Communication Networks

Prof. Goutam Das
G. S. Sanyal School of Telecommunication
Indian Institute of Technology, Kharagpur

Module - 10
Media Access Control
Lecture - 45
CSMA/CD

Ok. So continuing our discussion on this Ethernet or CSMA CD which is actually generally applied for coaxial cable. So, that is something we will be further discussing today. So, what we have already started discussing about is that ok.

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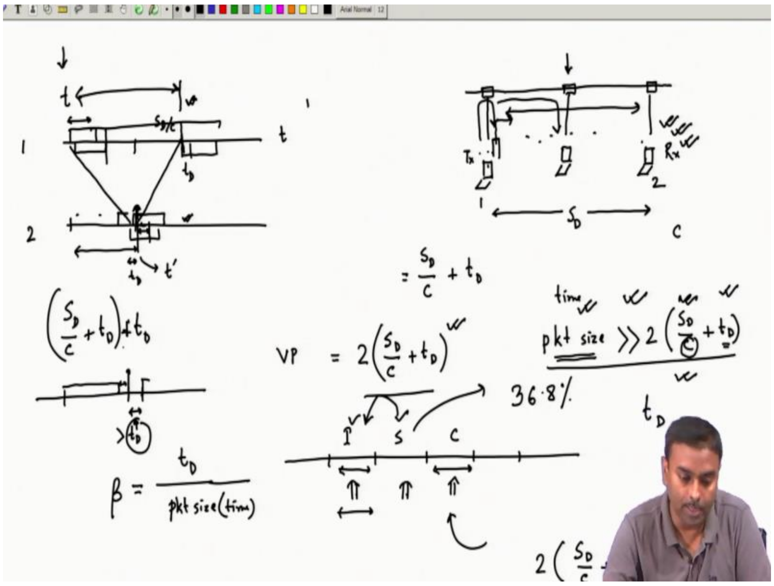

So, for CSMA CD or for Ethernet, let us say we have the Ethernet cable, and let us take the two distant nodes. So, we are talking about here Ethernet bus, of course, so two distant nodes, where the systems are connected.

Now, we have already demonstrated the time required for detecting a collision or detecting the presence of a particular node transmitting which is something we have seen. So, we have already been told that it is dependent on the span of the network. So, which is we have talked about SD as a span of the network that is the distance between two for this node.

And now if the velocity of electromagnetic wave, which is propagating through this coaxial cable is C then it is SD by C that is the time it takes for this signal whenever he is transmitting the first bit of it to reach this particular location from his transmitter to his receiver that is something we have already discussed.

And after that after this SD by C, we have also talked about, some amount of detection time, because we have to actually integrate detection is all about integrating. So, a few bits we have to take we have to integrate and then try to see whether it is beyond some threshold power level. So, that is the overall time to time taken to detect the presence of a signal.

Now, what about collision? So, if I am transmitting I need to know whether others are transmitting or not. Now for collision, we have also talked about this vulnerable period; that means, the period over which others cannot detect my presence can start transmitting and then I detect the collision. So, this might happen and that is due to this separation or distant distant location of two nodes and there is a finite propagation delay between them.

So, because of that, there is a vulnerability period where somebody might start transmitting even when he is transmitting he knows that channel is free still what might happen to others without knowing the presence? Even though they are doing carrier sensing without knowing the presence of this particular node they might start transmitting and then there will be some amount of time that we have calculated that will be taken for detecting this collision.

So, let us try again one more time to see what is that type. So, SDC plus t D is the time this receiver after this has started transmitting. So, let us say in time frame for this is let us say node 1. So, for one transmitter started transmitting the first bit this is for node 2 let us say this is node 2.

So, his receiver after some amount of time which is actually we are talking about this SD by C. So, that amount of time he will receive the first bit and then he will keep on receiving. But he also requires some t D amount of time which is required for his detection.

So, at this point, he can only detect that there is a presence of some other node and he will abort transmission. But what will happen the point let us say this is t from that time instance this particular amount of time is still vulnerable for this node; node 2. Because for node 2 he still does not know the presence of he only knows the presence of that node at t dash.

So, this amount of time SD by C plus t D is the time which is the vulnerable period where he can still transmit. So, node 1 can start his transmission. So, anywhere over here he can start initiating the transmission. So, from here or from here he can he can start transmitting if it transmits now let us see it from the perspective of node 1.

So, let us say at the last moment of the vulnerable period he starts transmitting. Then how much time it will take to reach over here it will take another SD amount of time SD by C and then he will be receiving the first bit. Again for detection, he requires t D amount of time. So, this will be possible.

So, let us try to see what the overall time that for node 1 to detect a collision even though he was the only one who had seen the channel free he was the only one who was transmitting. So, even then there might be collision because of this vulnerability period because of this propagation delay and finite distance between some two distant nodes. So, that will be overall SD by C plus t d into 2 which is the overall vulnerability period this is something that is a very important parameter you will see later on.

So, this is the amount of time that will be required to detect if there is a collision for detecting a collision. Now the thing is that if within this time my transmission is over then I will not be able to detect the collision as you can see what has happened. If this packet is this small like I have given in this example.

So, at this particular instant, his transmission which will be coming back from himself will not be able to detect that ok which is just coming back from this one that will take a very small amount of time. Because the propagation delay is very small from his node to the tap and back ok.

So, he will be receiving his own packet after some amount of time if this packet is over by the time he receives the other guy's packet ok. Then I will not be able to detect the collision or I can say there is no collision actually as such there might be a collision. If it is targeted from some other node for this node there might be a collision always we have talked about the collision as a phenomenon happening at the receiver.

So, it might be suppose he is targeting this one for this guy for him it might be a collision, but the one who is initiating the transmission will not be able to detect the collision. So, that is a danger that already there that I might not while transmitting I transmit my packet I take some amount of time to transmit the packet.

But detecting a collision takes a huge amount of time at least this amount of time that is required for detecting a collision. In the worst-case scenario if the other node that is transmitting is at the furthest location from me then detecting collision might take in the worst case this much amount of time. Within this amount of time my packet is already over the transmission time of the packet this is where we are talking about the transmission time.

So, that is this time. So, if the transmission time is over then I will not be able to detect collision because my packet is over. So, somebody else's packet I will be receiving and I will not detect a collision at that point. So, therefore, the packet size is very important packet size must be greater than to create to means avoid any kind of confusion that will be happening in the network. Because if this is not true what might happen I can still call means to create a collision at the receiver.

Let us say this node is exactly at the middle point between these two. So, there might be a collision chance of collision over here which will be created by the transmission of this guy and this guy simultaneously. Whereas, because my packet size is smaller than this propagation delay or twice the propagation delay plus the detection delay of this furthest node I will not be able to detect that condition, but it is happening at the receiver.

So, that is a very dangerous situation I should be able to detect collision because collision detection is one of the inherent features of this particular protocol. So, therefore, I have to carefully design it what is This careful designing is very simple just by putting this condition I take the furthest node which is SD which is the worst-case scenario to detect a collision.

So, I calculate that and I create a packet more than that packet size. So, packet size means the transmission rate. It will be the amount of time that the packet will be occupied occupying the channel for its transmission or that can be talked about transmission delay from the first bit to the last bit what is the time taken to transmit.

So, if my packet size is bigger than that I will be sure that whatever happens whichever node tries to transmit. I will always be able to detect a collision and once I detect a collision then I can abort transmission that is where I save actually the channel ok? So, that way I will be ensuring that you see this carefully.

So, what I am trying to ensure again we had that slotted system we have also talked about a few of the slots after I stabilized Aloha and all those things few of the slots will be free few other slots will be busy where successful transmission is going on.

So, if idle is successful and few other slots there will be collision we have also seen the probability of them ok. So, that is something we have already seen. So, what will be the probability of these things that also we have calculated? So, we have seen idle and success almost occupy the same amount of period 36 by 0.8 percent and collision takes a little bit lesser amount of this one ok.

But there is a catch to what we wanted to do. We have seen that if we do that only 30 at max 36.8 percent of utilization I can get if all these slots are identical. But we have also said that maybe we will now try to reduce this slot size, keeping the probability the same we will try to reduce this slot size and this slot size.

So, what was the assumption that this slot size could be reduced by doing this CSMA or carrier sensing? So, what do I do? Whenever I sense that somebody is transmitting I immediately declare that that is the end of the idle slot and I can go to the next slot. So, this is something I can always do and till somebody is if I detect somebody is transmitting then I can actually skip that entire transmission type. I will keep on sensing the channel I will still see he is transmitting.

So, I will keep on avoiding his when he is transmitting I will never collide because I am doing carrier sensing all the time because of this detector ok.

So, idle time is eventually what is happening just the detection time. If that detection time whatever the t D is is small enough compared to the packet size that is exactly what we are ensuring over here as you can see everything is falling in place. So, we are also proposing that the packet size or this packet size means it is in terms of time.

So, time occupies the whole channel if I am keeping much bigger than generally I will be trying to keep it much bigger than this one then my success time is much bigger whereas this detection time is much smaller. So, that will be my idle time just detection time or a little bit more than detection time.

So, I know that at least that much time is required to sense whether the channel is free or not. So, that is the definition of idle time. So, I will be at least keeping that much for idle time. So, every time that happens I wake up ok. So, maybe a successful transmission has happened. Then I will compute this means t D amount of time I will detect whether the channel is busy or not if I see it is not busy then I can immediately start transmitting ok.

So, if I take my success something like this it is the packet transmission time followed by a detection time. Then immediately followed by what will happen will be an idle time that will be again equivalent to a t D or just a little bit bigger than t D. If I do that then the next node also will be able to detect if nobody transmits over here.

At that point after detecting; that means the channel is idle. So, it will remain idle for just t D amount of time and then again another node can detect. If he has something to transmit if something comes over here he will be able to transmit and capture the channel.

So, the ideal time eventually becomes much smaller and this condition also provides that, but remember due to this particular thing there is a minimum size of the packet that is determined ok. So, that is something in Ethernet we have to see that there is a size that is the minimum size of the packet that must be greater than this that depends on the span of the network and the detection time these two things if we know.

So, let us say the span of the network depends on how much I can put my LAN up to what distance will be the furthest distance between two nodes? If I take that as 500 meters; accordingly I can know that this parameter C and I know this t d parameter. I will be able to calculate what is the minimal packet size ok.

So, these are the things I will be always able to calculate that is what people have done already. Oh so ok so that is why probably you will see this packet size will have a minimum packet size always specified that should be happening this is one thing. And through that, you can also see that protocol design is coming in place whatever we have understood from queuing theory or analyzing the stabilized slotted aloha. Whatever we have understood that is very nicely taken into account by the help of this CSMA.

So, I could reduce the idle time by a huge factor. So, that will be depending on this t D to packet size in terms of time by this factor I will be able to reduce. So, if I call this as beta. So, with a beta factor, I will be able to reduce my wastage due to idle periods which will eventually increase my overall throughput. So, that will always happen.

So, basically, I am now penetrating the throughput in this idle time that 36.8 percent idle time was there I can penetrate into that as I reduce my beta more and more. So, that I can increase the packet size more and more I will be able to actually penetrate inside this idle time. That means I can make this idle time small and his percentage will be reduced and the successful percentage will be increased.

The next thing that we should target is this collision part. So, now, let us from light of the previous discussion let us try to understand how can we reduce the collision time. So, let us say we have talked about collision detection time what was collision detection time.

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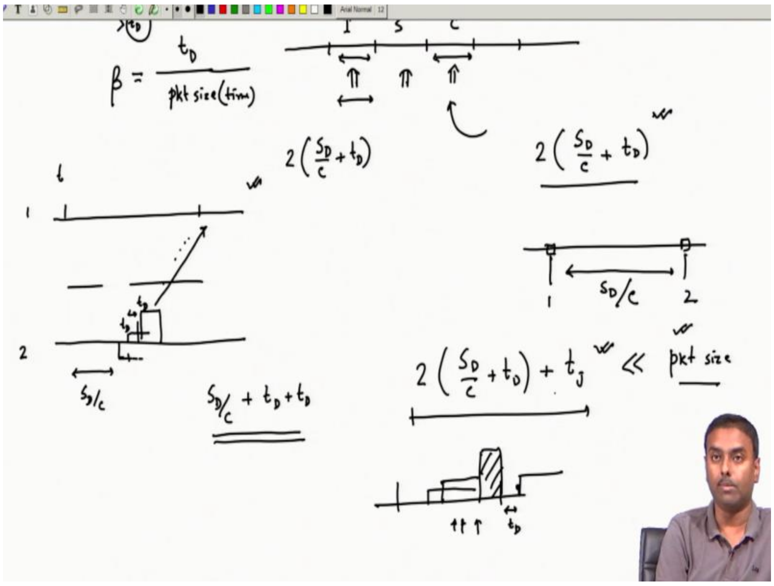

We have already seen that that is 2 into SD by C plus t D. So, that was kind of collision detection time worst case collision detection time ok. So, basically, this worst-case collision detection time if I take after detecting a collision immediately a node can abort transmission.

So, what will be the overall amount of time? So, let us try to see what might happen if you take this example of collision. Let us say the packet is quite big it goes beyond this vulnerable period SD 2 into SD by C plus t D. If that is the case one guy will be able to detect the collision that is the first guy, but for the second guy he has started transmitting, he might take some time or the other guy might take some amount of time.

So, we can try to see what is the worst-case collision detection time for all the stations. Let us try to understand for this guy what is the collision detection time when he will be able to detect the collision. As we can see he will be able to detect the collision immediately. So, after he starts transmitting, he immediately sees that the other transmission is coming in another t D he will be able to detect collision.

So, he detects collision much earlier as you can see. So, basically, what you can see in all other intermediate nodes is their detection of collision, collision will be at least much less than the amount of time that the node first node is getting. So, that is the worst-case scenario that uses initiate transmission you are probably the furthest node and you are getting collision with the other end node which is situated at the highest distance in the network possible.

So, for that node, that node 1 which we are talking about for him we can now understand that that is the highest time he will take to detect collision all other nodes will be detecting collision earlier. If that is the case this is the worst-case collision detection time immediately what I can say that if this is the worst case collision detection time. So, for that node that is detecting collision at an earlier stage, they can actually start issuing a jamming signal just to facilitate the collision time.

So, what is happening? As you can see over here we have observed that some of the nodes see this node is starting to transmit, and some of the nodes might detect collision at an earlier stage. So, talk about all receivers everywhere they are placed. So, now let us try to understand in the worst-case scenario who will be the first one to detect collision that will be the furthest node.

He will detect collision at the first instant at time SD by C plus t D after this time only he will be able to probably he has to add another t D. Because he has to detect collision also. So, after this much amount of time, you will be able to detect collision.

So, as we can see that is in the worst-case scenario that will be the maximum time to detect collision. Once somebody detects collision immediately he can start transmitting a jamming signal that he can do. What is the purpose of that jamming signal? Means it is a high power signal more powerful than any other transmission ok? So, if we transmit the jamming signal. What will happen? Now let us try to again delineate this particular thing diagrammatically.

So, let us say I have node 1 and node 2 they are the farthest ok 1 and 2. The distance between them is SD time travel from one node to another node is SD by C. So, let us say he starts transmitting at this instant t. So, basically, node 2 will be detecting it after an SD amount of time. So, this should be sorry SD by C amount of time. So, node 2, start detecting it ok.

Now, after that, he will take t D amount of time to detect his presence before that if he transmits he will still be able to transmit it ok. Now if he starts transmitting if this transmission is still going on then he will be able to detect collision after another t D amount of time. He will be the first one to detect this transmission in this worst-case scenario.

If two nodes are at the distance and they are transmitting simultaneously. So, you will be the first one to all other intermediate nodes after some amount of time when both these things come over here then only they will start detecting. So, they will be detected at a later stage and the last one to be detected collision is this guy and that time is 2 into SD by C plus t D that is something we have already discussed.

So, for him, it is actually SD by C plus t D plus another t D ok. So, that will be the amount of time this guy will be generally t D is very small compared to even SD by C also t D will be small. So, we can take that this is where the first means that the second guy will be able to detect a collision.

So, once it detects a collision it is his responsibility just to tell everybody else that there has been a collision. So, they will be taking a much higher amount of time. So, just to avoid that he might start sending a jamming signal. Now, if he starts sending a jamming signal you can see that that jamming signal is when it will be received by the other guy.

So, that reception of the jamming signal will be again with the propagation delay ok. So, whatever happens, as you can see this collision detection added with a jamming signal will always take this 2 into SD by C plus t D this much amount of time will be required plus there might be a jamming signal transmitted whatever time is required.

So, this amount of time is the collision time after the jamming signal has been transmitted everybody will abort transmission immediately they will detect ok. There is a collision going on till the jamming signal is gone they will align themselves up to they will be kept on listening up to the jamming signal end. They will align themselves whenever that jamming signal goes again they will start creating their slot. So, the collision ends over here after the jamming signal very high transmission.

So, in between there was some collision probably. So, two were transmitting together ok after that this jamming signal was transmitted. So, after this they will again everybody will wait for t D and then will attempt depending on the kind of protocol we have described already in means our, this slotted aloha or stabilized slotted aloha.

So, basically, all backlog nodes will try with some probability all these new nodes whatever they have received over here whatever transmission they have received that they can with some probability they can try those things. So, they can do that and then an idle slot will follow or if somebody captures the channel then again successful slot will follow.

But now whatever this time if this is again less than the packet size which we have already told then the success will be again having a higher this one compared to the collision one. So, again we get an advantage. So, the collision time will be a percentage of time will sorry percentage of their observation will be the same, but their time has been reduced.

So, the overall percentage of occupancy will be reduced and your throughput will be increased. So, this is the technique they have employed with collision detection and carrier sensing to enhance the throughput. So, what we will now try to do from there are two observations or two very important thing criteria. You have seen one that by carefully understanding the timing diagram we could come up with the packet size what is the lower limit of that packet size.

From there we could also understand what will be the collision duration and what will be the idle duration. And how they mean how by increasing packet size we can reduce these things or reduce the effect of these things which are the detrimental effect. Because they were reducing our throughput and we wanted to enhance the throughput. So, after we have understood these two things, what we can now do? We can see it is a wireless counterpart what happens over there ok?

So, that will be our next target in the next class we will be starting to discuss what happens in wireless media, common wireless media, not a coaxial media, not the wired media that we have been talking about. So, we will try to see that next class.

Thank you.