Communication Networks
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Module - 10
Media Access Control Protocol
Lecture - 49
CSMA/ CA Contd

So we have been discussing for the last few classes regarding this CSMA CA protocol and I think we are on the verge of finishing it. Today we will try to finish whatever is left over. So, we have already seen how this protocol by introducing 3 messages basically very nicely resolved all the problems associated with the channel, the underlying channel which is the wireless media, and also facilitates some of the things in the media. So, it enhances the usage of the media.

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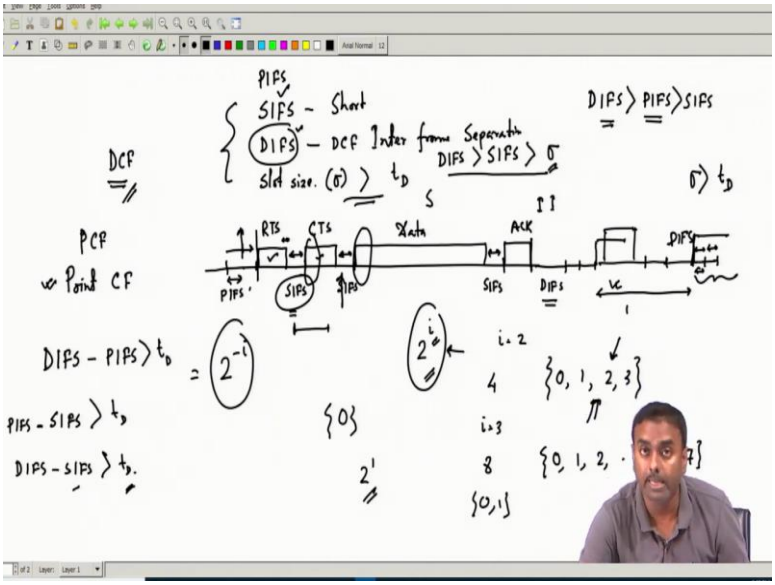

So, let us try to see what we have done in the last class. Trying to say how the sequence of data transmission goes on over here ok. Over here we have seen that there are some messages we have declared arbitrarily right now I have given the sequence of them also who is bigger and who is smaller. Why it is so we still have not discussed we will discuss that later on ok?

So, what we have seen is that any station that wishes to capture the channel has to initiate the transmission with RTS. So, he will give RTS after SIFS time why this is SIFS we

will also discuss that. After SIFS amount of time. So, with that short interframe separation time, CTS will be transmitted by the receiver, propagation delay we have neglected over here generally wireless these things the span will be very small.

So, the propagation delay of the electromagnetic wave will be just a few 100 meters. So, that will not be a big thing. So, the propagation delay we have ignored will be slight here and there that should be there that is fine. Then followed by CTS another SIFS actual data transmission by the actual user if RTS CTS are successful followed by SIFS acknowledgement. After that, every successful data transmission or collision is followed by DIFS ok.

So, that is being done. DIFS after that actually starts counting the slots. If he has something to transmit immediately every slot he will get that opportunity. So, like our aloha, it was there. So, it is a slotted thing. So, for every slot boundary, they just start initiating otherwise they just keep on counting the slots ok? Now if there is a collision, then he will wait for after SIFS, he will wait for CTS, and if he does not get anything he will declare that there is a collision.

Then after waiting for DIFS again, he will start the slots ok. After the collision what generally nodes do? Let us try to understand that part ok. We have talked about this binary backup. So, basically in binary backup what do they do? They put something called 2 to the power i and this is the slot count that they will be putting ok. We will come to what this means.

So, basically, this is associated with the probability, that there will be attempted transmission every time we in slotted Aloha we have discussed that every time there is a collision next slot they will put a probability of whether they will be attempting or not it is actually defined by this means.

This is how we are trying to do that, we will have also for stabilization we have been told that if more number of nodes goes into backlog we reduce the collision this one that transmission probability so that they do not collide and they eventually resolve the collision ok.

So, that is exactly what we are trying to do over here. So, what they will do? Basically, they take it in terms of slot count. So, whenever they actually collide. So, this slot they

declare that entire things to be a single slot this is actually a collision slot. After this collision slot is over this DIFS is over.

Then after that, they start counting the slots. And what do they do? They actually put this 2 to the pi power i number of slots or that is the kind of maximum count they want to put ok. Out of these 2 to the power i we will talk about what is i later on out of these 2 to the power i they choose a random number. Suppose i is equal to 2 in some situations. So, this will be 4 out of 4 means 0, 1, 2, 3 these 4 numbers ok.

If it is 2 i equals 3 then it will be 8; that means, it will go 0 1 2 dot dot dot up to 7. So, these 8 numbers will come. So, out of these numbers, they will be uniform with a uniform random this one they will pick one number. And that number they that will be his counter and he will decrease with every slot expiration ok? So, that means, actually, he is after that many slots whatever random number they will be picking, suppose they choose 2.

So, they will actually go for 2 two-slot counts after that only they will be attempting. Because it's uniformly distributed, and because 2 to the power i a number of slots they are taking out of which uniformly distributed one number they are picking. So, 1 by that will be the probability of attempting transmission at any this one. So, 2 to the power minus I becomes actually the probability of transmission.

This is exactly the probability a backlog node how he with what probability he attempts in a particular slot. Why we are doing that, why we are picking this random number? Because if 2 nodes collide, then suppose this is the first time they are colliding so, that collision count comes over I; if they are not colliding i is 0 ok. So, then immediately next slot they will be transmitting.

So, the new nodes generally never collide. So, they will be transmitting immediately next slot because this is 0. So, they have only one number 0. So, immediately next slot they will be transmitting that is 2 to the power 0. If one collision is there, it will be 2 to the power 1. So, that means, two slots there will be put 0 and 1 among them they choose. So, there is a possibility now, that if two nodes collide there is a possibility that one chooses 0, and one chooses 1.

Whoever chooses 0 will immediately start transmitting. So, as you can see immediately he will start transmitting. Now this time delta the significance comes into the picture this time is greater than the detection time t D we have talked about that over here. So, if he starts transmitting the other node will be listening to the channel, because this time is greater than t D he will be able to detect that there is a transmission going on this CSMA is possible.

So, immediately they will actually they will not transmit anything. So, if he transmits remember he will be transmitting RTS only. So, the other node will now know that somebody is transmitting RTS so, he will abort transmission. So, that way we will be able to facilitate this collision avoidance ok. So, this will be done if more collisions are happening our understanding this is the heuristic one we have already talked about earlier.

This is the kind of heuristic way of deciding how we update this collision sorry this attempt probability for the backlog node. So, we are making it 2 to the power minus i. Because if I collide 1 time then I think that there are 2 nodes at least, if I collide 2 times then I actually double that I say 4 nodes are there that is why it is called exponential or binary backup because every time binary multiplication I do ok.

So, I assume that 4 nodes are there. So, that is why between 0 to 3 4 number I choose so that choose some random number will be unique and then one will be transmitted, one will be successful, others will abort transmission will listen to RTS CTS, and they will allow this guy to transmit because he transmits then he will be taken out from the collision this one other two will also resolve collision and then transmit.

So, this is what will be happening, that is how the protocol actually operates. Now after giving this description of the protocol, let us try to see why these inter-frame sequences are there ok. So, this DIFS is related to this DCF Distributed Control Protocol or Distributed Coordination Function ok. So, this distributed coordination function is a specific type of protocol that has been implemented over here.

This is a distributed one, every node can decide whenever they want to capture the channel. So, basically, whenever there is a transmission end they wait for this DIFS distributed coordination function interframe separation that much amount of time they wait ok. After that much waiting that much amount of time they start capturing the

channel, if they have this collision count or with that they create the back off they do that, or if it is immediate capture they immediately capture that. So, they will do that.

So, all the nodes that are operating in the distributed fashion have to do that. There is also another thing called PCF or Point Coordination Function. Why it is a point coordination function? Because that particular mode of the protocol is centralized, where the access point we have already talked about access point there might be some access point Wi-Fi you know that there is some access point.

If access point instead of having this collision, he wants to do it like the pawn has done or like the optical fiber counterpart has done. He wants to just poll everybody and tell ok this is your turn, if he wants to do that point coordination of function that will be a separate kind of operation that might go on. So, to discriminate between these two there are two messages actually one is called PIFS, and another one is called SIFS.

Generally, what has happened, this DIFS is actually greater than PIFS and greater than SIFS. These timings are given just to give priority to others. If PIFS is smaller then as you can see suppose the transmission has been over, if you want to operate in DIFS you have to wait for DIFS, but if you want to suppose the access point wants to operate now capture the channel and operate in PCF mode.

Then after PIFS he can capture and he can start transmitting a broadcasting message which is called a beacon, then he will capture the following RTS and all those things will not be going on. For this priority to be implemented properly what do I need? Let us talk about this separation of DIFS minus PIFS and what that should be. So, if I capture after PIFS sorry PIFS then all the channels who are in DIFS by the time their DIFS is over must know something is going on in the channel.

So, therefore, this separation must be greater than t D the detection time, that is how the priority comes into the picture. So, if somebody the access point wants to capture, he just waits till a successful transmission or collision whatever is happening that goes stops. After that is stopped, immediately after that he counts for PIFS amount of time and captures it. Because DIFS is more than the detection time of plus PIFS.

So, basically, any other node who are waiting for DIFS to do the next transmission would not be allowed, they will immediately detect that somebody has captured the

channel that is the access point because the beacon has a means whenever he will be broadcasting beacon that has a separate kind of message structure they will read that they will understand ok now PIFS has been started we cannot do DCF.

So, they will abort transmission. So, this is this gives a very nice way of understanding this inter-frame separation a very nice way of giving all users the knowledge that ok something is going on. See why SIFS is there? Again this SIFS, that must be if you have this PIFS or DIFS minus SIFS this must be also greater than t D. Why is that? Let us try to understand suppose a successful transmission is going on RTS somebody has transmitted.

After that, he waits for SIFS. Why SIFS? Let us try to understand this. So, somebody might be doing this. So, RTS after that SIFS CTS is going on. Now think about this scenario suppose a new node comes into the picture, he has not seen all these RTS CTS suddenly he wakes up and wants to join this particular thing. So, what he has to do suppose he wakes up over here at this point. Now he has to wait for at least DIFS which is the DCF mechanism's basic mechanism.

At least this DIFS before he can start transmitting RTS. So, for every RTS whatever you want to do at least DIFS or PIFS you have to say sorry DIFS has to be an amount of time that has to be waited. So, if this guy immediately comes up, he has to wait for DIFS. Now DIFS is greater than SIFS plus some detection time. So, he will be able to detect the presence of CTS if he comes over here he will be able to detect the presence of data.

If he comes over here he will be able to detect the presence of RTS. So, all these things he will be able to see, and then he will abort transmission. So, basically, ongoing transmission will not be disturbed, if I have this SIFS difference between CTS RTS and all those things ongoing transmission will not be hampered. You can ask why on earth we are still giving this SIFS. I could have given it 0 no you should not do that.

Why? Because there might be some jitter around this RTS and CTS, because of the propagation delay. So, that is why CTS might RTS might be slightly delayed for another user, because of the propagation delay. So, that jitter should be taken care of by some guard band SIFS serves that purpose, it serves that guard band also ok. So, this is the beauty of all these things. And of course, as you can see because everybody has to be greater than this t D.

So, therefore, everybody must be greater than this t D or the slot size sigma. So, that has to be. So, those sequences are now very clearly understood as you can see. All these things have been very carefully designed so that whatever you want to give priority to they are getting priority. So, whenever this sequence is going on, everywhere this is SIFS the shortest one. So, that none of the new users with DIFS or PIFS can intercept this.

This will very smoothly go on they will immediately see either the presence of CTS RTS or acknowledgment of something, they will go up to this after that they can start capturing the channel of course, or they can fight for the channel whatever it is. But the smooth operation will go on, even though some new nodes are coming some disruptions are happening in between. So, there also smooth operation will be going on whatever operation you want them to go through ok.

So, that gives us closure to the description of this particular Wi-Fi protocol. We could have done the queueing analysis of this Wi-Fi protocol, but for the time shortage we will probably skip that part if anybody is interested there is a paper by Bianchi you can actually go through that whatever queueing theory understanding you have you should be able to successfully define means read that paper.

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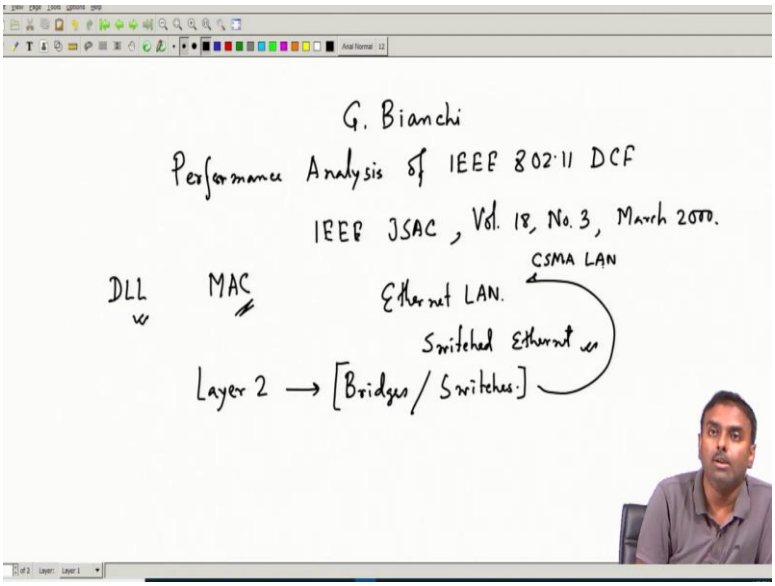

So, basically, the paper is named as it was written by G Bianchi. It is the paper's name is Performance Analysis of I triple E 802.11 which is the Wi-Fi DCF actually distributed coordination function DCF. So, it generally does the analysis of DCF, not the PCF the

other one the polling one does not do that. It was published in I triple E JSAC Journal of Selected Areas in Communication, volume 18, issue number 3. It was published in March 2000 ok.

So, that paper you can follow if you wish to really follow this particular part of the analysis of Wi-Fi ok? But otherwise the protocol we have covered, you have been given all the information about how to design a protocol that was my target actually in this course giving you all the details of how the physical layer influences a protocol design, every aspect of the physical layer how it affects the whole decision making of the protocol.

So, those things we have covered very carefully, you might now see that protocol designing is all about intuition coming up with a very nice intuitive solution and inside that, every corner will be covered. Like over here that has happened with the introduction of those 3 messages and all these inter-frame separation times, we could very nicely take care of all the issues that were happening in the wireless media.

So, that concludes our discussion. So, what we will try to do is we will just give a brief introduction of what next we will be doing and then from the next class onwards we will be taking care of that thing. So, the next part that has to be done is, we have discussed in data link layer DLL MAC heavily ok.

So, all the issues and all the aspects of MAC. Now what we will try to do we will try to see how the other part of the data link layer actually operates other than MAC there is also another part. It is mostly will see the application of the bridge. So, whenever you talk about this Ethernet network. So, we will talk about Ethernet LAN actually over here. So, whenever you talk about Ethernet LAN it has two kinds of things.

What we have shown is this CSMA CA is a kind of means broadcast domain Ethernet ok or it is a CSMA kind of Ethernet ok. So, where it is a common media everybody transmits, and then you actually from there you select. But there is also another part of Ethernet which is called switched Ethernet and later on you might see that has become more popular.

Instead of this broadcast or collision domain Ethernet basically the switched Ethernet become more popular. So, we will first try to see what is the switched Ethernet that is

something we want to understand. Once that switched Ethernet is understood then we will be also able to see how this switched Ethernet is being generated. Over there will be some extra devices which will be required other than these end nodes.

Which are this Ethernet nodes probably, that is called bridge or switch bridges or switches. These are generally because it is in the data link layer. So, these are called layer two switches there are layer 3 switches also which are IP switches probably. So, that we talk about later, but right now we will be talking about this layer 2 switches bridges or switches and we will try to see how this bridge or switch operates.

What functionality do they require what kind of facility do they give why it is advantageous compared to that CSMA LAN? How is this kind of bridge switch whatever Ethernet LAN we will be constructing the switched Ethernet most probably; that means, mostly what kind of advantage does it give over the CSMA LAN and what are the difficulties that they face these bridges?

And how we can actually expand the network with the help of these layer 2 switches? Ok. So, that is something we will try to discuss next. So, let us try to see what is switched Ethernet. At least today in the introduction we will try to see what is switched Ethernet. So, let us try to discuss that switched Ethernet part.

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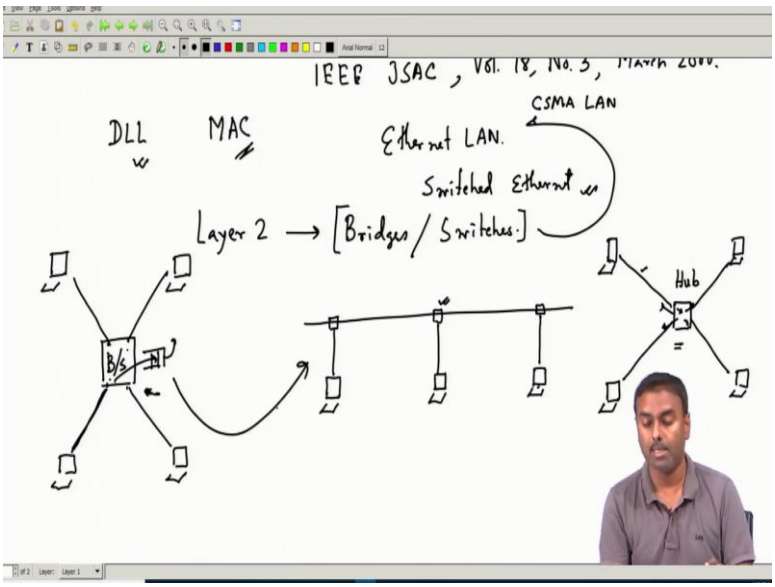

In general Ethernet, you had a coaxial cable right, and you were tapping them, and then connecting the machines. So, that was one way of understanding it. So, this is called an Ethernet bus or you had another way of putting that. So, that was a hub. So, it is called hub Ethernet. Everybody was connected to that hub, we have already seen that it is a star kind of network all the stations are connected through coaxial cable again these are coaxial cable and there is a hub that does nothing whatever port it gets data it broadcasts to every port including the same port.

So, it is just a broadcasting kind of device that broadcasts to every port. And in all ports, all the machines are connected. These are all CSMA Ethernet. So, the media is broadcasting media everybody gives whatever message they send that gets broadcasted to everybody can listen to that there is a collision domain they can collide we have already seen how to Ethernet how to devise the Ethernet CSMA CD protocol and all those things we have discussed this.

Now, from here we can change things. What we can do? Instead of this hub or this kind of tapping devices which are passive devices, they are not actually powered devices. So, instead of having those devices ok, we can have some active devices which has some logic implemented into it. So, that is called a bridge or switch ok? So, in the bridge or switch-like hub, I will be connecting all the Ethernet nodes.

This is generally the LAN that you will be seeing in your department or other places, another office scenario, that they are using these days. So, generally, they are connecting to an Ethernet switch which is a layer 2 switch. What happens in that? It is actually this having a buffer and this is having an interface at every port. So, at the interface, it is actually taking that data and storing it in its corresponding buffer. So, every interface might have its own buffer.

So, it stores it and it does a store and forwarding. So, instead of directly broadcasting it bit by bit it is doing something else it is storing putting it into the buffer. So, it is kind of doing the packet-switching philosophy over here ok. So, it then stores it. So, therefore, there is no collision domain over here. Up to this, it is a point-to-point link over here whatever comes that is being stored over here one after another.

And then whenever the other end is free, we actually read that packet. Sometimes over here what we can do? We can also see where which node is connected. So, it might be

an intelligent switch that later on you will be seeing also it might be a learning switch or learning bridge we will learn things which port is connected, he will know exactly which port is connected, and he can actually then whichever node he will read the packet, he will see where the destination id he can switch it accordingly.

So, this is the MAC switch, which is operating at layer 2 seeing the layer 2 ID only they do this switching part. So, over here mostly you will see that the collision domain is completely taken out, every port acts like a packet switching port, they have a buffer, they have also intelligence, they will be reading the packet and they will accordingly forward the packet.

They will not broadcast it to every port. That reduces the collision heavily and that also does a nice kind of throughput enhancement we will see that later on, but for that we need to understand what the functionality of that bridge does. What are the difficulties also it faces and how is it actually what kind of advantage it gives compared to this CSMA LAN? So, next class onwards we will start discussing these things in detail ok.

Thank you.