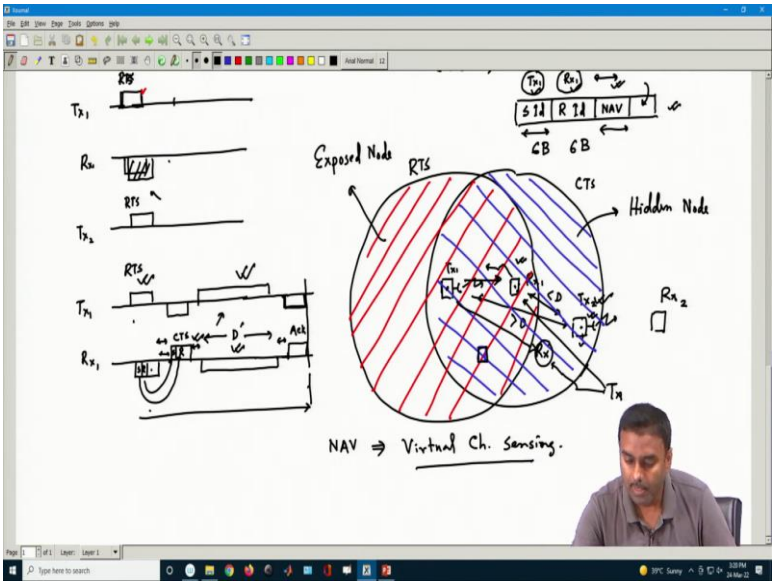
Communication Networks
Prof. Goutam Das
G. S. Sanyal School of Telecommunication
Indian Institute of Technology, Kharagpur

Module - 10
Media Access Control Protocol
Lecture - 48
CSMA/ CA Contd

So, we have started discussing about this RTS CTS in CSMA CA protocol. We have seen one advantage of it actually avoiding collision or it does not avoid full collision, but what it does is it facilitates the collision duration wastage to be very small. Like whatever target we had earlier with collision detection that same thing is somehow happening because of this probing packet. So, that is why a new kind of packet has to be now devised over here.

So, now you can see the protocol is being developed, so request to send clear to send and acknowledgement. These are the three packets which have been specifically devised for this particular protocol to work because the channel is a little different. Let us now try to see what is the full effect of that RTS CTS transmission.

(Refer Slide Time: 01:16)



So, if I go back to our previous class discussion ok. So, this was a scenario where we have seen that how RTS CTS goes through ok. Now let us try to see if I send RTS and

CTS what is happening exactly. So, this transmitter is sending RTS what is the range within which others will be able to sense that? So, that should be around this a circle of radius D ok? So, let me take a colour, this amount of area any transmitter or receiver who is there they will be able to listen to that RTS, that first RTS ok.

This RTS they will be able to listen to that. So, everybody in that area immediately knows that somebody named transmitter 1 with ID 1, is trying to transmit to receiver 1 with ID 2 and this transmitter transmission will go on for NAV amount of time whatever has been specified in NAV. So, it will specify that this amount of time channel will be occupied, so this is called virtual channel sensing.

We had a problem with channel sensing, now you can see there is a virtual channel sensing which facilitates the other things. So, this NAV is actually for virtual ok. So, what it is doing is actually instead of actually detecting whether there is something in the channel. If you can go through the RTS successfully then immediately this entire red-shaded zone, will know everybody in that zone will know that some transmission is going on for this much amount of time.

So, this much amount of time channel will remain busy, so immediately they will abort transmission. So, that is a good thing already I am trying to do this statistical multiplexing, I am trying to abort transmission for some of the users who will actually make this particular transmission collision means putting them in a collision. So, I am aborting that transmission, but is that good enough as you can see that is not good enough.

Because this transmitter is not in the red zone, particular transmitter he is a potential candidate who can be detrimental towards his reception of that signal because he is within D. So, I have to somehow make him or all these users who can potentially cause harm to this particular receiver I have to also make them aware. So, what does what are those zones, what is that at that particular zone; which user I have to make them aware of?

So, let us try to see I will give a blue shade to this zone for that receiver this is the overall zone as you can see which potentially creates collision. So, among that zone the intersection zone where both blue and red shaded areas is there in that zone everybody

has been already informed. So, they are not going to have any transmitter remaining over here they are not going to actually create a problem.

So, this transmitter is not going to create a problem, but this transmitter can create a problem. Now as you can see once the RTS has been transmitted what this guy will do this guy will now on air send a CTS which is the requirement. So, once RTS has been successfully transmitted the receiver is now acknowledging with CTS. So, he will be transmitting a CTS as you can see over here, so he will transmit a CTS.

Now, think about who will be aware of this CTS this CTS will be broadcasted in his circular disk where he is centred, so that will cover the entire green circular disk. So, this transmitter will also eventually know. So, basically, through RTS the zone of red all the users will be aware of this transmission through CTS this zone will be aware of this transmission ok? So, once these nodes also know they will about transmission.

They also know that this virtual channel sensing is still on because the NAV vector has been copied to CTS. So, through CTS they will also know how much time this channel will be occupied for this particular transmission between transmitter 1 and receiver 1. So, they will not disturb according to the rules of the protocol.

So, they will abort transmission now transmitter 1 can send the data very nicely and followed by acknowledgement, up to this the NAV vector will be specified. Because see when you specify the NAV vector you know the data size. So, this D you know or let us call that D dash because D we have already given for distance. So, this D dash you know in terms of time how much time it takes to transmit the packet because you know the packet size in your buffer. So, this is something you know and all other things are fixed.

This inter-frame delays or separation and the acknowledgement of CTS RTS everything is known. So, basically, you can find out this time sitting from here when you are trying to transmit RTS you can find out when that NAV, NAV will be over that acknowledgement transmission will be over if everything goes nicely.

So, because you know that you can put that in the NAV. So, this NAV calculation receiver or the R x 1 who will be sending CTS will just blindly copy that. So, everybody in that blue as well as red-shaded zone will know how much time the channel will be busy they will not disturb them.

So, that is the way we are actually fixing a special multiplexing domain ok? Any nodes which are outside let us say a transmitter over here, see this RTS CTS he will not be able to receive now he can transmit to his intended receiver. So, whoever that is that will be within some range he will be able to transmit to him because this transmitter is beyond this blue zone. So, he cannot create interference with him.

So, he can start transmitting the receiver will have no problem, that is the beauty of it as you can see. So, this is the beauty that this will not create any hampering within the zone ok? So, that is possible this is something which will be possible. Now, as you can see you can ask if this transmitter has a receiver ok which is somewhere over here. Can he transmit? Is that possible? Yes, he can transmit. Because as you can see this transmitter is more than D distance away.

So, this receiver will not have collision from this transmission and this transmitter is more than D distance away from the intended receiver of this particular P r transmission. So, therefore, both of them are protected due to this protocol.

So, this protocol very nicely resolves the whole issue of the special multiplexing, whichever transmitted receiver wherever they are they have now resolved their collision domain very nicely from the perspective of the receiver. So, every collision domain is from the perspective of the receiver and they have exactly resolved these things from the perspective of the receiver.

Because this has been done, so that is why they will not collide with each other. As you can see this has also facilitated the carrier sensing part because this particular transmitter who could have created means that could not have sensed the carrier, now has been facilitated to sense the carrier; in a different way. What is happening he is sensing the carrier through the receiver's CTS.

So, this acknowledgement message because now he is within the vicinity of the receiver he might not be within the vicinity of the transmitter. So, by this acknowledgement message or CTS, he is able to sense the carrier. And then he is able to abort transmission. So, the carrier sensing has been facilitated a virtual carrier sensing has been employed. So, every node whenever there is a transmission going on every node is aware of that.

And the collision domain or basically the collision duration that has been reduced. So, by this simple mechanism, all the problems have been resolved beautifully, so that is the beauty of this protocol. So, that simple protocol with one trick of probing the channel with a control packet while the receiver has to give acknowledgement back to that control packet. So, RTS followed by CTS just by introducing this you can see that the collision period has been or collision duration has been reduced significantly because actual data is not colliding.

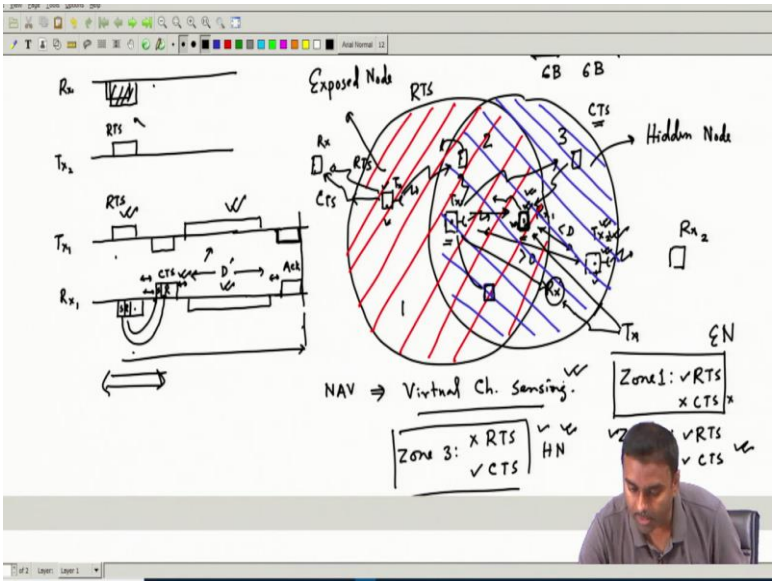
Now, there is no question of actual data colliding. So, if you have a collision what you will be doing whenever you have a collision; that means, CTS you want to receive. So, again you start transmitting RTS, but now when you are transmitting RTS you know that there is a collision.

So, you will be now going through the collision avoidance mechanism binary backup or exponential backup. So, all those things you will be employing that something you will be doing. So, that is something we will also discuss in detail, but this is what happens. Now, there is some specific terminology which has been used for these zones. So, only the red zone is called the exposed node, well I will talk about them and what this means.

Only green zone, the only blue zone that is called hidden nodes or the terminals which are there over here like this transmitter two that is a hidden terminal ok. We will talk about why these names have arrived what to do with these things why these names are so important. Now, let us try to carefully see. So, let us try to carefully see what the collision domain is always with respect to the receiver.

So, all the transmitters present in this entire blue zone are the potential collision creators. If they start transmitting then only collision will be happening ok. Among those things the common zone which is both red and green that portion of the if you take that as a Venn diagram. That portion that if RTS and this is CTS RTS intersection CTS that zone, that zone is actually where all the transmitters are already aware of transmission from the RTS message itself.

(Refer Slide Time: 13:30)



Because they can listen to this transmitter, so they have no problem. But as you can see these transmitters in the only green means blue zone. So, these transmitters are potential troublemakers because the RTS they could not hear they could not listen to. So, that is why they are called the hidden terminal.

So, if I do not properly resolve this then they will be if they start transmitting they will not be able to hear this RTS from transmitter one and they will be creating a collision with the receiver if they start transmitting because they cannot hear they cannot do CSMA. So, that is why these nodes from the perspective of transmission 1 to transmitter 1 to the receiver 1 transmission it is called hidden nodes.

So, as you can see hidden node will be always defined it's only defined by these two circles. How these two circles have been created putting transmitter intended transmitter and intended receiver at the centre. So, therefore, the region of hidden nodes or who will be hidden nodes has been always decided by the respective transmitter and receiver position. So, these transmitters and receivers which are the intended transmissions that I am talking about for them nodes are hidden.

In the only blue region whichever nodes will be there, they are hidden or they are called hidden terminals or hidden nodes. Now the CTS resolves that CTS actually informs because CTS goes from this receiver. So, all the other nodes which are in the hidden node will be informed about this transmission. So, hidden nodes are getting information

about a transmission ongoing transmission that has been requested where the RTS has become successful.

So, that is being given by the CTS remember the transmission will go through only if both RTS CTS are successful. If when he is transmitting CTS somebody else transmits something, then also there will be a problem the CTS will not go through probably ok. So, that is where we have to be careful ok. So, this is something we will have to really look forward to or we have to keep in mind ok.

So, what is happening now, with the CTS as you can see everybody in the hidden terminal is being informed about a transmission going on they will not disturb it. So, the entire blue zone now every user, earlier by CTS that RTS intersection CTS that blue-green zone common zone was informed.

Now by CTS, this only blue zone has been informed; that means, the entire circle of CTS or I should say the entire circle around this particular receiver has been now involved they cannot really disturb him. So, the data transmission goes through very smoothly. So, if RTS CTS become successful rest of the data transmission is assured at least collision-wise there will be no problem. There might be channel errors and other things that a separate issues, but nobody will create a collision to their data transmission that is a very good thing you have resolved the collision. So, actually, as you can see you could resolve the collision by method means of RTS CTS.

The only collision that can happen is now in RTS or CTS. So, we have to resolve that because those are smaller packets we can resolve that collision, but the actual data packet will not be allowing them to collide. Because they are a longer packet if they collide a longer duration of channel will be wasted. So, that is something we want to resolve and we also do not want to resolve the collision through this longer packet.

Then every time I collide next time also again I can collide, so I will keep on wasting huge amounts of time. Instead, I will resolve the collision beforehand with RTS CTS, once RTS CTS has been successfully transmitted I know that I have nothing to resolve. Through NAV everything has been resolved and the data transmission can go through without any disturbances, without any other nodes who are in the vicinity of the receiver creating collision to that data or creating interference to that data.

So, that will not be happening ok. Now, these are hidden nodes now let us try to see why these only red zone nodes are also being specified, so what is happening as you can see? Suppose there is a transmitter over here T x, as you can see because he is in the red zone only he is more than D distance away from the receiver. So, the receiver should not get any collision if he transmits at the same time.

He should not create if he transmits on the air something he will not create any problems to this receiver this particular receiver, is alright. Now if his receiver is somewhere over here this transmission can go through simultaneously, but unnecessarily because initially I have sent RTS all these transmitters in the red zone also they have been alerted they have got the NAV they will abort transmission. This is an inefficiency of this particular protocol.

If I listen to this protocol this way. So, basically what is happening these nodes in the only red zone are becoming exposed nodes. So, they are being exposed to the danger of collision whereas, actually there is no danger of collision this might be happening. So, they if they abort transmission knowing that there is a transmission going on between transmitter 1 and receiver 1 they are doing the wrong thing.

Because they can never collide with receiver 1 their transmission cannot be listened to by receiver 1 they are not inside the collision domain of receiver 1. So, therefore, they are free to actually transmit, but I am unnecessarily because he has listened to CT RTS he will unnecessarily block his transmission. That should not be, but what I can do is I can facilitate him.

So, how the exposed node is being identified? Let us try to see this 3 zone if I say this is zone 1 this is zone 2 and this is zone 3. During RTS CTS transmission, suppose the RTS CTS transmission has been successful; means that has seen success. Then what will be happening in zone 1, all zone 1 nodes what they will do? They will listen to RTS because they are in the red zone within the D circle of the transmitter who is transmitting RTS transmitter 1.

So, they will listen to RTS can they listen to CTS no because these zone 1 nodes are not within the radius of the receiver who is transmitting receiver 1 who is transmitting actually the CTS message. So, they will not they will receive RTS they will not receive CTS that is what happens in Zone 1. Zone 2 what happens? They receive both RTS and

CTS because they are in the vicinity means within the D radius of both transmitter and receiver.

What happens in zone 3? They do not receive RTS they receive CTS from this sequence all the nodes will actually know which zone they are in. Now as you can see zone 1 is the zone of an exposed node or exposed terminal. Zone 2 is ok where actually we should not call them anything because they are vulnerable, so they should abort transmission definitely. Zone 3 is actually the hidden nodes, zone 2 and zone 3 should not transmit.

So, if I see this pattern I have not received RTS, but I have received CTS. So, if I receive CTS definitely I will not transmit ok. So, if I just take that strategy then everybody from zone 2. 3 will not transmit and will not contain the channel. Whereas, zone 1 hidden node if you see they have received RTS, but they have not received CTS.

So, if they do not receive CTS they can assume that I am probably in the exposed node. So, I can still even though I have seen the RTS I can still transmit. So, then this transmission can still be initiated without having any problem. Now the problem is if his intended receiver is inside this zone then there might be a problem because this transmitter might create a collision, but that will be resolved because this particular node will be able to receive both RTS and CTS.

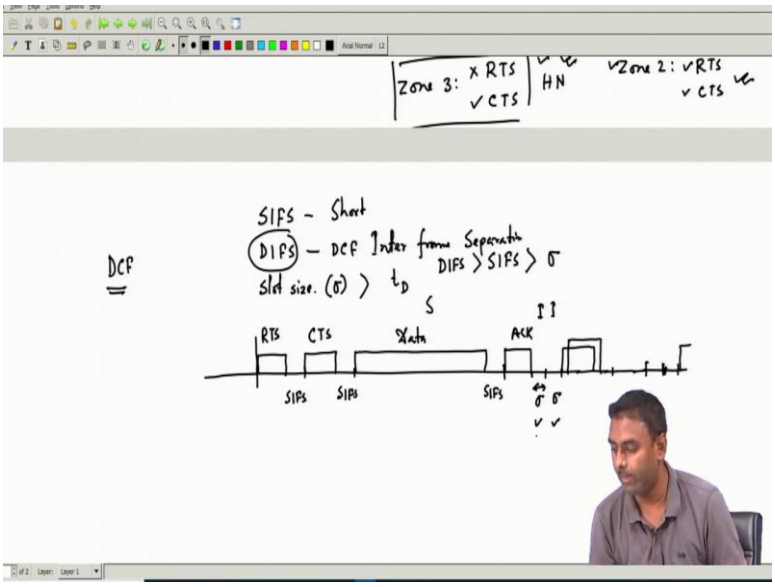
So, he will not even if this guy gives RTS to him he will not send back the CTS because he knows that he is in the vulnerable zone, so he will not send back CTS. So, therefore, this guy will never listen to CTS and he will never transmit. So, you can see very nicely by this logical consequence of the algorithm they can resolve where exactly they are as if their locations are virtually being realized, they exactly know who will be creating collision and who will not be creating collision even though it is all jumbled up.

So, this transmitter transmits to the receiver if he sends RTS he will send CTS because he cannot listen to the other CTS. So, therefore, he will send CTS and that transmission will go on, so wherever special multiplexing is required that is facilitated by identifying all these things and wherever special multiplexing is not facilitated that is properly resolved. The collision domain or collision duration is being shortened and carrier sensing is being facilitated very nicely.

There is also an additional thing of virtual carrier sensing where most of the time you do not have to keep on detecting the channel. Once you receive an RTS or CTS you immediately know that there is an NAV vector this transmission is going on, so I should not really sense channel up to that time. So, this is already understood by the nodes, that is the beauty of this nice protocol as you can see.

It is a very simple protocol, you have just added instead of transmitting the actual data you transmit to the control message before that and that does all this trick in a very complicated scenario it solved everything in the time domain beautifully solved everything. Now what is a backup algorithm that will be employed and how do they employ that? So, for that let me introduce a few variables over here or a few constants actually these are timing inter-frame constants.

(Refer Slide Time: 24:45)



So, let me introduce that. So, one is called SIFS the other one is called DIFS and the other one is called the slot size ok. Let us call that Sigma and SIFS DIFS. What is this slot size slot size must be greater than the detection time t d. So, this is almost like idle time ok. So, that is being defined as slot size or this is the idle time actually what are these SIFS DIFS? So, generally, this SIFS or short inter-frame sequence is called DIFS and comes from the DCF inter-frame sequence. So, what is DCF? Distributed Coordination Function, which is actually the whole protocol.

So, it's a conceptual thing, it says if this distributed protocol is going that is called distributed coordination function. So, for DCF I am putting inter frame inter frame separation sorry ah. So, inter-frame separation, so this is DCF inter-frame separation similarly this is short interframe separation.

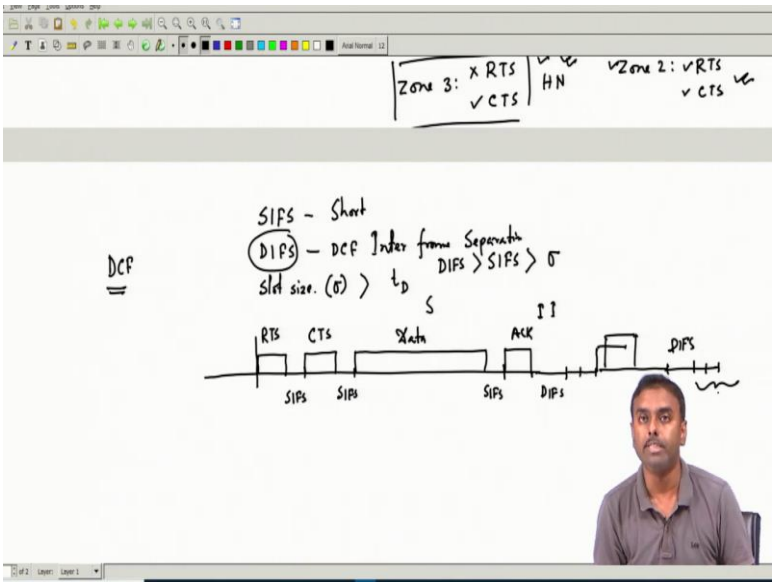
So, generally what happens this SIFS is greater than sigma which is slot size and DIFS is greater than this these are inter-frame differences. So, if you see the whole protocol and what happens I will take a successful case. So, you have an RTS, followed by this SIFS, followed by CTS given by the receive, followed by another SIFS. So, every time you put a packet between that and another packet you put you put a particular slot duration.

Followed by a CTS, followed by packet transmission, followed by another SIFS, followed by acknowledgement. That is how the data transmission goes on after that the slots are getting counted. So, this is sigma and so on ok. So, every transmission goes on like this if it is a successful transmission it will be like that if it is idle just Sigma nothing will be happening again next time an attempt might happen.

So, suppose two idle times are there. So, this is idle this is idle this is successful transmission after that let us say there is a collision. So, the collision might be due to RTS, so RTS to RTS is being transmitted. So, during this SIFS nothing will happen because RTS has collided. So, these things will not come over. So, CTS will not come followed by another SIFS ok. So, this will be happening, so nothing will happen.

So, now remember, so everything every either successful or a collided thing that happens after that you put this DIFS ok. So, after that after DIFS time again next transmission means slot count you can keep on doing ok. So, this idle will be always put after every successful one you put this idle period right after everyone that was not exactly correctly depicted. So, basically, after every successful thing there should be a DIFS or after every collision there should be a DIFS followed by that you will be doing other things.

(Refer Slide Time: 28:55)



So, every acknowledgement must be followed by a DIFS and then it might be an idle period if nothing is there. Then after that, if somebody starts transmitting then there might be a collision. So, after collision nothing will happen then DIFS again you can put and then again you can start ok.

So, it will go on like this, so always if it is idle for a very small duration it will be idle that sigma duration. If there is a successful transmission it will go on like this sequence. If there is an unsuccessful transmission, then what will happen in those slots afterwards you will be putting your binary backup algorithm. So, that is where the binary backup algorithm will come into the picture.

So, what we will do we will try to see this particular part in the next class how this binary backup algorithm goes on in every node and how this SIFS DIFS actually helps in accessing the channel properly ok? So, something will try to understand why this protocol will be very efficient and something will be discussed later on.

Thank you.