Communication Networks
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Module - 11
Learning Bridges
Lecture - 50
Learning Bridges

So far we have discussed about in a particular LAN or let us say in a media access control protocol, how do we develop a particular protocol, and knowing the underlying system or underlying physical layer. We will go one step further towards more of a switching kind of thing.

So, first thing that we will be discussing today is the Bridges. This was the first thing which was introduced. I will talk about why this was introduced and this is probably the beginning of switching in packet switch network era. So, basically the packet switch network as we you know we have already discussed about that history in DARPA it came and they started means connecting the machines within a local area network. So, within a lab or within means in the same locality few labs.

Their machines they wanted to connect, so that is why they introduced LAN. We have seen what kind of topology and all those things and then associated protocol also we have seen. But then when people started expanding it that is when bridges came into picture. So, we will talk about that today, ok.

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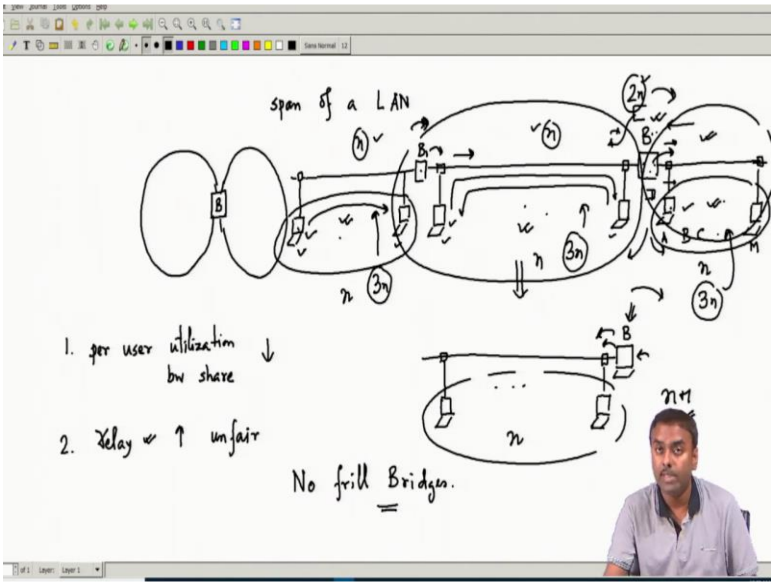

So, if you just start discussing about this bridges. So, what happens actually, when people started, we have already seen that there is a sudden span of a LAN because we have discussed that suppose it is a bus kind of thing. So, there is a certain length up to which this LAN can span, because of the propagation delay. Because the maximum propagation delay affects the collision detection procedure.

So, accordingly the packet size has to be bigger than that. So, that is why this span cannot be bigger than some d because of the packet size. Already there is a restriction, because whatever the overall end to end delay, so this entire round trip delay, packet size or packet must be present. One guy who is at the furthest end his packet must be present more than that amount of time to facilitate the collision detection otherwise that collision detection will not be facilitated.

So, due to that, they knew that the packet size cannot be bigger than that, and the bigger you make the packet there is more probability that the packet will be erroneous. So, you want to avoid that. So, there is a way tension I cannot make the packet smaller than this value that whatever the length is, I cannot make the packet too much bigger there is a problem because there will be too many errors then every time you will have to retransmit, so that will waste the physical channel.

So, that is why there is a compromise. The compromise is because packet size is lower bounded by this span length. So, I should not go span length or increase span length beyond some value.

As you have seen span length increment means the vulnerability period increases, and then the ideal time also will be increased. So, accordingly, the protocol performance will mean it will be lowered. So, that is why we have a restriction.

So, once we have a restriction now suppose I want to really start connecting means more number of stations in a dispersed or more distant, they are located in distant geographical locations. So, if I wish to do that what can I do, that is when the DARPA started encountering this particular problem. That, what can I do, how do I expand this LAN? Because there is a restriction already, a physical restriction, and I cannot go beyond that.

So, then they started coming up with a solution which is called the bridge. So, what they did is something like that. So, if I have two LANs, I can actually in between put a device which is called a bridge, and then connect two LANs, ok? So, this can be another LAN and that will go up to the up to its span length and so on and so forth.

If they are a ring, I have one ring and I can then connect another ring with this bridge, ok? So, that is why it is called a bridge because it is bridging between two LANs, ok? So, this particular device is kind of working as a bridge between two LANs.

What is the functionality? Why this suddenly I can increase by introducing this device? Suddenly why I cannot increase this span length? What exactly we are doing over here in this particular thing, so that my collision domain still gets restricted, and my packet size does not get increased due to the detection of collision requirement?

So, what Bridges does is something like this. It is a kind of switching functionality, so that means, every packet it actually first stores and then forwards it into the other LAN. So, suppose somebody this guy is transmitting a packet. So, he does not have, he will still have a collision domain within this he does not have collision coming from here because they are still not the same media, they are separate media. They are just connected by this bridge, and what the bridge does is something like this.

He will whatever packet will be transmitting bridge will receive that, now, irrespective of whom that packet is meant to. Irrespective of that he will store every packet that comes to him and after that, he will be queuing them. And after queuing one by one he will be trying to push those packets. He will become a transmitter on this side on the other side of the LAN and he will try to push those packets into those sides.

So, basically what is happening; is the bridges are, and it sits both ways. So, basically from this side also whatever packet will be coming, he will be storing them, he will be putting them in another buffer, and then one by one he will be pushing into this LAN. So, every packet of this LAN also goes to this LAN, but in a different manner.

It goes via this bridge and what bridge does it does not allow the broadcasting of that packet. So, he does not broadcast that packet. He actually takes that packet and then he becomes a soul as if he is the source now. So, he is within the span limit and he retransmit that packet or kind of relay that packet.

So, basically, he takes that packet, and stores it in his buffer then he starts actually doing the CSMA CD protocol on this side of the LAN and then whenever his turn comes he competes with it along with all the stations. So, he just acts like a dummy station over there in that LAN and vice versa in this LAN also. So, basically, he acts like a dummy station in both the LAN.

So, as with this bridge, I can see this LAN to be an extended LAN like this. So, it has a station, it has another station, and all intermediate stations are there. And over here as if there is another station where is that bridge? And what is the traffic he has? He has all the traffic coming from the other LAN. So, for every traffic that comes from another LAN he takes, he buffers them and then tries to push them. So, it is like this, this particular bridge now has the same span.

If earlier it had n station, now it has n plus 1 station, this 1 station being the bridge itself. And that particular bridge assumes the traffic, it assumes more traffic than all other stations. So, basically, if all other stations are putting some amount of traffic, now this particular bridge puts all the aggregated traffic coming from all other stations. Let us say this, if this is A, station A, this is station B, C and let us say M.

So, for all traffic from A to M, he assumes that traffic is put in one buffer and then he fights for that traffic in this LAN. Similarly, the same thing happens on the other side. He assumes everybody's traffic from this LAN, takes that, puts that into a buffer, and then fights for that traffic also in CSMA CD protocol in the other LAN. And like this, if I keep connecting LANs, so this will be happening, ok.

So, if I connect 3 LANs, so on the other side also if I connect another LAN, now what will happen is something like this. So, let us say the station is there and he has his own other stations. So, in that case, whatever traffic is coming from here you never know because 3 LANs I am connecting, and in networking connectivity means every station to every station connectivity.

That means this station must be able to connect to its own LAN station. He must be able to connect to the second LAN station, every station, and he must also be able to connect also the third LAN stations. So, connectivity means full connectivity. I need to provide full connectivity among themselves, all the stations that are connected to them, and all the machines that are connected to them.

So, if I have to facilitate then what will happen? This bridge, let us call that bridge 1. Now, what will happen? All the traffic coming from here will be broadcasted over here by this bridge. So, he will assume all this traffic, put it in the buffer, and then forward it to the next LAN. And what this LAN will do? He will also take all those packets and he will broadcast them to the other LAN. So, this is how it works.

So, that is why every traffic goes to every LAN, but you reduce the collision domain. Very good. Up to this, there is no problem. But now, as we can see as I increase the number of LANs, if we are connecting more and more LANs we can immediately see that all this amount of traffic is unnecessarily being pushed to every LAN.

So, what is happening? Every LAN is now sharing all other LAN traffic. So, overall throughput will be heavily reduced, per user throughput if you try to see because now if there are n stations over here, n station over here, n station over here, actually 3n stations traffic are being broadcasted over here, ok. Similarly, 3n stations traffic are being broadcasted on this LAN as well as this LAN, ok. That is exactly what is happening.

This is not a very good scenario because what is happening unnecessarily, I am pushing traffic in every LAN. All the stations from all other LANs have their traffic through the bridge we are incorporating into every LAN. So, basically, overall LAN throughput or I should say per user throughput or per user share is getting reduced.

So, immediately when this happened people started thinking can we do something better than this, is there a possibility that we can go one step forward and devise something a little better than this, ok? So, that is the one problem I have talked about.

So, one is that everything is broadcast everywhere. So, per user utilization or per user I should say bandwidth share is getting reduced, ok. What is the second thing that is happening let us try to understand that. Think about suppose let us take this LAN and this LAN, from this station I want to transmit something to this LAN in some other station. Let us say he is targeting this one.

So, what will be happening? All the traffic from here will come to the bridge and it will be queued in the bridge. Now, the bridge then will be pushing that traffic over here. But, now as you can see compared to all other stations this particular bridge which is also taken to be a dummy station of that particular LAN, now has a huge amount of traffic because it is assuming or it is taking traffic from all the stations on the other LAN and if there are subsequent LAN everybody’s traffic he will be taking.

So, if I take this scenario of 3 LANs connected if this bridge has to forward traffic to over here, he has to take all the traffic from this guy and all the traffic from his this guy. So, 2 the amount of traffic he will have to push over here, ok? So, if I take all stations to be homogeneous, then whatever traffic in this LAN is being circulated, this bridge is pumping double that traffic, alone. So, if he has to do that think about how much time it will take, and in that time all packets will be buffered.

So, his scenario is going to be that those packets are going to be unnecessarily delayed because he will be having a huge queuing delay, and whenever he gets a chance he can only clear one packet at a time. Every time he has to compete for the station then only he can push another traffic. But he is actually getting a huge amount of traffic.

Of course, in the CSMA probably he will be competing for more amount of time. So, he might get a slightly better advantage compared to the other nodes, but not heavily. As you can see, as I start expanding this number of LANs, the amount of traffic will be with 3 LANs which is 2 times the whole traffic assumed by all other stations in this LAN. So, this is already putting pushing 2 n traffic. If there are 4 LANs it will be 3n and so on, assuming homogeneity among the users.

So, that is a huge traffic and that will suffer from delay. This particular delay is kind of unfair delay because whenever LAN traffic goes on, there will be a delay because that has to go through the bridge, and sometimes multiple bridges. So, he has to compete over here. Suppose, the station he has to transmit to the furthest LAN and he has to compete over here where the traffic is already increased then he has to compete over here. So, it just keeps on going.

So, the delay will be accumulated. So, a huge amount of delay and it will be an unfair delay. Whenever you are going towards a multi-hub LAN or a station that is connected via multiple bridges, then you have to go through all these bridges and all those bridges will be adding your delay.

So, some stations in between will get huge delays whereas, some other stations suppose from here to here if you wish to transmit that will not be having huge delay. So, there will be a huge discrepancy among the stations or between the stations who are communicating in terms of delay which is unfair also.

So, this is also another thing which is delay is increasing and it's unfair, depends on whom to whom you are communicating. This is also something that is not desired because in networking I do not want to make it deliberately unfair. I want to make it fair. Every station should have equal importance.

If I can deliberately give priority, but here I have no hands on that. Suppose this station to this station-to-this-station communication is a very priority communication, but by design, they are separated physically in such a manner with multiple bridges in between that my design will always get huge delays. So, I cannot really control that.

So, even if I wish to put priority, I wish to put unfairness, but that is not under my control, it is just because of the topology because of the way the network has been designed. So, can we do something to alleviate these things? That should be our next target or that goes the next development of bridges.

So, this kind of bridge where everything was just stored and broadcasted on the other LAN was named no frill bridge. Now, from no frill bridges, we will come to another kind of bridge which is called learning bridges. This is the bridge kind of bridge that is being used these days.

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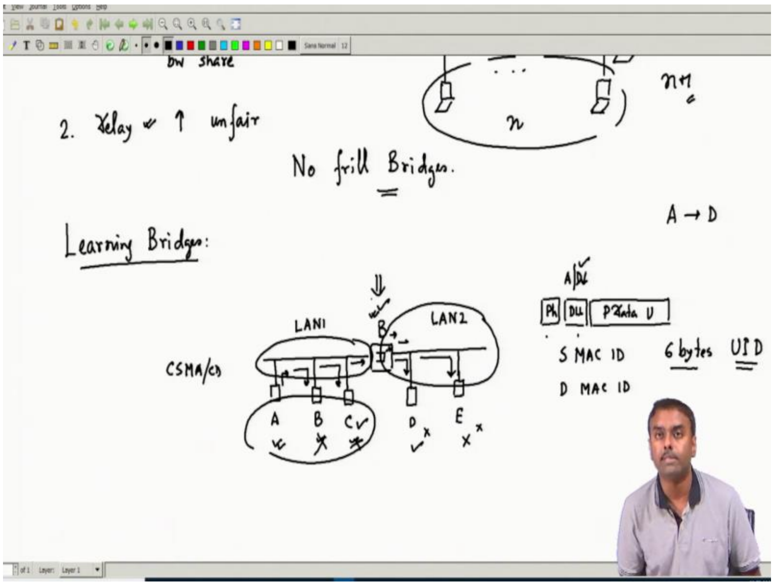

So, let us try to see what is learning bridges, ok? So, let us try to connect a few nodes of one LAN. So, let us call this station A, station B, and station C, these are there in one LAN. Then I have a bridge, and with this, I have another LAN, so this is LAN 1 and this is LAN 2. And let us say bridge sorry stations D and E are connected over here, ok?

Now, let us try to understand what will be going on. So, let us say A is trying to communicate, ok? So, what he will be doing? A will be generating a packet. So, that is the data, we already know. So, A whenever he is trying to communicate. So, he will get the data or the upper layer just means because LAN operates from layer 2. So, layer 2 and layer 1 only will take the physical layer and data link layer.

So, he will add the data link layer header. So, basically, this is data plus upper upper-layer header. So, it might have an IP header, TCP header, and all those things. So, that is we take that as a protocol data unit or we call it a PDU Protocol Data Unit, ok? So, we take that. And it adds his DLL header over here that is what we have seen. Generally, protocol transmission first packetizes the data and then adds a header, if you have multiple layers every layer will add headers.

So, the DLL header is added over here. Inside also there might be an IP header, TCP header, application header all kinds of things can be there. So, we can forget about that. After that, the physical layer will add its own header, physical header, and that data will be communicated over here.

What will be there in this DLL header? So, the DLL header will at least have a source MAC ID where it is and a destination MAC ID. These MAC IDs are generally 6-byte unique address unique ID, ok. So, that is universally unique. Whenever somebody produces that LAN card, ok whichever company is producing they will be always securing a unique ID from the proper authority, ok.

So, they take that ID and then put that ID which is the source ID of that particular LAN card. So, every LAN card will have an ID. If you add that LAN card to a particular machine that machine will have that MAC ID now, because the LAN card is the machine identification in terms of layer 2 protocols, ok.

So, that is the 6-byte ID, unique ID, universally unique. No two MAC IDs will be the same, for any two LAN cards whichever LAN card you produce be it Ethernet MAC or be it CSMA CD MAC, or any other MAC you produce, the MAC ID will be unique and is governed, well governed by a centralized body. So, you always have to block ID and you cannot take any ID which is already being used.

So, therefore, you have guaranteed that is a unique ID. You will never have confusion. Station A and station D will not have the same ID. They will always have a guaranteed unique ID. So, if that is the case they can always be distinguished.

Now, what you are trying to do? Whenever you are trying to send a packet you already know some destination. So, let us say A is trying to send the packet to D, that A is the source and D is the destination, ok? So, therefore, source MAC ID, he will put that unique 6-byte address of A and in the destination ID, he will put the unique MAC ID of that destination D. How he will know that will come to that later?

There are protocols to know means whichever destination we want to go; how do I get the MAC ID that is another part of the protocol. We will come back to that later. But somehow let us say he knows locally, he has that information that whomever I am trying to send the data his MAC ID is so and so.

Now, I will put it over here and I will send it. So, of course, there will be a CSMA CA protocol going on or CSMA CD protocol let's say its Ethernet LAN. So, then CSMA CD protocol is going on, accordingly, he will be accessing the channel, and he will do career sensing. If he sees free he will try to access it. If no collision is there he will be able to transmit the packet. If there is a collision he will go into collision detection mode.

After that, he will resolve the collision by whatever method we have discussed. So, somehow he will be able to push the packet through in the LAN, ok? So, he will capture the media, he will push his packet.

So, now what will happen to that? What is the fate of that packet? Because that is destined for D, ok? But it will be broadcasted, remember CSMA CD will only broadcast the packet within the LAN. So, it will be broadcasted to this guy, it will come to this guy and it will go to the bridge. So, everybody who is listening to that particular media, everybody will be getting a copy of that packet.

These two guys what they will do? They will try to see the destination ID. They will read the packet, after the physical layer they will go to the DLL header. In the DLL header, they know exactly the location where the destination ID has to be checked that 6 byte ID they will check, they will check whether that ID is matching with his own ID if not we will discard that packet. It is not meant for him. It is not the packet for B he will discard it. C will also do that same thing.

So, in Ethernet within the CSMA CD domain, everybody will receive the packet and everybody sees that and they discard the packet. For bridge B he has the additional duty. So, he will receive that packet and now if it is a no-frill bridge, he will put that into his buffer and he will try to transmit that packet on the other bridge or on the other port of the bridge.

So, a bridge will have because it is connecting two LANs, so it has two ports. Remember it is because it has two ports, it has two LAN cards it has also its own ID, MAC ID. So, that also he will be having. He also has his own MAC ID which is something that means remembers what will be happening. Right now we are not dealing with that, but later on, we will be dealing with that one, ok? So, they will be forwarding this.

When they are trying to forward this, at that point no frill bridge means he will again compete for the CSMA CD axis over there and he will forward it. If he is successful then that packet will come over here come over here. D will see that the destination ID is matching with him, so he will take that packet, will discard that packet. This is the whole process of A to D the packet transmission, ok. So, this will be happening.

Similarly, if any other station A transmits to C, ok C will receive it, but unfortunately, that packet also will be broadcasted over here because the bridge does not understand. It is a no-frill bridge, so he does not understand. He will also broadcast that; over here none of them will receive that. So, those will be all discarded. But every packet like generic LAN will be broadcast to everybody. The only thing is that this broadcast is a little bit delayed.

Whenever A sends the packet it immediately gets whenever he is getting access to the channel to all A B C, but in that task or in that particular time instant it is reaching B only. Then B is again waiting for his turn to get access to this particular LAN and then he is broadcasting at that time only, at a later time this will be broadcasted to all D and E. So, this is how it operates in a no-frill bridge.

Now, this is good. Can I now make this bridge a little bit more intelligent? That will be the importance of learning bridges. So, in the next class, we will try to see if from this source ID, destination ID, the bridges can learn a little bit extra and they can make things more efficient, ok? This unnecessary broadcasting he can restrict, can he do that? So, that is something we will be studying next.

Thank you.