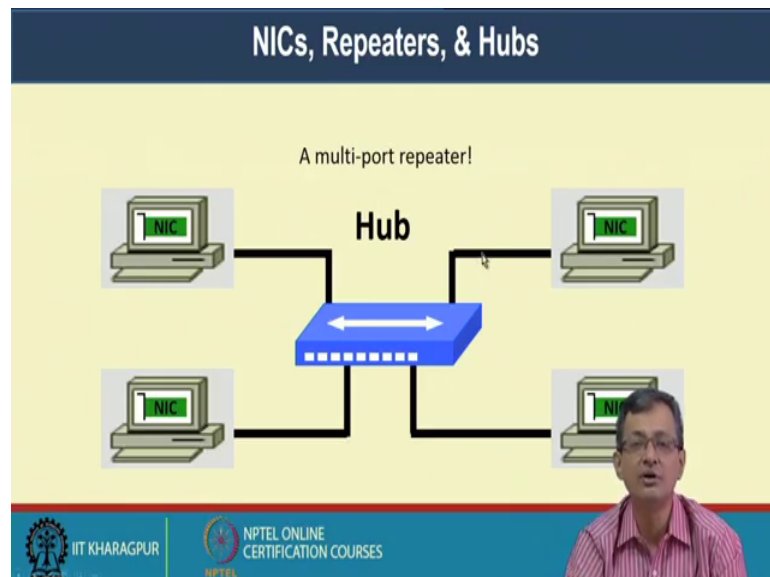
And one we look at the concept of hub, if there a number of points needs to be connected then we have a hub or multi port or also a sort of a multi port repeater right. So, these are the devices which are at the manifestation at the network here the layer 2 or the physical

layer. So, any other layer thinks like instead of the hub if I have a layer to switch, that also works as a signal regenerator and have this physical layer connectivity. So, that instead of hub, I could have a have a layer to switch or I even can have a layer 3 switch or where we have the routing for the network layer level active activation right.

So, any of a layer has all the lower layer phenomena. So, that is absolutely fine it works with right. So, another things what we previously also discussed we just to mention again that, see at the layer 1 I am in the same broadcast level or at the same as a thing the same collision domain also. So, as we are in the same collision domain. So, the more is the collision or more simultaneously the stations want to exchange information, there will be collision and retransmission of the signal right.

Suppose considered this a four port switch, a four port hub of say 100 Mbps for our some arguments thing right. Now with the four systems are connected. So, and they all are communicating at the simultaneously. So, there in huge amount of collision or retransmission of the signal or effective bandwidth will form right. So, even if it is a backbone of 100 Mbps. So, effectively if or in a what is situation we will get a around 25 Mbps right. So, divided by across the thing. So, the half the overall bandwidth is divided by the number of ports of the end type of things. So, that is a as in the same collision domain all right.

But the other side is that, more you go on the higher devices more cost increases right the hub is the switch is much costlier than hub, layer to switch a layer 3 router is costlier than the layer 2 switch and so and so forth as you go on the things right. So, hubs are go for some very small network or for extending a network and type of things, but may not be that if you see into do that. But our basic consideration is not that immediately finding the overall performance efficiency, but to look at that how to connect systems across right at the physical level right. So, this is the thing.

So, what we have seen today is more of looking at the different aspects or of that of at the physical layer of the layer 1 and in our subsequent lecture or what we will look it to some more phenomena and go little deep into the some more phenomena of this physical layer like that including multiplexing and so and so and forth, how they work and type of things right. So, that in subsequent lectures in this. So, with this let us conclude today and for and we will continue in the in our next class.

Thank you.