Communication Networks
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Module - 11
Bridges
Lecture - 51
Learning Bridges contd

So, we have started our discussion about Bridges and now, we are going towards this concept of Learning Bridges. So, let us see what we mean by this bridge which can learn.

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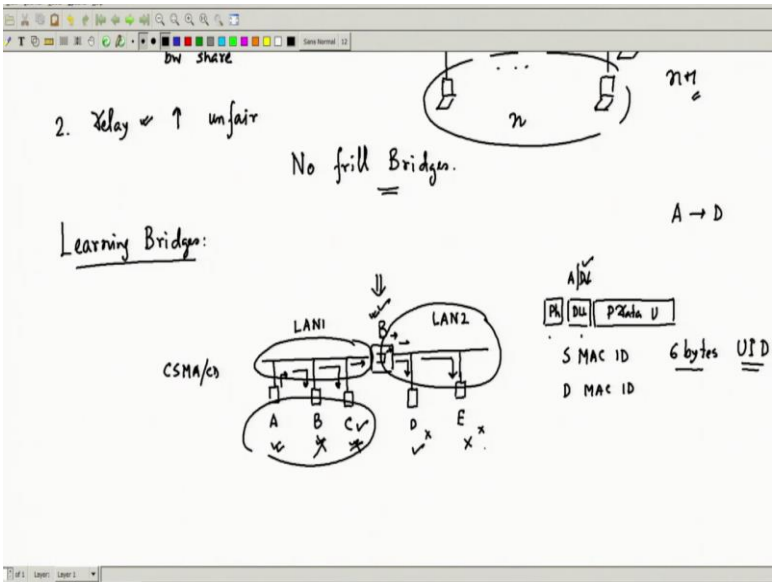

So, this was our discussion in the last class. So, let us try to see now, what extra we can do in this same scenario. So, basically, I have A B C D, and E connected to 2 different LANs, connected by a bridge B ok? Now, if we just try to see if the bridge puts some intelligence. So, what is that intelligence? So, whenever he sees a packet from A, what he can do?

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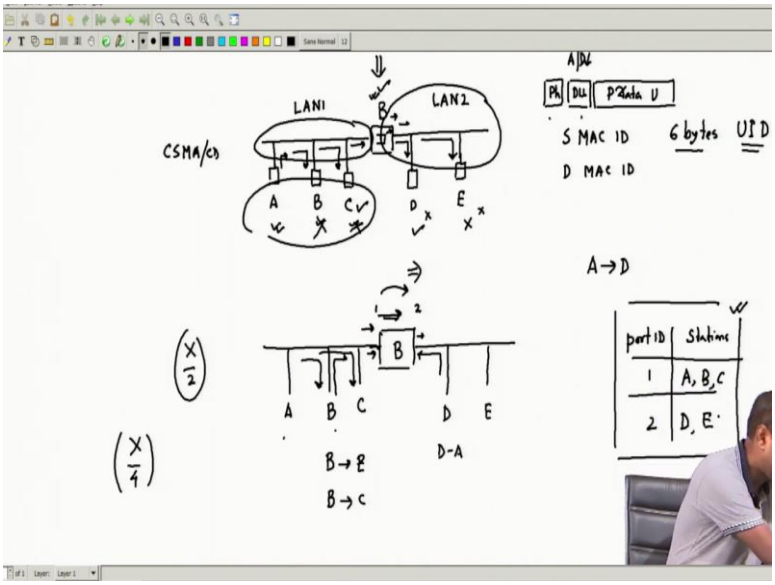

So, let us say the same LAN scenario A B, and C are connected, over here D and E are connected. So, let us say the first packet A to D is coming to the bridge after broadcasting.

Now, bridge he can start producing a table. This is the learning part he is doing. So, what is that table we will have? So, he has 2 ports; port 1 and port 2. It will produce a table a port ID and stations. So, this mapping he will do. Now, whenever he sees a packet coming from A from this port, port 1 means he puts that entry in his table. This is the learning table or learn table that Bridge is trying to maintain.

So, in port 1 he will say that I have observed a packet coming from a in port 1 therefore, my understanding is station a must be connected in port 1. Next time, if he supposes that he forwards at that time, he does not have he does not know anything about in 2nd port which is connected and all those things he does not know. So, suppose this is the first time he is learning it. So, the first time he broadcasts this packet to this one that is ok. Again CSMA CD axis he will take he will broadcast it.

Now, it reaches D, and suppose D gives an answer. So, now D will be transmitting a packet, which will be D to A. Now, what will happen, this packet will come over here. Immediately, this will understand that D is connected to port 2, like this every successful packet transmission from a particular station will reach that bridge.

And then he will start entering them. So, only one packet is required to be transmitted from each of the stations or broadcasted successfully in the LAN, in its specific LAN and then the bridge will learn about its existence. He just tries to learn in which port which particular stations are connected.

Once he completely populates this particular station IDs corresponding to their port. Now, you try to see suppose B is now transmitting a packet to E. What he knows, he gets the packet over here, he knows that it has to be forwarded on the other side because E is connected in the 2nd port. So, it has to be broadcast on the other side.

So, he does that, but if B is transmitting a packet to C, he immediately sees that this packet is meant for C, B has already broadcasted and C is in the same port. So, therefore, they are in the same LAN. So, he does not have to broadcast this packet further. This is the learning he sees and then he selectively filters the packets for broadcasting.

Once he has this complete understanding of this table, he knows exactly which packet to be forwarded on one side and which packets are not to be forwarded on one side. So, immediately, he decides the packet which has to be forwarded on the other side, only those packets he will forward.

So, therefore, the throughput gets increased, because not everything will be forwarded. Let's say it is homogeneous. So, station A let's say he has X amount of packets to be transmitted over a time duration. Now, every station will have because there are 4 stations. So, X by 4 amount of packet he has to transmit. So, out of that X by 4 will be for B and X by 4 will be for C, and only X by 4 and X by 4 will be for D and E so.

Basically, earlier he was transmitting the entire X packet he was forwarding over here. Now, only half of them X by 2 packets he will be forwarding, rest X by 2 he will not be forwarding and he does it for every station. So, therefore, huge amount of traffic, and he is no longer unnecessarily forwarding to the other side of the bridge.

And this helps us in scaling the bridge quite a lot. So, that is the facility of a learning bridge. So, learning bridge does these things which is very useful, because every bridge will start learning his status. They will understand what needs to be done and then from there, they will start executing. Let us try to see, if I connect multiple such bridges what will be happening ok.

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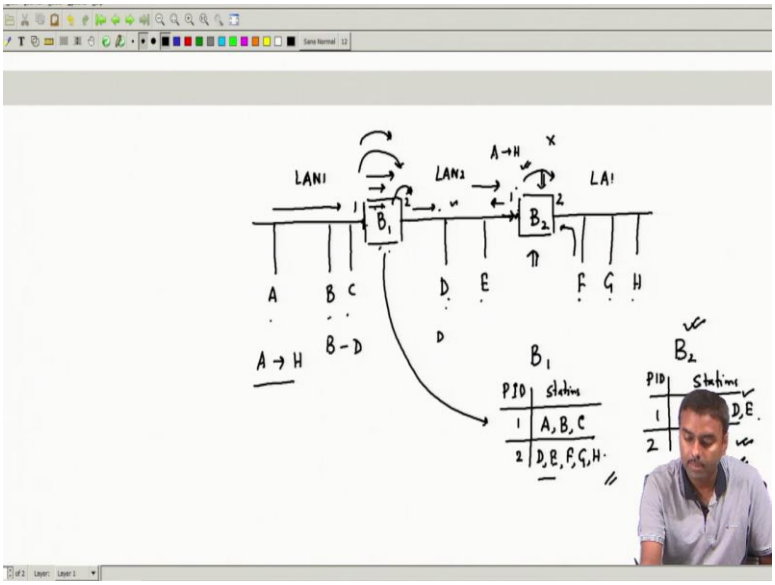

So, let us say instead of this 2, I connect multiple LANs with 2 bridges, bridge 1 and bridge 2. Station A and B, let us say C is connected over here, D and E are connected over here, and F G, and H are connected over here. Now, what will happen to the learning bridges? Let us try to understand that.

So, for bridge 1 he has port 1 and port 2. Bridge 2 also has port 1 and port 2 ok. So, bridge 1 will have his have his own learning. So, port ID and station and bridge 2 also will have his port ID station; now, let us see how they will learn. So, A B C if they forward some packet, then he will learn port 1 has bridge 1, we learn port 1 has A B and C ok.

Now, sometimes A B C might forward the packet to D E F, or G what will happen is that will be forwarded over here and this bridge will also receive it. So, what he will see, he will see as if he sees it locally. So, he will see packet from A comes on this port only which is the only possibility.

Because that will come via this bridge and will be broadcasted it will come on this port. So, in port 1 he will also record that he has A B, and C, but what will also happen to E D, and E that also he will see in port 1? So, finally, when he sees the packet transmitted by D and E, he will also learn D and E over here.

But what bridge 1 will learn, he will learn D and E is over here. Similarly, in this packet, F G H will learn they are there in bridge 2 will learn that they are there in port 2. But this guy will learn that they are also there in port 2 because this will be sometimes occasionally if f is sending the packet to E that will be forwarded over here.

He will see that packet that source ID F is coming in port 2. So, like this F G, and H you will learn. So, as you can see these 2 bridges are learning 2 different tables, D E is in port 2 of bridge 1, and D E is in port 1 of Bridge 2. So, this is how they will learn and from there they will know exactly what to do. So, suppose now I have a packet from A to H.

What bridge 1 will do from A, it will be broadcasted bridge 1 will get that. Now, bridge 1 will consult his table he will see the destination ID is H which is connected to port 2. So, he will forward it to the bridge and will try to transmit it with a CSMA CD over this LAN, once that is forwarded it will be again broadcasted that will come to bridge 2.

Now, bridge 2 will try to see the packet because this packet is forwarded, but the packet source-sided destination ID will not be altered which is still A to H. So, he will see that packet that is coming from A but it is going to H, where the H is connected in port 1 it is coming, where H is? H is in his port 2. So, therefore, he will also forward. So, that is how the packets will be appropriately forwarded.

If now B sends the packet to D as you can see this packet will be forwarded because in B 1 you can see D is in port 2. So, he will forward this over this bridge, but bridge 2 will see that this B to D packet is coming over here, destination ID is D where is D D and it is coming from here where is D D is for him it is in port 1. So, it is there only he knows that within this collision domain D is existent. So, he does not have to forward. So, B 2 will not forward that packet.

So, as you can see it is properly segregated in domains where packets will be forwarded because the bridges have learned this particular thing. So, they have properly learned each other and they have learned the location of the station. So, they will learn like this they will have this table, but with this table, they will know which packet to forward further and which packet does not need to be forwarded.

So, this is something they will configure very nicely and that is the beauty of these learn bridges. So, as you can see this is a very fantastic thing which has happened because the

bridges are learning they learn in a distributed fashion. They learn actually from their observation. So, from that they learn in a distributed fashion.

But together they do the right thing, which packet has to be forwarded up to which LAN they know exactly, but it is done completely in a distributed fashion which is the beauty of this learning bridge. Now, is this a complete problem, let us try to understand that it is a complete problem you will see that later.

As long as they are connected these bridges through the LAN are connected in a tree fashion. What does that mean? That means no loop or circuit being created among the bridges. So, from one bridge to another bridge, there is no alternate path, you only have one unique path. Over here that is how it is from B 1 to B 2 you can only go via this LAN, if this is LAN 1 this is LAN 2 and this is LAN 3.

Then you can only go via LAN 2 from B 1 to B 2 and vice versa ok. So, as long as this loop-free architecture is there you have no problem. Now, you will see and people have also earlier seen that if we start expanding this there is a possibility that we will be randomly correcting these bridges.

And once we do that if there are some loops constructed, then there is a problem. So, I will try to first demonstrate that problem and then we will understand how to solve that problem.

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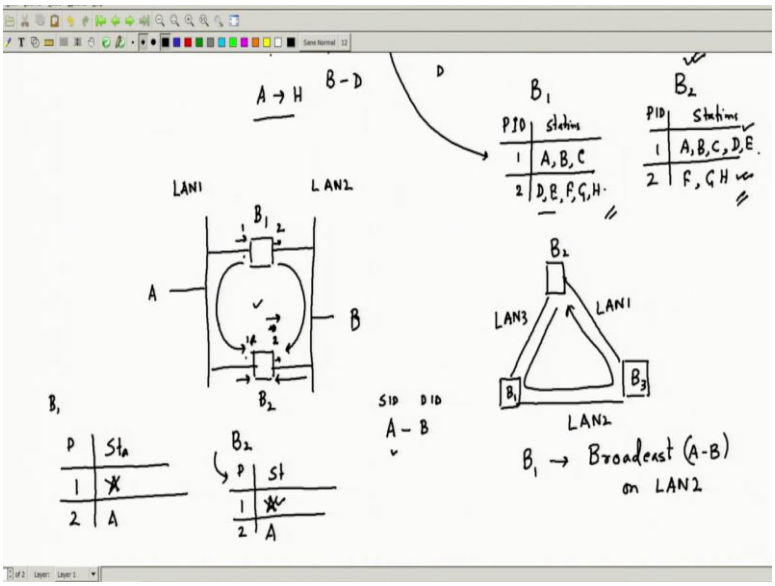

So, let us try to see suppose we have 2 bridges, bridge 1 and bridge 2 connected to the same LAN. So, this is LAN 1, this is LAN 2 ok.

So, both the bridges are connected in a similar fashion and there is a loop being created as you can see bridge 1 to 2 you can go via LAN 1, and from bridge 1 to 2 you can also go via LAN 2. So, there is a loop where there are alternate paths from one bridge to another which was not possible earlier.

So, it is not a tree architecture where a unique path you can find, you can find an alternate path. So, there is a loop or a circuit being constructed, because of the structure by which we have connected this. This is a direct loop that has been created. We can also have something like this indirect loop bridge 1 bridge 2 bridge 3 and this is LAN 1 LAN 2 LAN 3.

So, here the loops the bridges are not connected means via the same LAN ok, but there is a loop. So, that means there is an alternate path from B 2 to B 3, it can be via LAN 1 or via LAN 3 and LAN 2 through bridge 1. So, there are 2 paths from B 2 to B 3. So, that means, again there is a loop as you can see.

So, it might be a direct loop it might be some via indirect loop, but whatever it is you will have this alternate path. If that is there we want to see what will be the problem of the learning bridges. So, that is something we want to understand. So, let us say station A is connected over here and another station B is connected over here ok?

So, now station A wants to communicate with station B. These are learning bridges remember ok. So, we have connected 2 learning bridges in this configuration with a loop ok. So, this is how we have configured them. Now, if they are learning bridges, let us try to understand what will be happening over here. So, if A is communicating a packet where the source ID is A and the station ID is B.

That package will be broadcast over here. So, he has to first capture this LAN 1 CSMA CD through that protocol he has to capture that, he has to successfully transmit it. Once it is successfully transmitted what will happen? It will go to this port of B 1 and it will also go to this port of B 2. Now, at that point, bridges have not learned it ok.

So, this is the beginning of their learning. So, what B 1 and B 2 will do? Now, B 1 B 2 they immediately see a particular. So, suppose this is his port 1 and this is his port 2, this is his port 1 and port 2. So, B 1 will keep a local copy or he will populate his local routing table. So, for port ID he will put 1 and 2, now station he will learn that port 1 A is connected.

Because he has received a packet from A to B in port 1, similar things will happen also for B 2. So, what you learnt port 1 2 station he learnt port 1 has A. So, immediately they will have these 2 learning, very good. Now, because they do not know anything about where B is. So, they have to now broadcast it. So, they will store this packet and try to broadcast it over here.

But remember both the bridges port 2 are connected to LAN 2. So, what will happen now, because of the nature of CSMA CD, one of them will get the first chance whichever way the collision is resolved; who will get the first chance I have not bothered about that. It might be B 1 first wins the channel he transmits it or it might be B 2 first wins the channel and he transmits it.

So, let us say now suppose B 1 wins it; the logic will be the same ok. If B 2 wins first the logic will follow. Suppose B 1 wins, so, now what B 1 will do? B 1 will broadcast this packet A to B, where source ID is A and station ID is B on LAN 2. Now, the problem starts. If it transmits this in LAN 2 it will also go to port 2 of B 2.

So, now what will happen to B 2? B 2 will see a packet on port 2 has come where the source ID is a then he tries to check his rooting table. He sees that my rooting table entry is wrong because A is connected to port 2. He will discuss this, he will put in an A and once he does that he will do it. He will store this packet because he still does not know where B is. He will store this and he will try to forward, try forwarding this on this particular port.

Plus he has another packet he does not know. He has another packet which is again A to B, according to previous learning experience, and he has to forward that also over here. So, basically, what is happening with every chance, they will relearn. If this process continues then what will happen? If he transmits the next packet then B 1 also will take that learning he will say A is connected over here.

Then they will issue 2 packets on the other side that will again change the whole thing whole scenario. So, they will keep on broadcasting packets, on every port and they will keep on relearning; their learning will never be converged. If there is a loop this is the problem that will be happening. They will never converge on their learning and not only that they keep on broadcasting they never stop because they are not sure from the other side again they are seeing a packet, which is being broadcasted.

The same packet is broadcasted in LAN 1 and LAN 2, again in LAN 1 and LAN 2. It keeps on proliferating; this is a very dangerous situation. It not only means stopping learning about it, it just keeps on increasing the number of packet that has to be broadcasted in each LAN.

After some amount of time, these 2 LANs will be completely saturated if we loop it. This looping is a little different from if means later on we will be discussing if in routers or in layer 3 there is a looping, it is not this problematic. There also there is also a problem, but it's not this problematic, because in a router it will just be the packet will never reach the destination, it will keep on looping.

But only a single packet, will not be making copies of the packet; because of this broadcasting of this LAN, they will be storing that packet making a copy, and re-relate. So, because of this keep on relaying the number of packets will be increased also which they are broadcasting. It is the same copy of the packet, they will make a recopy again and again, and every time they will broadcast both LANs.

After sometimes both the LANs will be saturated by those packets only. So, this is a big danger if there is a loop inside the bridge network. So, what do we need to make loop-free that should be our first target, and how do we make these things loop-free that is when people started discussing a particular protocol which is called spanning tree protocol.

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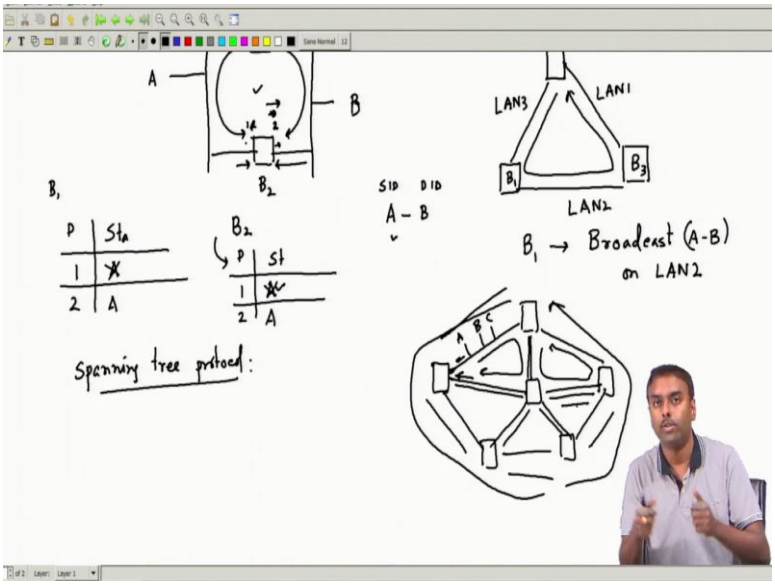

This is the protocol where if there are because of the topological design there are inherent loops. So, let us say I have these bridges they are connected like this ok? So, there are lots of loops as you can see these are all loops, the way bridges are connected there are multiple loops this bigger one also might be a loop.

So, you have to make it loop-free, what you can do; some of the links you can deactivate. So, basically among all these links or among all these LANs you do not deactivate the whole LAN, you just deactivate the forwarding of this bridge. So, the bridges will understand some of the links I will not forward my packet ok, but I will deliberately not forward those packets.

So, you deactivate those links. This LAN will have its machine A B C. So, what I can do, I can stop forwarding whatever packets come from other LANs, I will stop forwarding them. So, I will that is what is called deactivation, but if it comes from the other side from A, I will probably forward them. So, basically what I will do? I will make this forwarding decision, which port I forward and which port I do not forward I deactivate that.

By doing that, I can make a tree-like structure; so, basically some of the links I do not take as forwarding links. So, suppose among this I just take these links, this one this one this one this one, and this one, immediately this becomes a tree-like structure or I can

also do in a separate way whichever tree is better for me, I can take this link, this link, this link and this link that makes and this link that makes another tree.

As you can see it is called a spanning tree because, with this tree, everybody is connected it is still a fully connected network. Everybody is connected to everybody, but the predominant structure is a tree now. So, it is a; it is a tree structure which is being constructed over here. So, this is what we will be targeting.

We wish to do this kind of structural design ok. And that has to be done through a protocol that means, now we have gone one step forward towards learning bridges; so, that we can restrict the means packet distribution domain ok or packet broadcasting domain so, that the overall throughput gets increased.

Now, we want to give further learning capability. So, network protocol design is all about making those devices intelligent. So, that they can function in an automated fashion. So, we have already identified a problem. Now, we want to give them that intelligence. So, that they can detect this problem and immediately make the network in such a fashion or reconfigure the network in such a fashion that this problem never arises.

The bridges will show later on in the next class, that how these bridges can learn themselves. What is going on over there, what kind of topology do they have in a distributed fashion? Each bridge will learn what is in its own things and learning means it is just by passing messages among themselves, you will always see distributed learning or distributed optimization is all about passing messages among themselves.

Passing meaningful messages from where they can run a protocol or algorithm through which they learn the whole thing, the entire about the entire network, and then they take a unified decision towards making it proper. So, that is exactly what we will be targeting. Next, we will be discussing a distributed spanning tree algorithm.

Where every node in a distributed fashion learns from others' messages and also facilitates this learning of others by passing messages and through this they make a uniform learning. So, a particular topology which is a partial mesh or whatever it is that is not loop-free becomes loop-free. This is exactly what they will be doing.

So, of course, there is a rich literature on spanning tree algorithms. There are algorithms also these spanning tree algorithms which can be shown that it has a linear programming structure, which is optimization structure, which is linear optimization and that can mean sitting in a subclass ok.

This can be solved very easily with a very simple algorithm which is called greedy algorithm. So, there is a greedier version of the algorithm in a centralized fashion which is Prim's or Kruskal's algorithm, we will not go and discuss those things; how they are being devised we will not discuss that.

Because this course is not for that it requires graph theoretic and linear optimization and comminatory optimization techniques. We will not go in that direction, but what we will do? We will try to show the protocol that has been devised of course, it is a distributed spanning tree that comes from that same greedy approach and it can be graph theoretically proven that the greedy approaches are optimal over here.

So, it can locally do a greedy search and then decide what is best for everybody, and by some simple message passing they can come to a joint conclusion, that what should be the tree structure together. So, that everybody functions properly. So, this is something that we will be doing next. We will discuss in the next class, how this distributed spanning tree can be implemented ok.

Thank you.