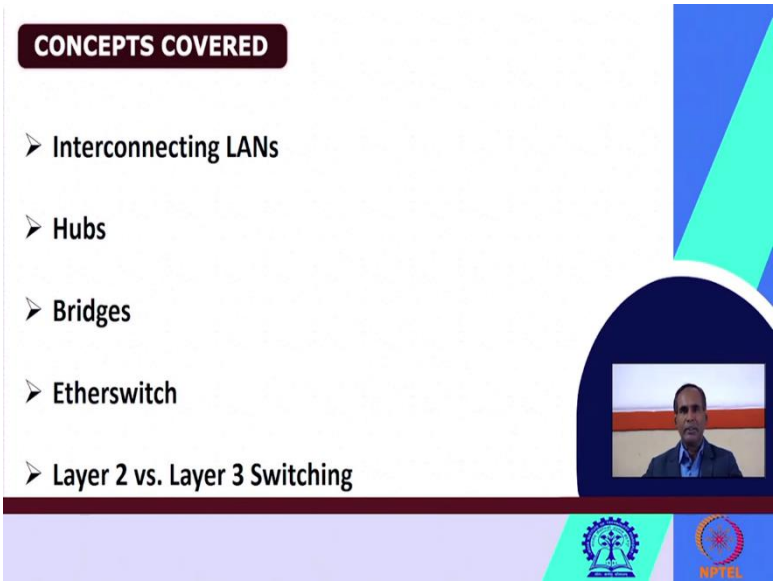
Real Time Systems
Professor Durga Prasad Mohapatra
Department of Computer Science and Engineering
National Institute of Technology Rourkela
Lecture 50
Basics of Internet

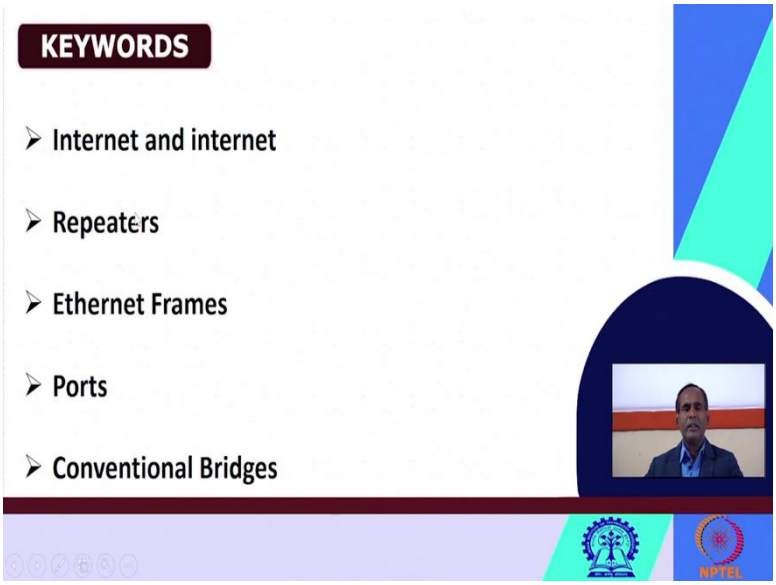
Good morning to all of you, last class I have told you that three kinds of networks are relevant to real time systems, one is controller area network or CAN second is local area network and third is internet which is an example of packet switch network. So, today we will discuss about basics of the internet, last class already we have discussed about control area network and different topologies of LAN, ethernet etcetera we have discussed in the last class. Today we will discuss about this internet and how it is suitable for real time communication.

(Refer Slide Time: 00:56)



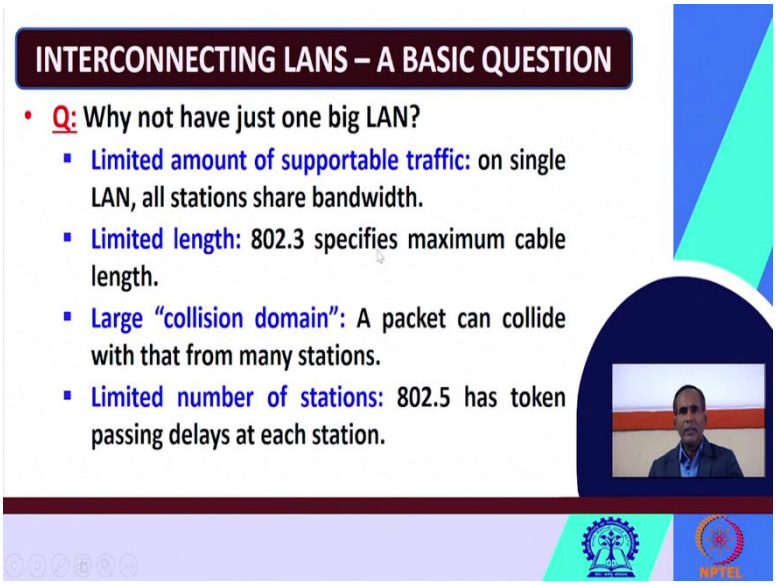
So today we will discuss about the basics of internet we will discuss about why just interconnecting a number of LANs is not suitable then we will discuss the concept of hubs bridges, Ether switch etcetera. Final we will discuss about layer 2 switching versus layer 3 switching.

(Refer Slide Time: 01:11)



We will use these keywords very simple keywords Internet and internet places as a difference Internet starting with capital I and internet starting with small i, what is the difference? Then repeaters Ethernet frames, what do you mean by ports, conventional bridges etcetera those things we will discuss.

(Refer Slide Time: 01:31)



First let us start with as last class we have already discussed about LAN. Now let us see is it possible we can just interconnect a number of LANs to just get a big LAN, is it possible? A very basic question I am asking, why we do not have just one big LAN instead of what getting out so many small LANs and can we connect them in to just get a big LAN.

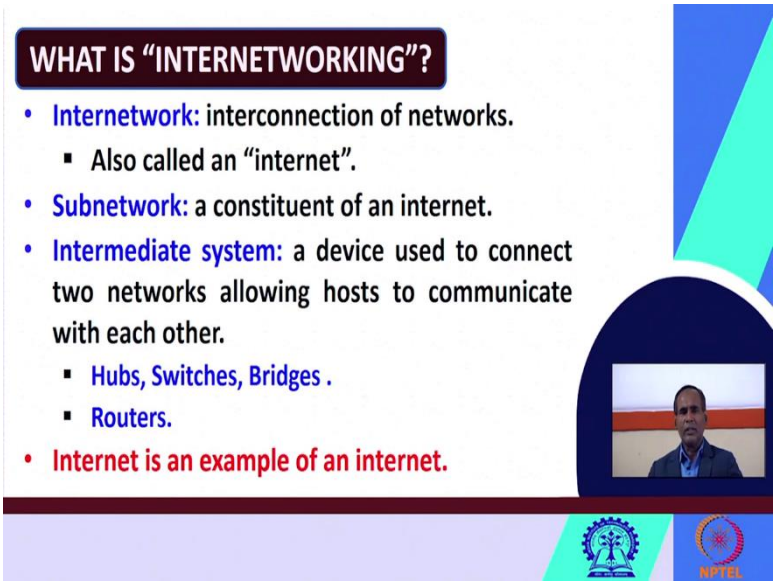
The answer will be no, it is it will not be suitable. Why? Let us see the reasons why it is not suitable just to have a big LAN by interconnecting some small LANs. Number one reason limited amount of supportable traffic. See why we cannot connect many LANs to get a big LAN because there is a limited amount of supportable traffic only. On single LAN all stations they will share the bandwidth, that is number one reason why we cannot have just a big LAN.

Second, there is also there is a limited length and you know 802.3 it specifies the maximum cable length you cannot exceed that length. So, it is difficult to get a big LAN by interconnecting these LANs. third largest collision domain a packet can collide with that from many stations when you will interconnect some LANs, then what may happen a packet it may collide with the other packets from many other stations.

So, that will lead to large collision domain and one of the another or one of the reasons is that limited number of stations. How many stations you can have when you will interconnect LANs? Can you go to indefinite number of stations infinite number of stations? No, 802.5 standard says that it has token passing delays at each station.

So we have to limit the number of station we cannot go beyond certain limit. Because the 802.5 standard it has what this it has this assumption that the token passing it delays at every station so we cannot exceed the number of stations by a certain value there is a limited number of station. So, these are some of the possible reasons why we should not have just one big LAN by interconnecting LANs. Then what is the solution?

(Refer Slide Time: 03:46)



The solution is we should go for internetworking. So what is internetworking? Internetwork means it is the interconnection of some networks, internetwork means it is interconnection of what some networks it is a call also called an internet internetwork by what in short we call as internet work, it starts with small i.

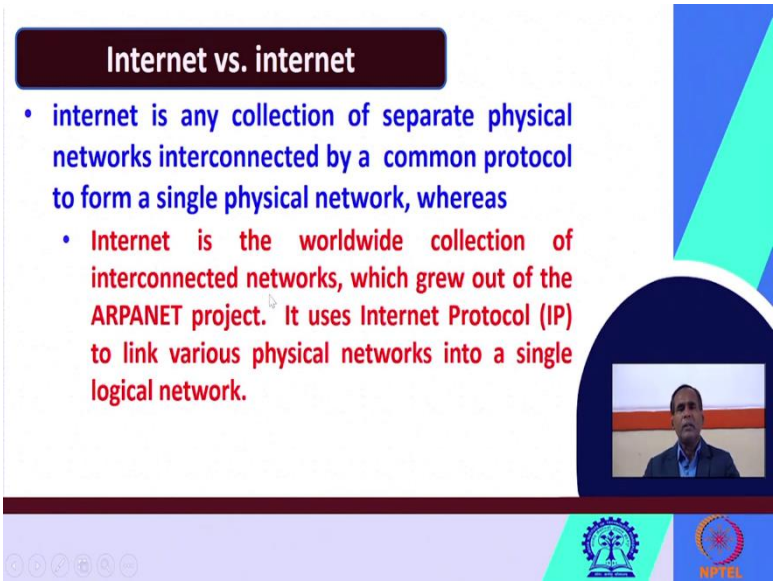
So, what do you mean by sub network? Sub network means a constituent of an internet while you are taking this internet and you it takes different components different constituents of internet. So, a constituent of an internet is called as sub network. What is an intermediate system? intermediate system is a device which is used to connect two networks allowing hosts to communicate with each other.

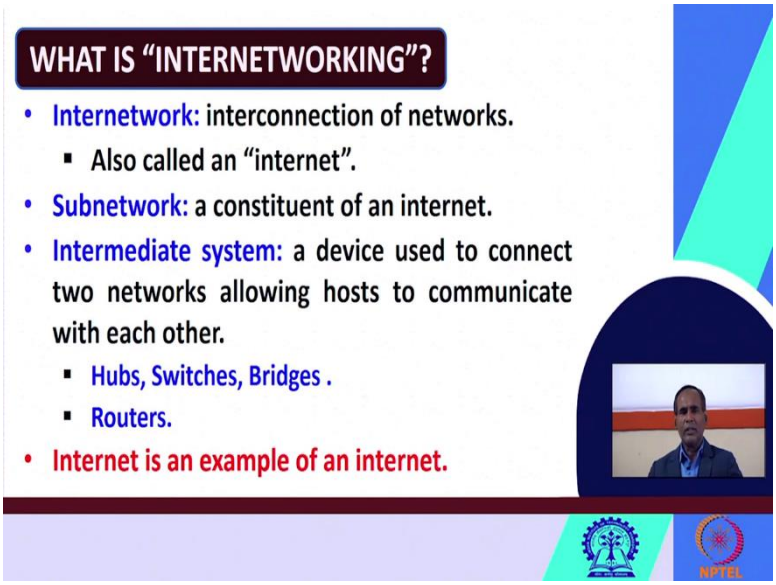
So intermediate system means it is device which can be used to connect two networks, which will allow the hosts to communicate with each other to communicate among themselves. So, examples you can see as I have told intermediate system these are devices, what could be the possible devices the possible devices could be the hubs, switches, bridges, routers, etcetera.

I hope these things you must have learned in your computer network paper subject in some earlier semesters and now you will see I am taking an example of this internetwork so you can see Internet is an example of an internet please mark the difference this starts with the I and the capital I whereas this internet starts with small i.

So, this internet with small i mean it is an internet work it is stand for internetworking but this capital I Internet starting with capital I it is an example of internet. Now let us see what is the difference between this Internet and this internet.

(Refer Slide Time: 05:37)





So, internet starting with the I versus internet starting with small i. So, when the internet is start with small i means this definition, I already told you it is a collection of or it is the interconnection of networks. So, internet starting with small i means it is any collection of separate physical networks. So, internet starting with small i means it is any collection of separate physical networks which are interconnected by what which are interconnected by a common protocol and why they are interconnected they are interconnected to form a single physical network.

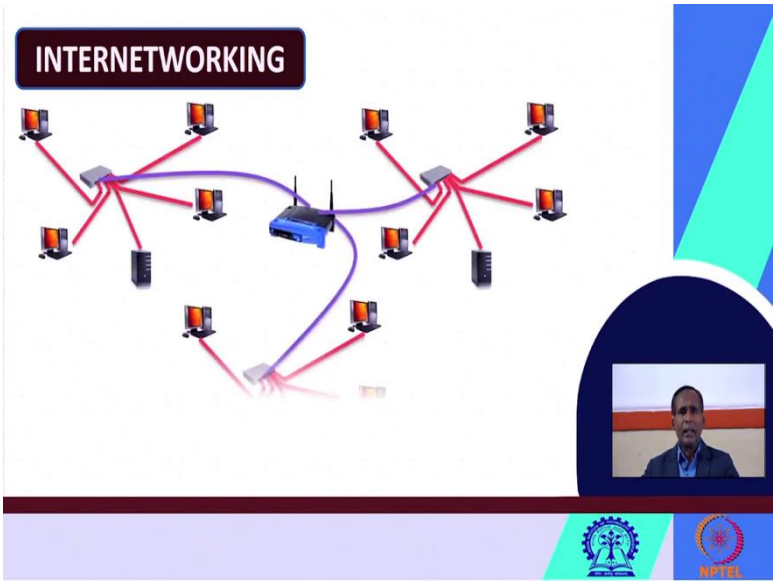
So, internet starting with i it is a collection of some separate physical networks which are interconnected by some common protocol in order to form a single physical network and what is the internet which starts with capital I? So, internet starting with capital I is the worldwide collection of interconnected networks I have already told you internet starting with capital I is a what, it is an example of small this internet starting with small i.

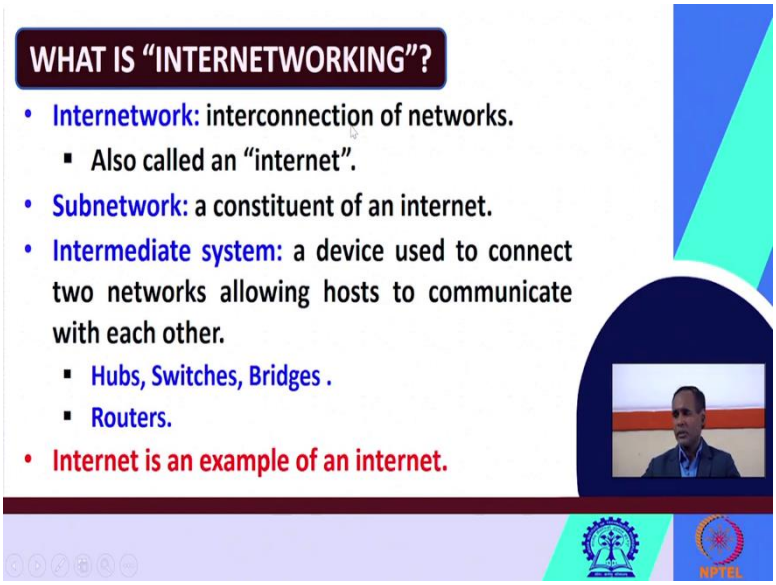
So, this internet is a worldwide collection of what? It is a worldwide collection of some interconnected networks and which grew out of the ARPANET project, I hope in a computer network paper you have learnt about ARPANET project so this internet is a worldwide collection of interconnected, some interconnected networks which was grew at that time out of the ARPANET project, it is a US newest project.

So, this internet starting with capital I it uses a protocol called large IP internet protocol I hope you have already known this IP protocol and the various versions of IP protocol you know IP version 4 IP version 6 etcetera. So, this internet it uses IP that means internet protocol. Why?

This uses internet protocol to link the various physical networks into a single logical network. So, this internet this uses internet protocol or IP to link the different physical networks into a single logical network. So, this is the difference between that internet starting with capital I and the internet starting with small i.

(Refer Slide Time: 07:50)





Now let us the details of this internetworking. You can see as I have already told you internet means what collection this definition of internet, I have already told you it is interconnection of some networks. So let us see, this is a small example of internet I have shown so there are you can see here some networks are there, this is a network, this is a network, this is network, they are interconnected through this one. So, this is the intermediate device here. So, in this

way this shows a good example of this internetworking. So, here are some networks they are connected by a device.

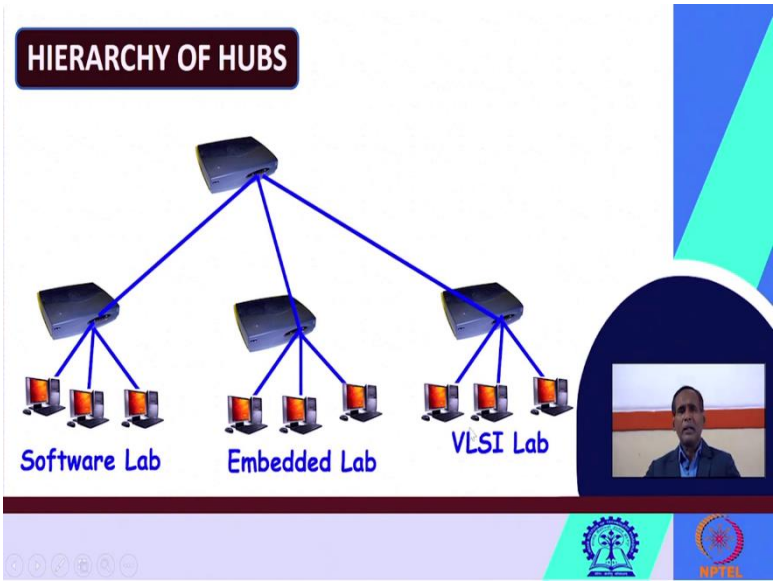
(Refer Slide Time: 08:27)

Now let us see I have already told you these devices, examples of devices like hubs, bridges, routers, etcetera. So, let us see about first the hubs. This hub is a physical layer device. So, last class I already told you in OSI there are 7 layers, starting from physical layer data link layer and like that. So, there are 7 layers. So, this hub is a physical layer device and it essentially it is a repeater operating at bit level.

So, this hub it essentially works as a repeater operating at the bit level. So, what does it do since it acts as repeater, what it does? It repeats the received bits on one interface to all other interface. So, as it acts as a repeater, it repeats all the received bits on one interface to all the other interfaces, the how the hubs can be arranged?

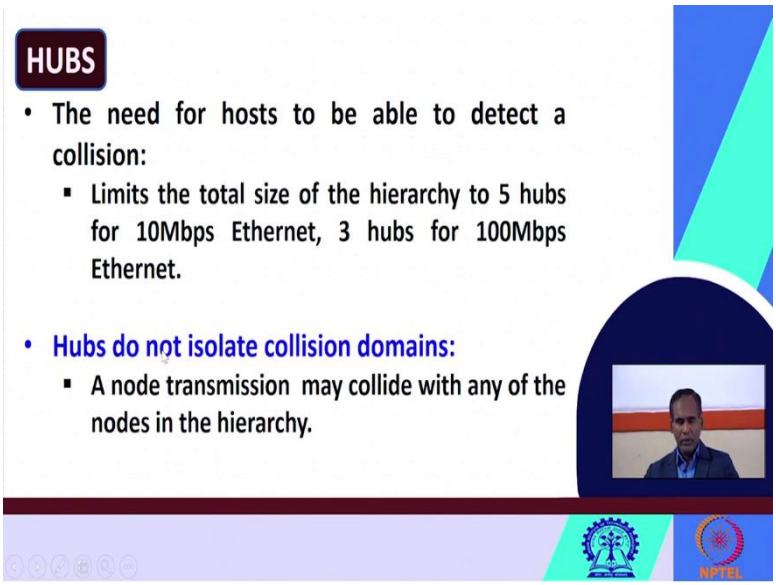
Normally, if will see any computer center or in your institute, so normally hubs they can be arranged hierarchically. So, hubs can be arranged in a hierarchy with the backbone hub at the top. So, at the what will happen, so, at the top the backbone hub will be there. So, the hubs normally they can be arranged in a hierarchical manner with the backbone hub present at the top.

(Refer Slide Time: 09:41)



Now you can see a hierarchy of the hubs how they are arranged. So here are the this is the first let you can say one hub, then hierarchical again there are three hubs on each hub now these two each this hub say now three computers are connected to this hub and the three computers are allotted say these computers are in the software lab, these are in embedded lab, these are in VLSI lab. So, in this way the hubs are arranged hierarchically. So, hubs can be arranged hierarchically.

(Refer Slide Time: 10:10)



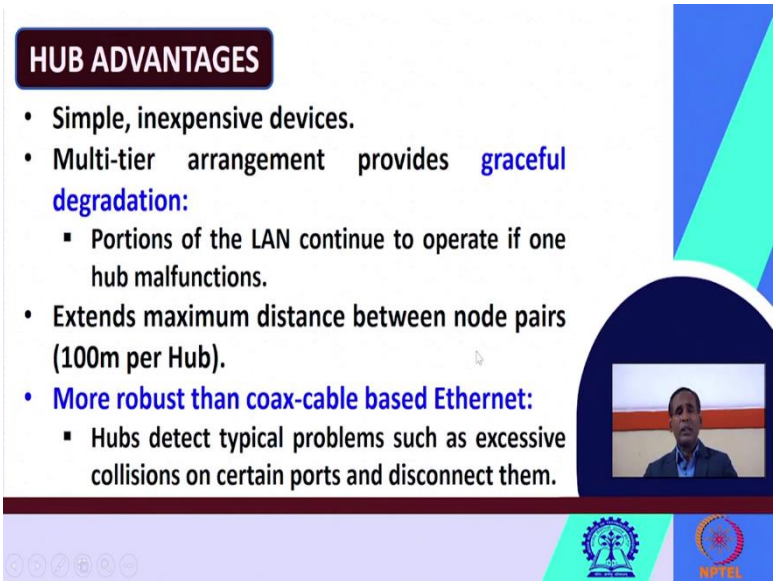
The need for hosts to be able to detect a collision. So, what is the need of the hosts? So, the need for the hosts to be able to detect a collision, how the hosts they can detect the collision. So, for this what needs to be done the need for hosts to be able to detect a collision is to limit

the total size of hierarchy to up to 5 hubs. So, in order, what detect the collision, you have to limit the total size of the hierarchy to 5 hubs for 10mbps Ethernet.

So, if you are using a 10 Mbps Ethernet you can limit the total size of the hierarchy up to 5 hubs and if you are using 100 Mbps Ethernet then you can limit the total size of the hierarchy up to 3 number of hubs, that is the restriction that you should remember. Please remember hubs they do not isolate collision domains, these hubs that you are using, these hubs they do not isolate the collision domains. A node transmission may collide with any of the nodes in the hierarchy.

So, whenever any transmission occurs a node transmission there is every possibility, a node transmission may collide with any of the nodes present in the hierarchy that is possible. So, hubs they do not isolate the collision domains whenever any transmission is there a node transmission may collide with any of the nodes present in hierarchy this is possible. So, collisions may occur.

(Refer Slide Time: 11:33)



Now, let us see the advantages hubs this very simple, the hubs are very simple and what inexpensive devices so multitier arrangement provides graceful degradation I have already told you this what hierarchical arrangement. So, you are arranging the hubs in multiple levels, hierarchically.

So, this multitier arrangement it provides a graceful degradation. What do you mean by graceful degradation? That means whenever some portion of the LAN continue to, it fails or one of the hubs it fails or it malfunctions, then the LAN would not stop immediately what it

will do, rather it will just continue to operate in a degraded manner or in a graceful degraded manner.

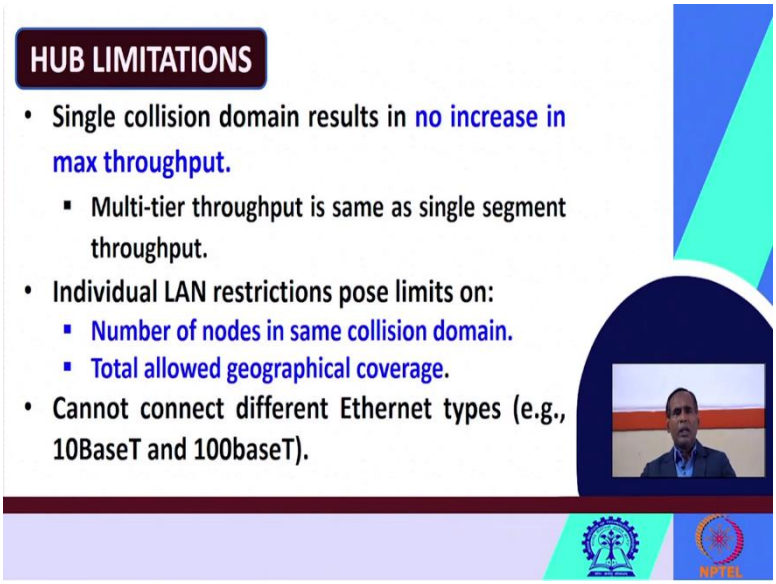
So, the point of speaking is that the due to this hierarchical arrangement due to this multitier arrangement, it provides graceful degradation, graceful degradation means whenever any hub it malfunctions or it fails the whole LAN does not fail rather the portions of the LAN which are they have not been failed then those portions of the LAN they continue to manage the job, they continue to operate, but maybe in a graceful degraded manner. The it is hubs another advantage is that it extends the maximum distance between node pairs.

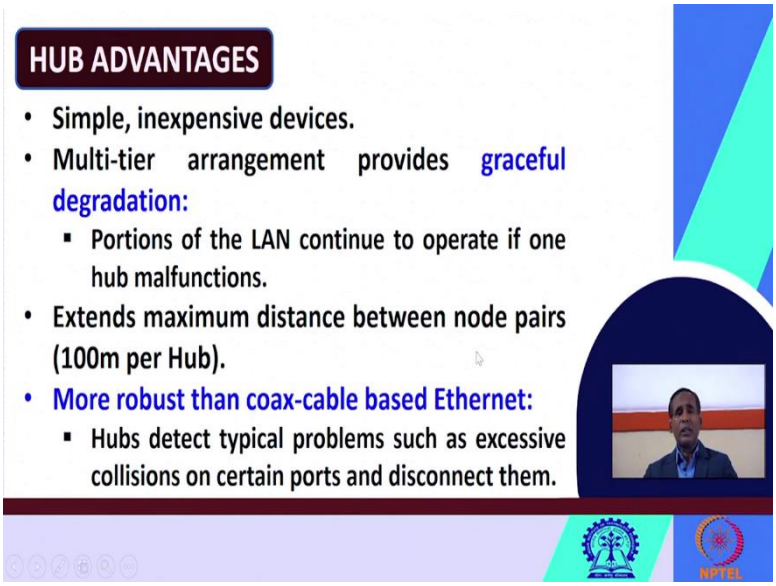
So, if there are two nodes this hub it can extend the maximum distance between node pairs maybe up to 100 meter per hub in this way it can extend the maximum distance and another advantage is that it is more robust than the coaxial cable-based Ethernet. I have already told you in the last class, the Ethernets, some of the Ethernets like 10 series of this what some of the things Ethernets they are using coaxial cable and some of the Ethernets they are using twisted pair those things we have discussed in the last class.

So, this hub one advantage is that it is more robust. Why? Because here you can see that it does not use a coaxial cable, it is a more robust than the coaxial cable-based Ethernet. So, last class we have seen this what a 10 base to 10 base 5 etcetera where coaxial cable is used. So, in comparison to that it is more robust. So, hubs are more robust than coaxial cable-based Ethernet. Here the hubs they dictate the typical problems such as excessive collisions on certain ports and disconnect them.

So, whenever these they found or the hubs, they found some typical problems such as what some very excessive collisions, excessive collisions are there on some portion or on some on some of the ports or on certain of the ports, then what happens? After detecting, immediately the hub detects those portions where it finds a greater number of collisions. So, in this way this is more robust than the coaxial cable-based Ethernet.

(Refer Slide Time: 14:19)





It has also some limitations, in spite to have of getting the advantages still, hub has some limitation let us see, what are the limitations. The single collision domain results in no increase in maximum throughput. So, we have already told you here that the collisions are actually can they can be detected and that can the corresponding ports can be disconnected but still, the single collision domain it results in no increase in the maximum throughput, the throughput is not increased significantly.

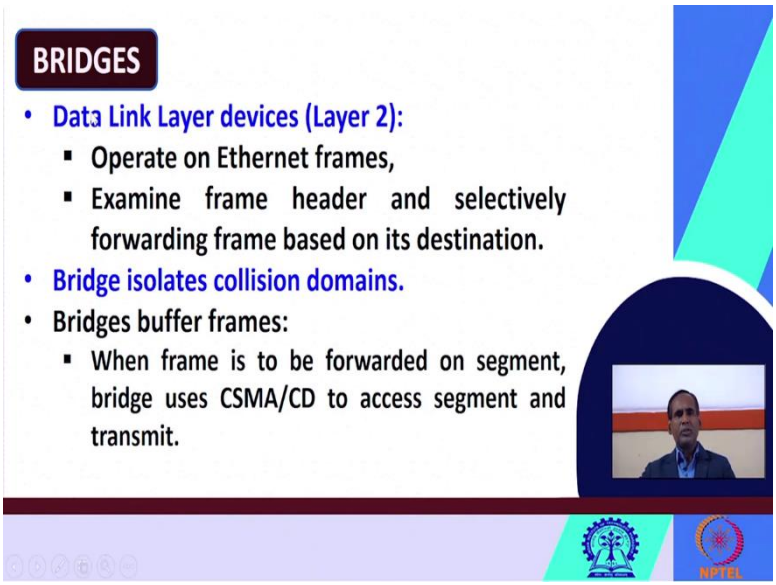
The multitier throughput is same as the single segment throughput even if you are using this multitier throughput. It is almost same as the single segment throughput. The individual LAN restrictions pose limits on two things. So, these because internet means what you are doing you

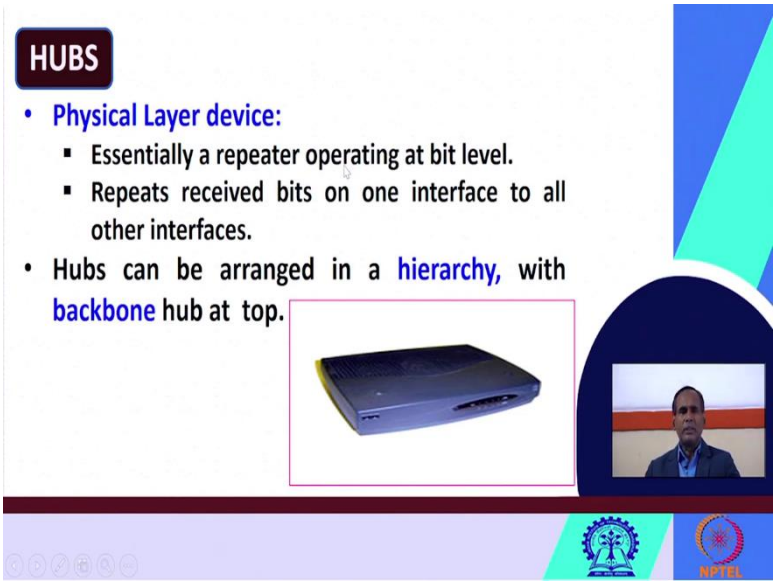
are connecting some individual LANs. The individual LAN restrictions, they pose limits on the number of nodes in same collision domain.

What would be maximum number of nodes present in the same collision domain? There is a limit there is a restriction on it. Similarly, total allowed geographical coverage how much area it can cover. So, the total allowed geographical coverage is also some limited so, these are also drawbacks the individual LAN restrictions pose, they pose also limits on the number of nodes in the same collision domain as well as the total allowed to geographical coverage how much area it can cover.

Another limitation is that it cannot connect different Ethernet types that is one of the biggest disadvantages. The hubs they cannot be used to connect a different Ethernet as for example, 10baseT and 100baseT there are two different Ethernets, it is 10baseT and this is 100baseT you cannot connect this two. Similarly, 100baseT and 1000baseT you cannot connect this two Ethernets. So, that is why the hubs they cannot be used to different, connect different Ethernet type this is another drawback.

(Refer Slide Time: 16:09)





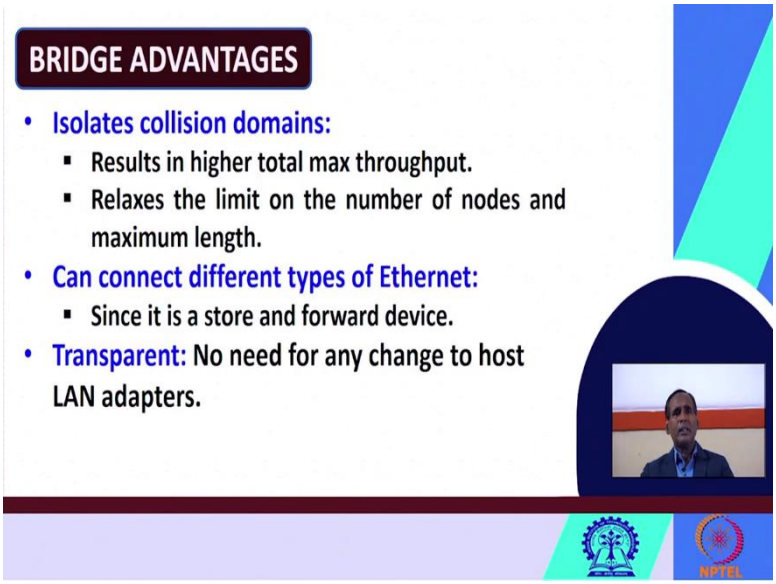
Next you will see the next device that is the bridge I have already told you these hubs which layer device I have already told you it is a physical layer device. Now let us see device of this which layer of this data link layer. So, bridges they are known as the data link layer devices and they are also known as layer 2 devices, is not it? Because they are data link layer devices. So, bridges are known as data link layer devices or layer 2 devices.

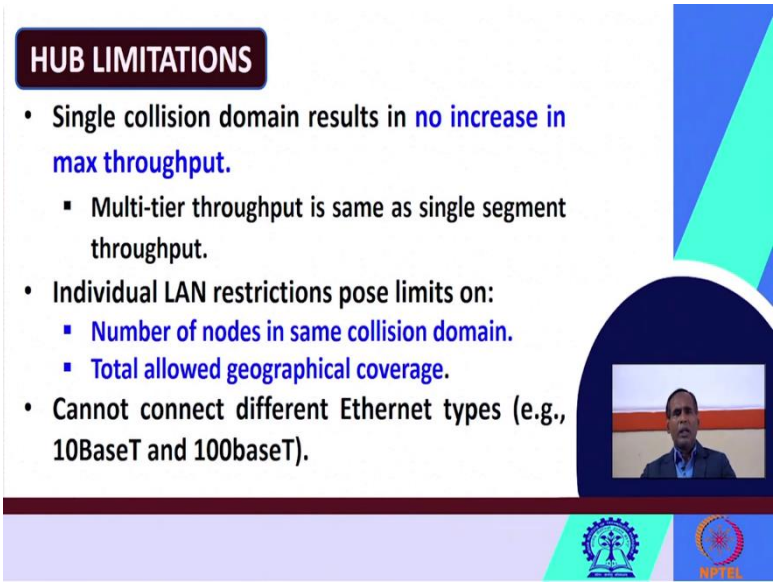
They operate on the Ethernet frames; these bridges they can operate on the Ethernet frames. These bridges what do they do? The bridges can examine the frame header and selectively forward the frame based on this destination. The bridges normally they can examine the frame header and then selectively forwarding frame then they can also examine the selectively forwarding frame based on its destination.

So, based on the destination, they all examine the frame and they will selectively forward the frames to those destinations, the bridges they isolate the collision domains, another important feature of bridges the bridges can isolate what are the collision domains they can isolate them.

So, bridges buffer the frames that means they stored the frames, so bridges can be used to buffer the frames when any frame is to be forwarded on segment then bridges, they use which protocol they used CSMA CD to access the segment and transmit them. So, I am repeating again the bridges they buffer the frames whenever the frame has to be forwarded on segment. The bridges what they do, they use the CSMA CD protocol to access the segment and then transmit. So, this is how the bridges they work.

(Refer Slide Time: 17:55)





Just like as hubs bridges as bridges they have also several advantages for example, they have the isolate the collision domains I have already told you, bridges isolate the collision domains this number one advantage, it isolates the collision domains. It results in higher total maximum throughput. So, these bridges they can yield higher total maximum throughput.

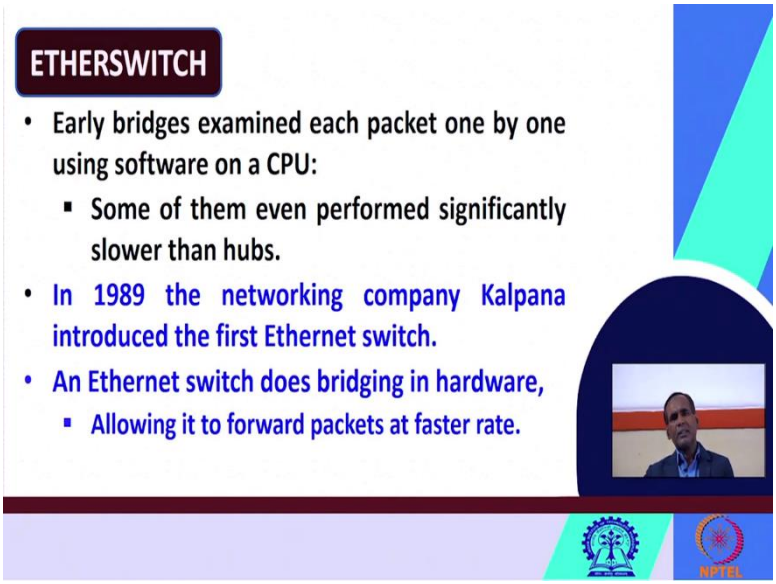
Similarly, it relaxes the limit on the number of nodes and maximum length because we have already seen in case of the hubs, it puts limits on the number of nodes in the same collision domain as well as the total allowed graphical coverage, but here you can see these bridges they can they relax or the limit on the number of nodes as well as the maximum length.

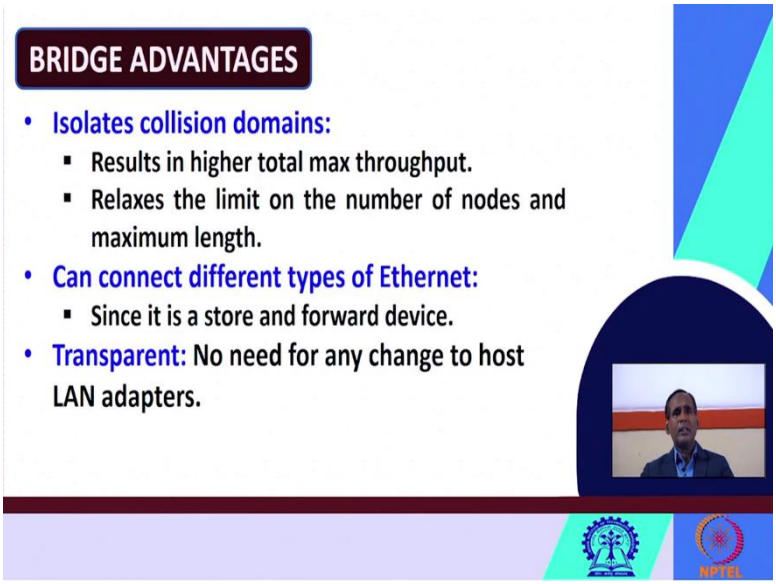
It can be used to connect different types of Ethernets, we have already seen one of the drawbacks of hubs it cannot use to connect different Ethernet types, but bridges can be used to

connect the different types of Ethernets. So, we can easily connect what 10baseT and 100baseT those types of Ethernets. Because it is acting as a store and forward device only.

So, since bridges they are acting as a store and forward devices, though they can be easily use to connect different types of Ethernets. So, another advantage is that the bridges are very much transparent. Transparent means there is no need for any change to host LAN adapters. So, you do not require, you do not require for any change to the host LAN adapters in that way, they are much more transparent. So, these are some of the advantages of bridge.

(Refer Slide Time: 19:26)





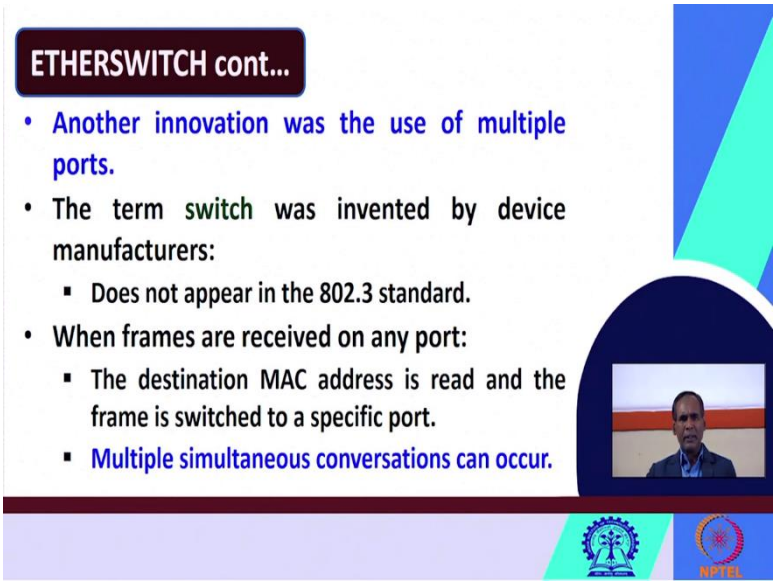
So now let us see about this ether switch. These early bridges we have seen they examine each packet one by one using a software on a CPU. So, we have discussed about the bridges. So, the

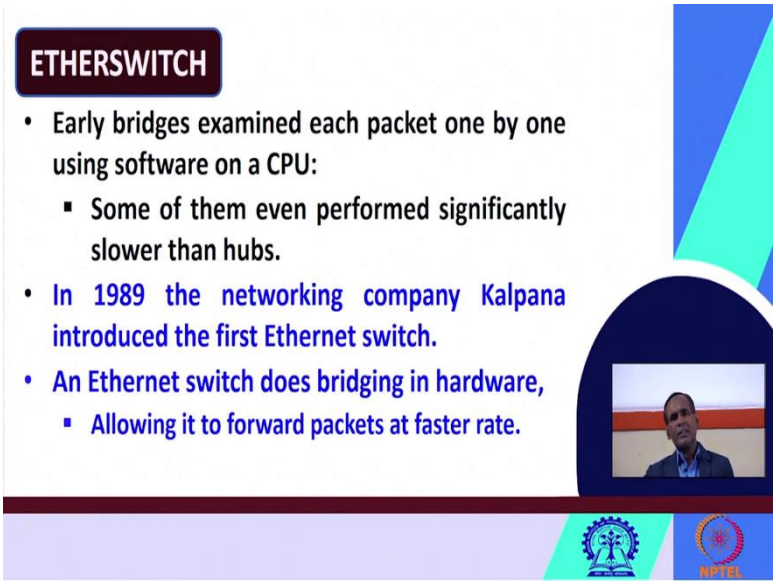
traditional bridges what they are doing, they normally they examine each packet, each data packet one by one using some software on a particular CPU.

So, some of them that mean some of the traditional bridges they even perform significantly slower than the hubs. The traditional, we have seen the bridges has so many advantages. But still, some of these traditional bridges they even perform so bad they even perform significantly slower than even the hubs. In 1989 the networking company Kalpana it has introduced the first Ethernet switch, in 1989 Kalpana has introduced the first Ethernet switch.

So, an Ethernet switch it also does bridging please see Ethernet switches also a bridge now let us see what is difference an Ethernet switch it also does the bridging what activity in hardware and Ethernet switch it also acts as a bridge it is does bridging in hardware allowing it to forward packets at faster rate. So, these Ethernet switches they can forward the packets at a much faster rate than the traditional bridges. So, this ether switches they are much faster than these traditional bridges.

(Refer Slide Time: 20:53)



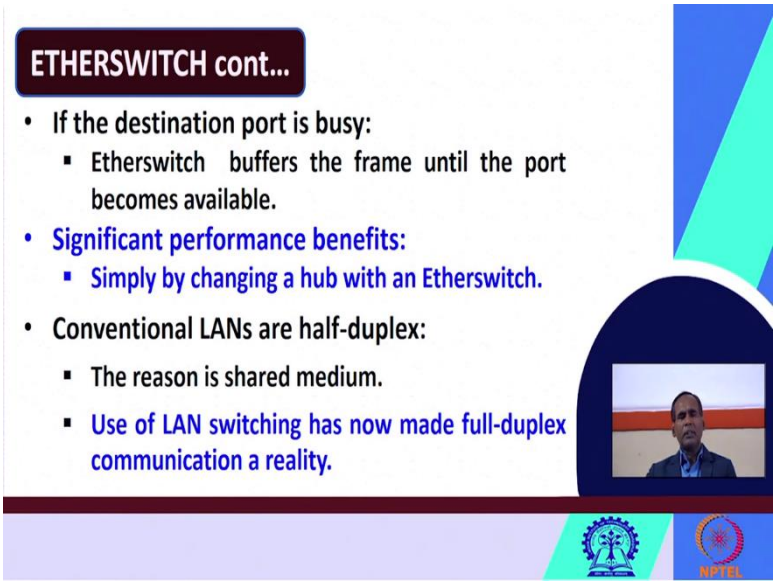


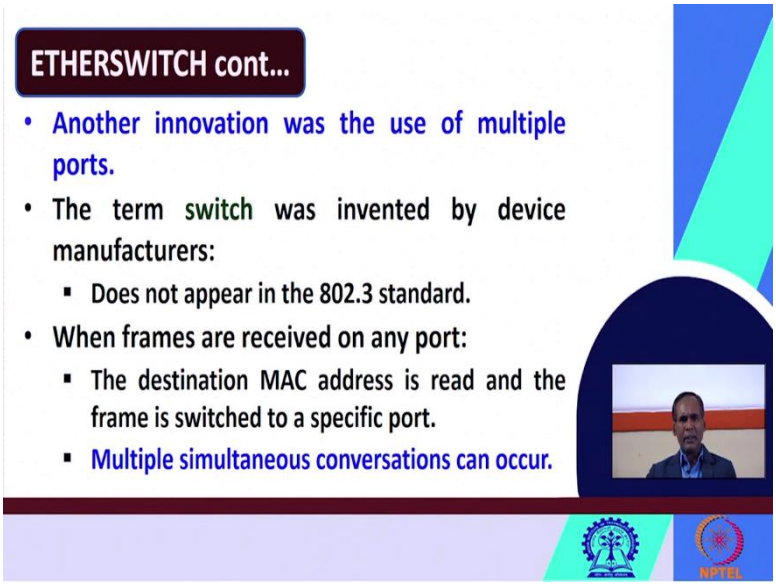
So, another innovation was the use of multiple ports. So then since then 1989 these Ethernets have underground so many changes. So, another innovation was the use of multiple ports here the term switch was invented by device manufacturers. So why they are saying Ethernet switching because it is a basically bridge, why they are saying switch? This term switch was invented by the device manufacturers it does not appear in the 802.3 standard. So, this term was not appearing in the 802.3 standard.

So, when frames are received on any port, the destination MAC address is read and the frames is switched specific port now let us see how the Ethernet switch works. So the Ethernet switch it acts as it works as follows when the frames are received on any port then what happens; the destination MAC address is read and then the frame is switched, where it is switched? Then the frame switched to a specific port to a particular port.

So multiple simultaneous conversations can occur. In Ethernet switch you can achieve multiple simultaneous conversations. So, Ethernet switch multiple or concurrent multiple simultaneous conversations can also occur.

(Refer Slide Time: 22:06)





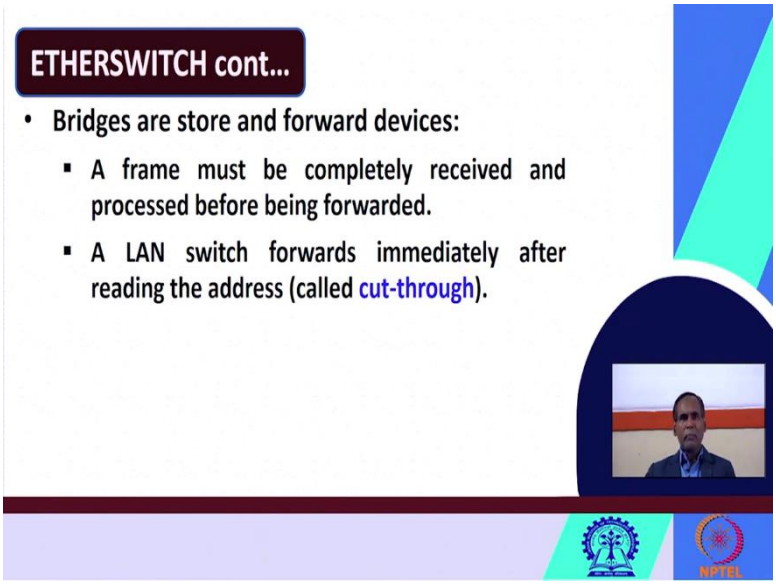
Now, let us see if the destination port is busy, I have already told you here when the frames are received on any port, the destination MAC address it will first read and the frames is switch to what if the frame switched to a specific port. Now suppose that destination port is busy then what will happen if the destination port is busy then the Ethernet switch it buffers the frame until the port becomes available.

So, if the destination port at that time it is busy, then the Ethernet switch it buffers, what? It buffers the frame, until what time? Until the port becomes available then only it will transfer, it will transmit the frame, the significant performance benefits. So, this Ethernet switch it has a significant performance benefit over the traditional hubs. In other words, we can say that significant performance benefits can be achieved just by changing the hub with an ether switch.

So, if you can replace if you can simply change a hub with an ether switch then you will definitely achieve significant performance benefits your what transmission it will be at a much faster rate. We have already discussed LANs in the last class the conventional LANs are normally half duplex, I hope you have already known about half duplex and full duplex in computer networks those who have forgotten please see again.

So, the conventional LANs that we have discussed these are normally half duplex in nature. Why? Because the reason is that they use a shared medium, that is why they are half duplex use of LAN switching has now made full duplex communication a reality but due to the use of these switches, now it is possible to make this full duplex communication. Due to the use of LAN switching, it has now made full duplex communication a reality possible.

(Refer Slide Time: 24:04)

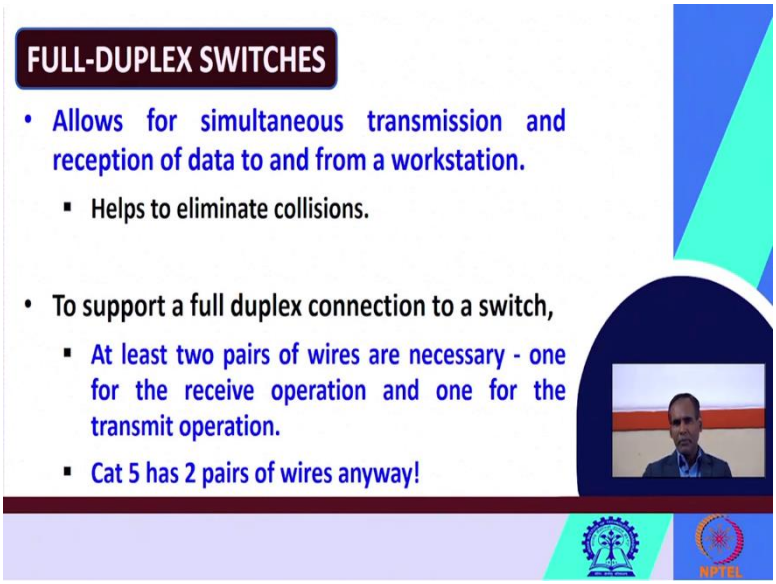


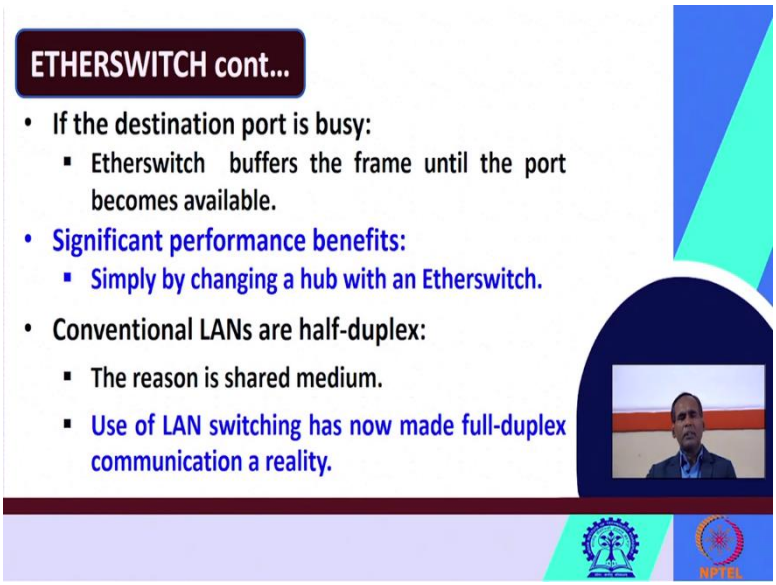
I have already told you the bridges they are normally considered as store and forward devices they would just simply just store and forward the packets or frames. So, the bridges are just a store and forward devices. A frame must be completely received and processed before being forwarded, please see.

Whenever a frame is what it has to be forwarded, it has to be completely received, not some portion of the frame cannot be lost or they cannot be what received after some time, no delay is allowed so frame must be completely received first and then processed before being forwarded. So before forwarding that frame it has to be completely received and if any processing is required, you have to process it completely then only you can forward it.

So since the brides are store on forward devices, hence a frame must have to be completely received and processed first before it is forwarded. A LAN switch forwards immediately, what, a LAN switch forwards immediately after reading the address. So, where it will go? Where it will transmit? A LAN switch it forwards the frames or the practice immediately after reading the address which is called cut-through.

(Refer Slide Time: 25:17)





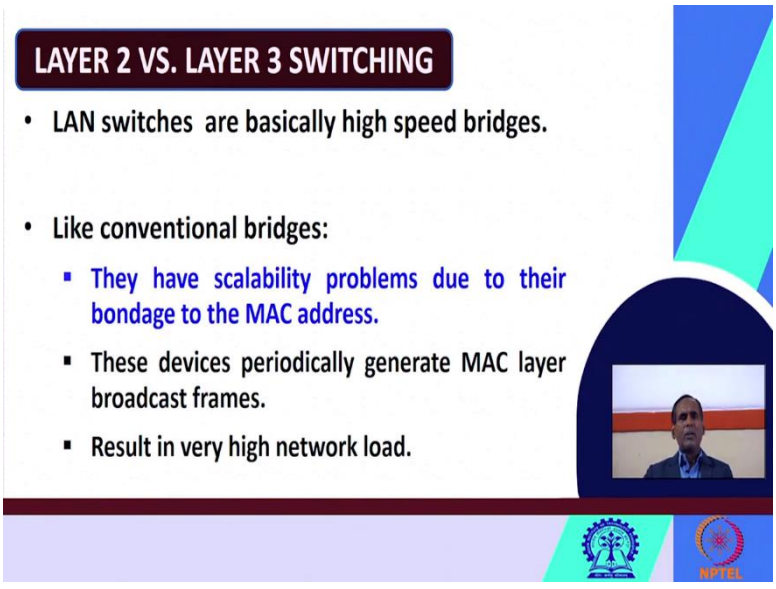
As I have already told here that use of LAN switching has now made the full duplex communication a reality. Now, let us see how we can achieve this or what the advantage it provides, the full duplex switches they allow for simultaneous transmission and the reception of data to and from a workstation.

You know in in half duplex what happens only in one direction you can send or receive, not both the send and receive operations can be performed simultaneously. No, in half duplex both send and receive operation cannot be performed simultaneously, but these full duplex switches they allow us for simultaneous transmission and reception of data to as well from a workstation. And what are the advantage you will get by using full duplex switches? It will help in eliminating the collisions; collisions can be eliminated significantly.

Now in order to support the full duplex complexation to switch what thing is required? What is, what does it require? Two things are required, it required two pairs of wires. So that simultaneously you can do this reception as well the transmission operation. To support a full duplex complexation to a switch, what is the minimum requirement at least two pairs of wires are necessary. Why two pairs?

Because one will be used for the receive operation, for the reception of data and the other pair will be used for the transmission operation or for the transmit operation. And I have already told you Cat 3, Cat 5 etcetera in the last class, so you know Cat 5 has anyway it has 2 pair of wires. So full duplex connection can be easily established if you are using this Cat 5. These are somehow we have discussed about this full duplex switches.

(Refer Slide Time: 27:05)



Now let us see about the difference between layer 2 versus the layer 3 switching. I have already told you layer 2 switching because they are used at the data link layer. So, all the traditional LAN switches or these traditional conventional bridges we have seen normally we call them as layer 2 switches.

So, now let us see about the layer 3 switches and how to the differ, I have already told you the LAN switches are basically high-speed bridges, I have already told you, is not it? The LAN switches they are very fast; they are faster. The LAN switches are basically they are high speed bridges.

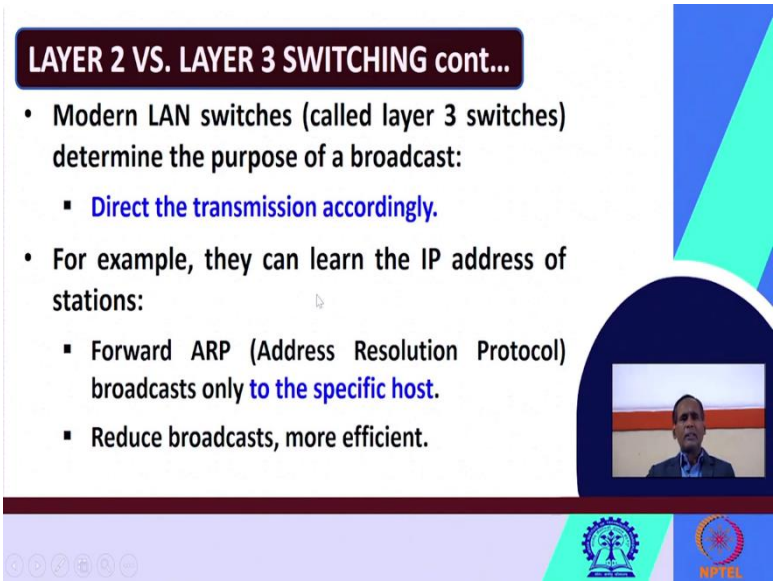
Now let us see I have already told you these conventional bridges normally they are called as these layer 2 switches, like the conventional bridges they have these scalability problems or sorry I am sorry the LAN switches, the conventional LAN switches, the traditional LAN switches will call them as this was layer 2 switches.

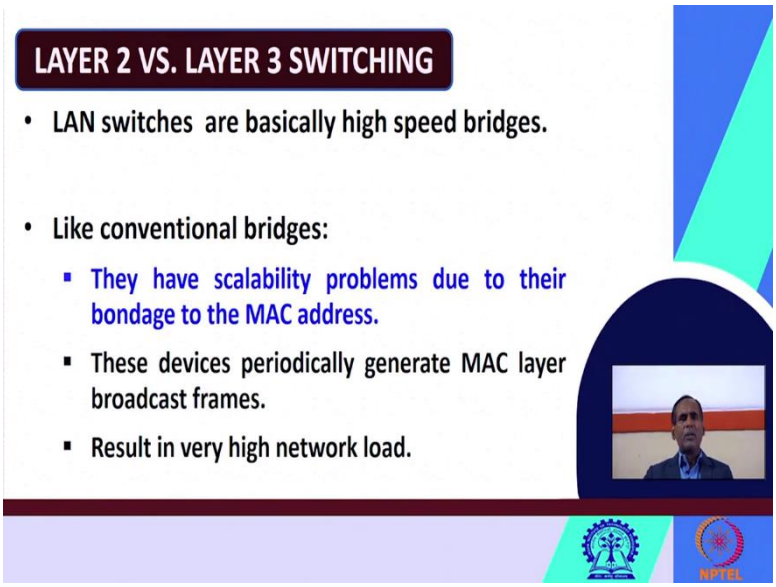
Now whenever we are we have already seen bridges earlier. So just like the conventional bridges, these traditional LAN switches they have also the scalability problem they cannot be easily scalable, why? Due to their bondage to their MAC address, just like this what here the LAN switches they are also tightly bonded due to their bondage to the MAC address they are they cannot be easily scalable; you cannot easily extend them.

So, like the conventional bridges, the traditional LAN switches which you call them as layer 2 switches, they are also having scalability problems due to their bondage to the MAC address. These traditional LAN switches these devices they periodically generate MAC layer broadcast frames.

These traditional LAN switches we call as the layer 2 switches these devices they periodically generate the MAC layer broadcast frames which result in very high network load. Because it periodically generates the MAC layer broadcast frames, so it results in very high network load. So now let us see the how this layer 3 switches they are better than the layer 2 switches.

(Refer Slide Time: 29:13)





So, let us see about this layer 3 switches. So, we have seen about the traditional LAN switches we are calling this a layer 2 switches, but the modern LAN switches nowadays we are using they are called as layer 3 switches modern LAN switches which we are currently using they are known as layer 3 switches.

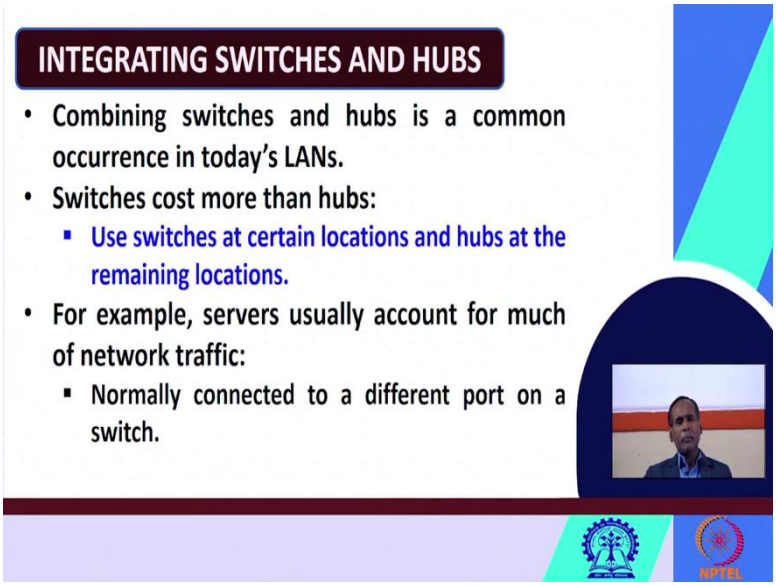
What they do, what do they do? They determine the purpose of a broadcast. So why broadcast is made? The current LAN switches they determine the purpose, the objective of a broadcast and then they direct the transmission accordingly. After knowing the purpose or the objective of a broadcast, then the modern they LAN switches they direct the transmission accordingly.

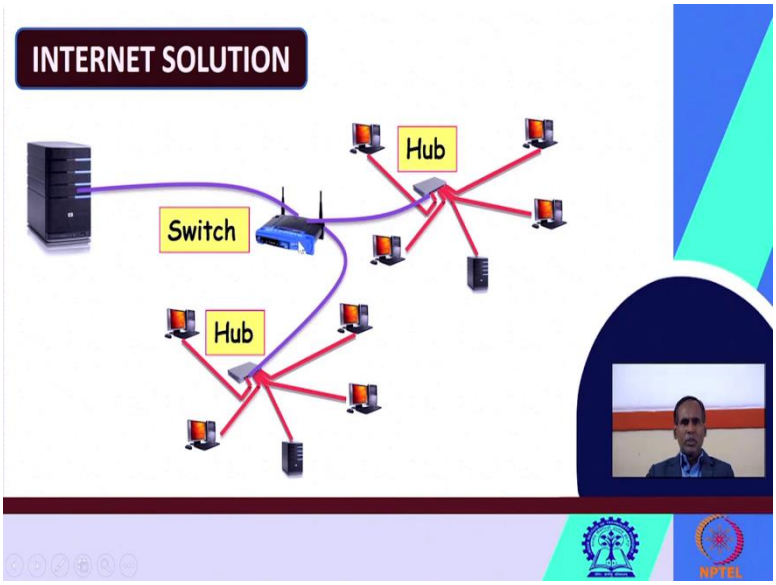
For example, let us see here what happens these layer 3 switches they can learn the IP address of this station, what is the IP address of the stations they can learn and after knowing the IP

address they can forward the ARP broadcast only to a specific host, not to the all the addresses, all the hosts. ARP you know, it stands for address resolution protocol you might have already heard in the computer network paper.

So, this is how here I have given an example how the modern-day LAN switches they know they determine the purpose of the broadcast and then they perform the transmission accordingly. For example, here they can learn the IP address of the stations and after that then they forward the ARP broadcast only to the specific host, only to the particular host instead of sending to all the hosts. This ultimately reduces the broadcast and it becomes more efficient. So that is why these layer 3 switches they are more efficient than the layer 2 switches.

(Refer Slide Time: 31:02)





So, how these switches and hubs can be integrated? So far, we have already seen what do you mean by hub what you mean switches, layer 2 switches, layer 3 switches etcetera, how they can be integrated, how they can be combined. So, combining the switches and the hubs is a very common occurrence in today's LANs.

In modern days, people are combining the switches and the hubs. You know the switches cost more than the hubs, hubs are much inexpensive, I have already told you but switches are costlier. So, switches cost more than hubs. So, what you can do while you are integrating the switches and hubs you can use the switches only at some specific locations only at certain locations and you can use hubs at the reaming locations.

So, since these switches they are costlier than hubs while integrating while combining the switches and hubs, you should use these switches only at certain locations only at some specific locations and you can use the hubs at the remaining locations. For example, suppose you want to connect some of these servers and some of these simple PCs. You know that servers account for most of the network traffic, is not it? Servers normally they account for most of the network traffic.

So, when you are combining what you should do? For example, since the servers they usually account for most of the network traffic, so what you should do? Normally you should connect or the normally these servers are connected to a different port, you should connect the servers to a different port on a switch and other places you can use the hubs.

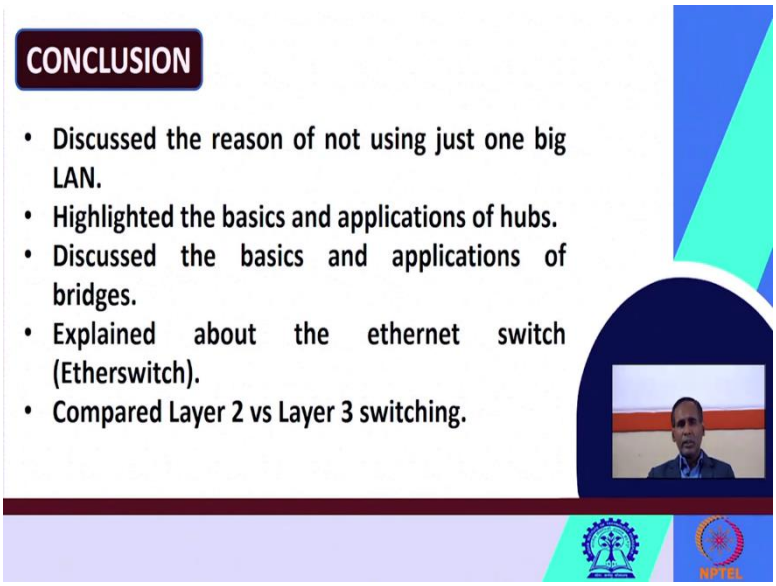
See pictorially I have shown it, the internet solution for combining these switches and hubs I have shown, so here you see there are several just a simple nodes or simple computers, they are connected with a hub, here also in this network there are simple some computers or nodes, they are connected to the hub. But when you are connecting the server, the server is connected to a switch in one port and these hubs they are connected to other ports.

So that is why what I have already told you when you are now combining these switches and hubs try to use switches at certain locations, some specific locations and hubs at the remaining locations. For example, if you are using servers, try to connect the server to a different port on a switch and other nodes can be connected to the hubs.

This is how you see; these the nodes are connected to hub; these nodes are connected to hub and these two hubs in turn are connected to a switch but the server is directly connected to a

port on this switch. In this way you can interconnect, you can integrate the hubs and the switches this is how the hubs and the switches can be integrated.

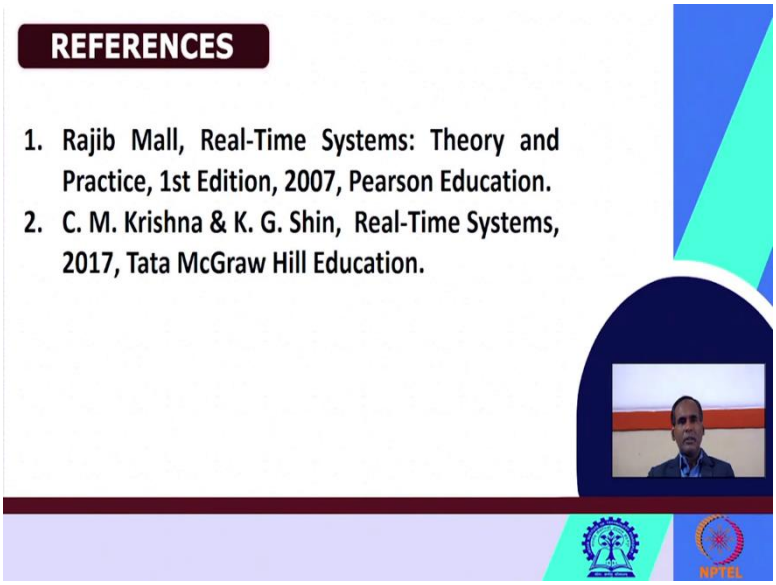
(Refer Slide Time: 33:37)



Today we have discussed the reason of why not just using one big LAN, why we should not use a one big LAN. We have highlighted the basics of, the basics of the hubs the different applications of hubs, we have discussed the also the basic applications of the bridges we have explained about the Ethernet switch called as the Etherswitch.

And we have compared this layer 2 switches and layer 3 switches, is not it? We have compared layer 2 versus layer 3 switching also we have already told you how you can combine or how can integrate these hubs and the switches.

(Refer Slide Time: 34:16)



We have taken these references from these books. Thank you very much.