Data Communication
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Lecture # 26
Medium Access Control- II

Hello and welcome to today's lecture on Medium Access Control techniques. Today is the second lecture on this topic. In the first lecture we discussed about contention based protocols which are essentially random in nature and we have seen that there are collisions and because of collisions it is necessary to do retransmissions after random amount of time. And as you know whenever collision occurs it leads to wastage of bandwidth and whenever the traffic load increases there are many collisions leading to loss of throughput and ultimately it may lead to thrashing situation.

In this lecture we shall consider about collision-free protocols where collision is completely avoided. Here is the outline of today's lecture.

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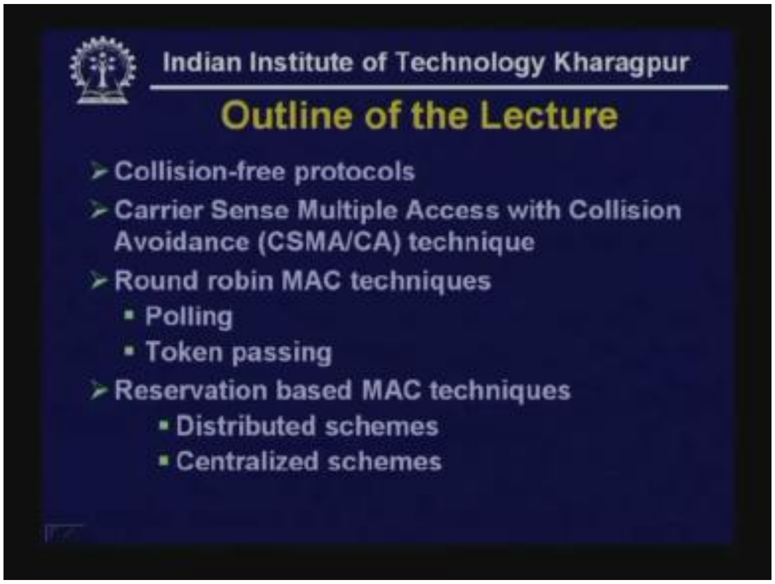

I shall explain what you mean by collision-free protocols, then we shall discuss one important protocol which is primarily used in wireless communication that is Carrier Sense Multiple Access with collision avoidance, here collision is avoided. Then there are two more techniques which are essentially controlled access techniques, also known as round-robin medium access control techniques known as polling and token passing.

Then we shall discuss reservation based medium access control techniques and they can be broadly divided into two types distributed and centralized. We shall discuss several examples of both the types. And on completion of this lecture the students will be able to understand the need for collision-free medium access control techniques.

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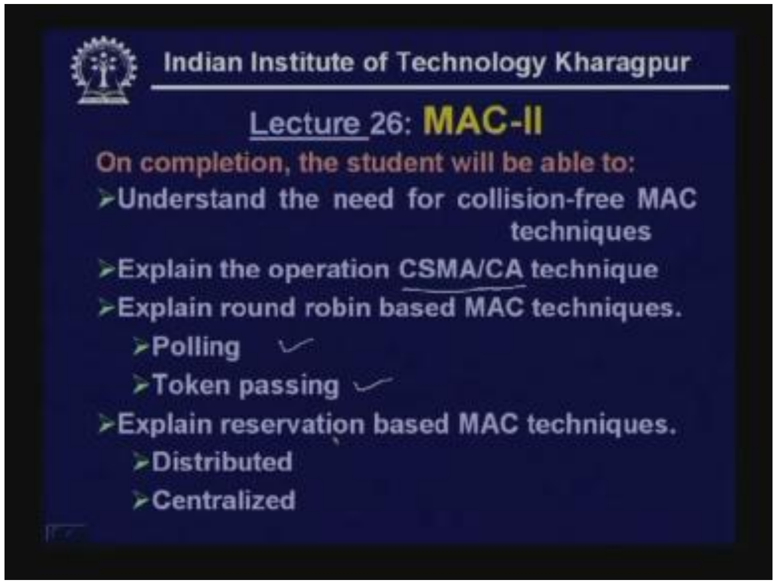

They will be able to explain the operation of CSMA protocol which we shall discuss and they will be able to explain round-robin based medium access control techniques such as polling and token passing. And finally they will be able to explain reservation based protocol techniques which are primarily used in satellite network which are distributed as well as centralized, both protocols are there so we shall discuss both of them. They will be able to understand and explain both these types.

Here is the overview of the total picture. In the last class we have discussed the random access protocols like ALOHA, CSMA, CSMA/CD, pure ALOHA and slotted ALOHA. As we know these are all contention based where collision is allowed to take place particularly even the traffic increases and collision occurs.

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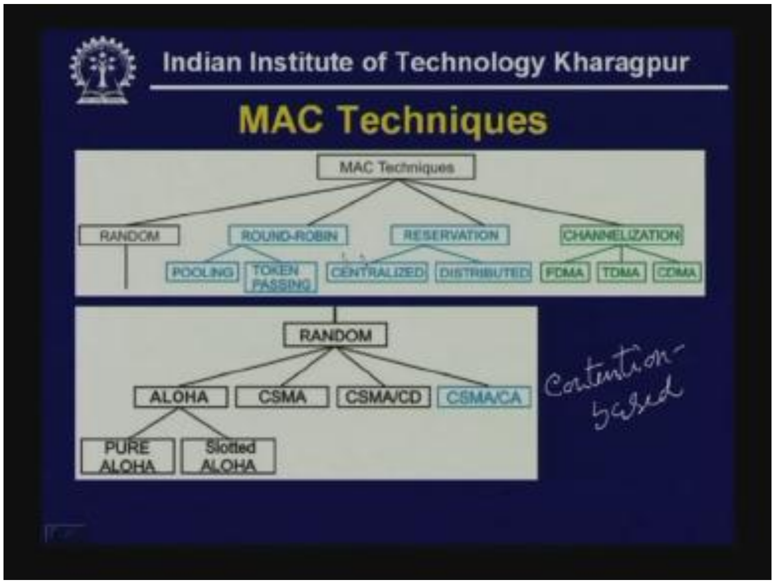

In this lecture we shall consider CSMA/CA, and then round-robin and reservation based protocol. Question arises why you need CSMA/CA or Carrier Sense Multiple Access with Collision Avoidance, why do you need it.

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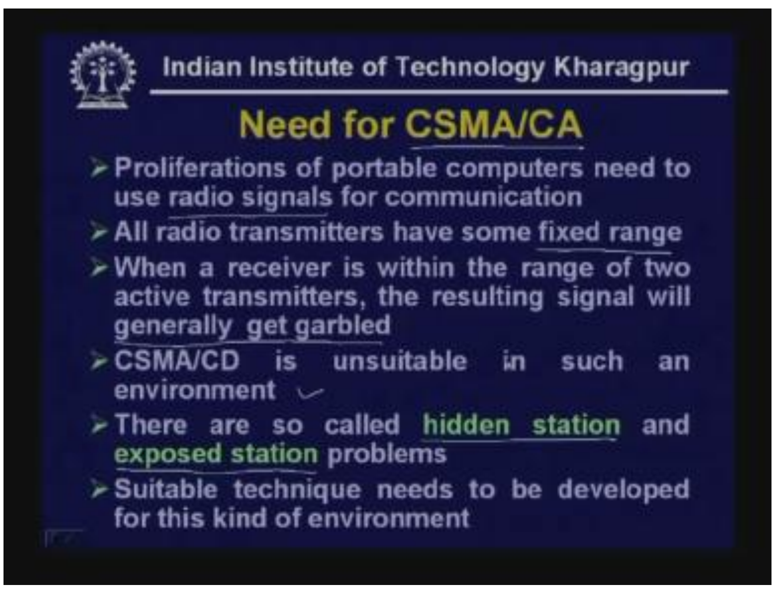

The need has arisen because of the proliferation of portable computers which requires radio signals for communication. As we know the portable computers although they can be connected but to maintain portability they should communicate with radio using radio signals. And as you know all radio transmitters have some fixed range. So, as the range increases the intensity decreases at the rate of d square. When a receiver is within the range of two active transmitters the resulting signal will be generally garbled. That means whenever a particular station is in between two transmitters it will receive signal from both the transmitters and the signal will get garbled and it will be useless, that's why this type of a situation should not be allowed to happen.

And as you know CSMA/CD is unsuitable in such environment. The reason for that is in wireless environment it is very difficult to detect collision because of attenuation, fading and also in the radio level it is very difficult to detect collision, that's why the CSMA/CD protocol cannot be used here. Moreover, there are two problems because of the special situation that I have mentioned, these are known as hidden station and exposed station problems which we shall discuss in detail. We have to develop techniques which are suitable for this kind of environment. Let us first discuss the hidden station problem.

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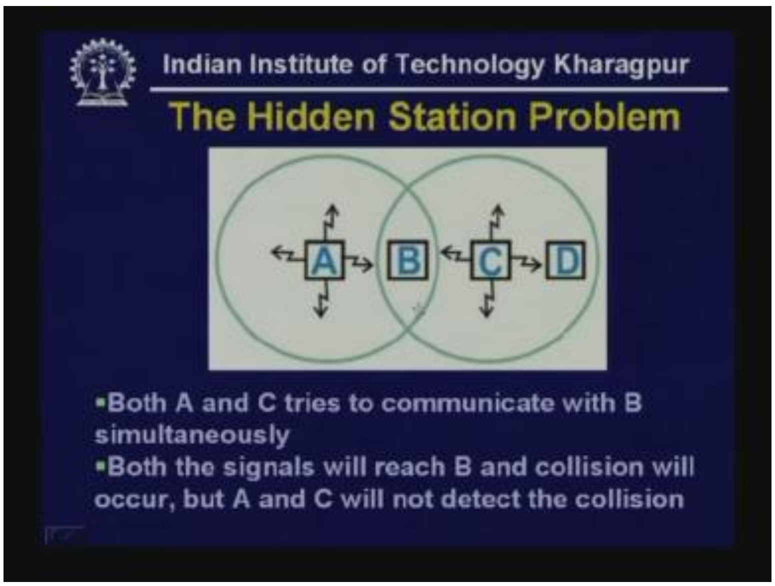

Here as you can see this station A is transmitting some signal and this circle shows the range over which the signal is receiving properly and beyond that the signal is very weak and particularly the signal to noise ratio will be very small and signal cannot be detected properly, that's why this is the range of this transmitter A station A (Refer Slide Time: 6:48).

On the other hand, this C is also transmitting simultaneously and this range is shown with the help of the other circle which is this circle. Therefore two circles are showing the range of two transmitters that are transmitting simultaneously.

As you can see B is in between. as a consequence B will receive signal both from A and C. As a result this signal here what will be received by B will be garbled and it will not be able to get the packet or the message which is sent either by A or by C but unfortunately the transmission sent by A will not reach C and also the transmission sent by C will not reach A because of longer distances. As a result they will not know that some kind of collision has taken place and B has not been able to get the signal. That means in such a case both the signals will reach B and collision will occur but A and C will not be able to detect the collision so A and C will not know, this is the hidden station problem as this is hidden between two stations. The other problem is known as exposed station problem.

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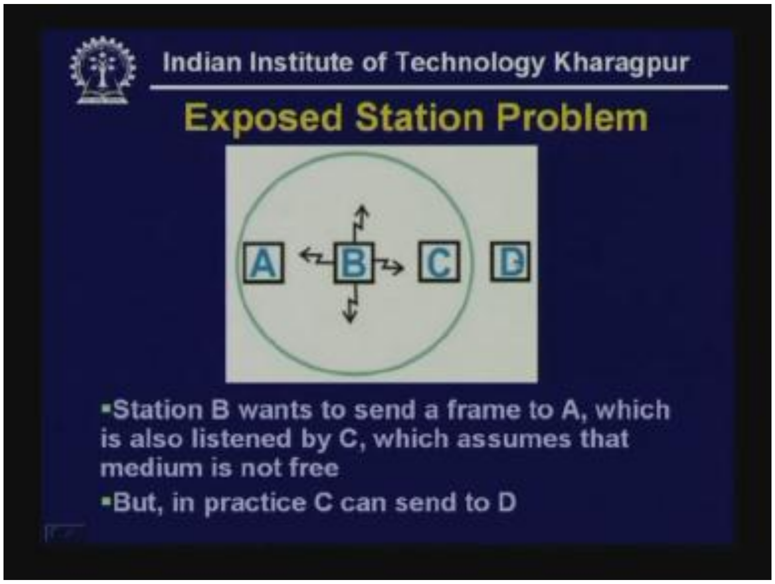

Here as you can see station B wants to send a frame to A which is also which is also listened by C. That means both C and A are within the range of B. As a result whenever B transmits both A and C will listen to it. And as a consequence C will decide that C is not able to transmit to D because it will assume that the signal sent by B will also reach D and collision will occur. This is known as exposed station problem.

Although in practice when B is transmitting to A, C can simultaneously transmit to D it is possible. But if we normal technique like CSMA or CSMA/CD this cannot be done. Hence what I intend to say is, in this situation B can transmit to A and C can transmit to D simultaneously but our protocol will not allow it unless we develop a suitable protocol. That can be avoided by using a special protocol known as Carrier Sense Multiple Access with Collision Avoidance. Here collision is completely avoided by using suitable protocol. Let us see how it is done.

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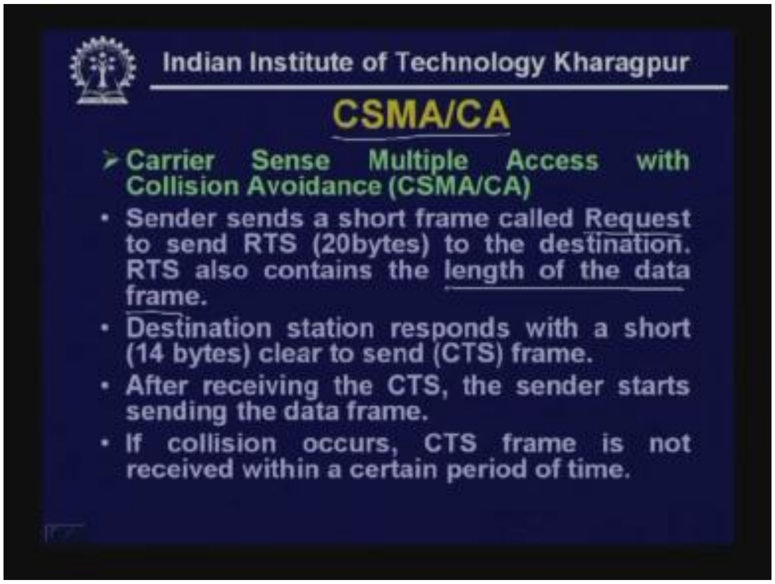

Here the sender sends a short frame called Request to send RTS which is about 20 bytes to the destination. The request to send also contains the length of the data frame. This means request to send packet will contain information about the length of the data frame. This destination station will respond to it with a short frame which is of 14 bytes known as clear to send frame and after receiving the clear to send the sender starts sending the data frame.

Here all the stations which will receive this clear to send will defer transmission. So, if collision occurs of course there is a possibility that there will be multiple clear to send frames present in a particular situation and in such cases there is a possibility that clear to send frame will suffer collision. So, in such a case that back up technique has to be used so that the clear to send message or packet is received by the sender. Let us see how exactly it happens.

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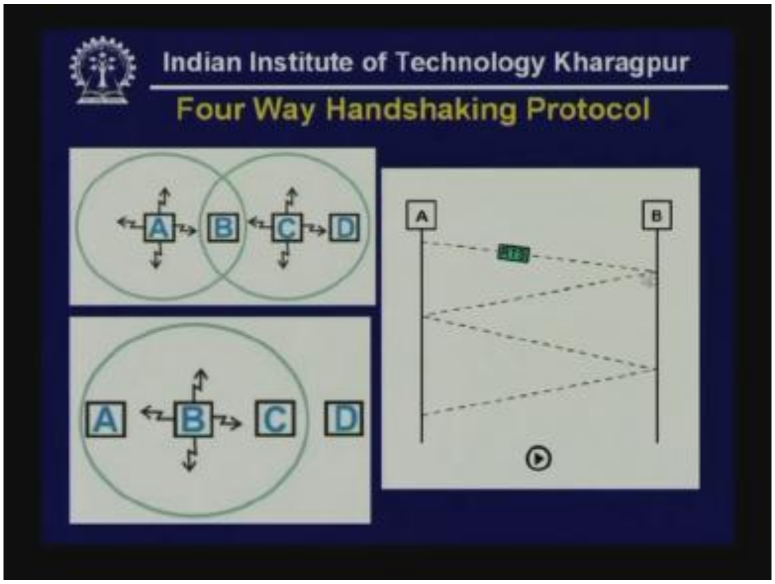

So here A sends a Request to send frame which is of 20 bytes and when it reaches B which sends a 14 byte Clear to send frame.

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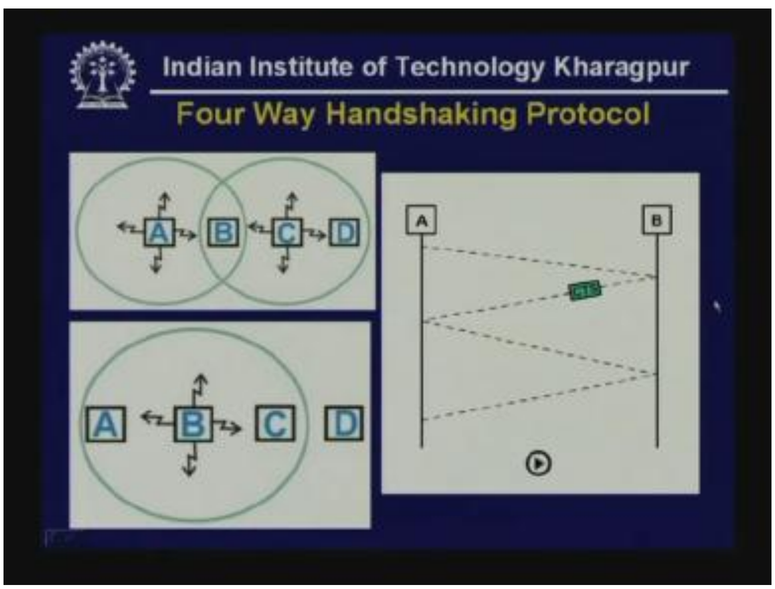

Now after hearing this clear to send as you can see here A is sending request to send, B will send the clear to send and that particular signal will be listened by C as well as by A. As a result C will defer transmission and of course if both of them request simultaneously then there will be some kind of collision but clear to send will be sent either to A or to C one of them will be sent and the other one will defer transmission. And as a consequence as one of them will defer transmission this exposed station problem will be overcome.

After receiving this clear to send data will be transmitted by either A or by C depending on who receives the clear to send and after the data is sent the acknowledgment will come from the receiver.

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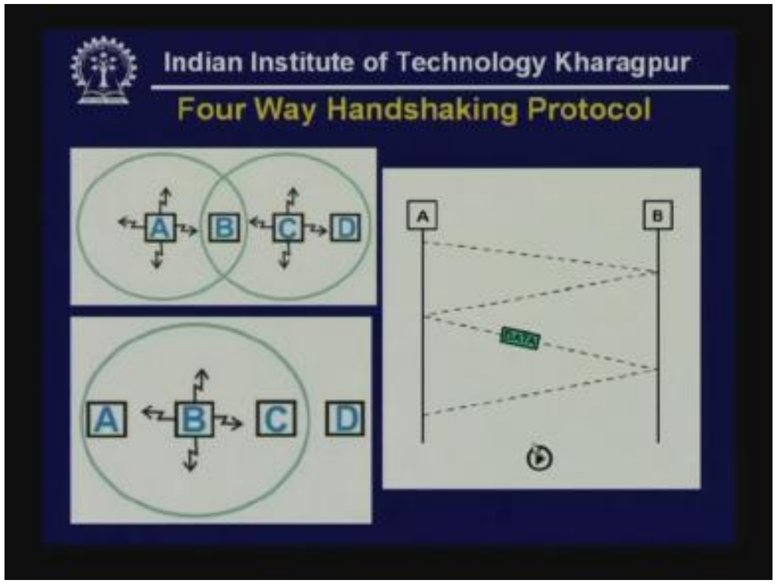

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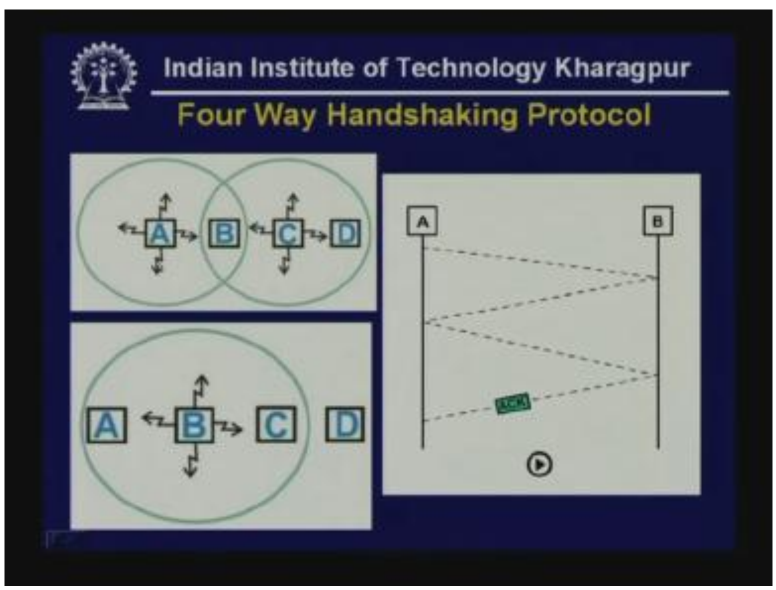

Now, the exposed station problem also will be overcome here. For example, whenever B sends a packet to A then request to send packet will go from B to A and A will send clear to send. Let us start once again. Here it is B and B is sending to Request to send to A and A will respond with a clear to send.

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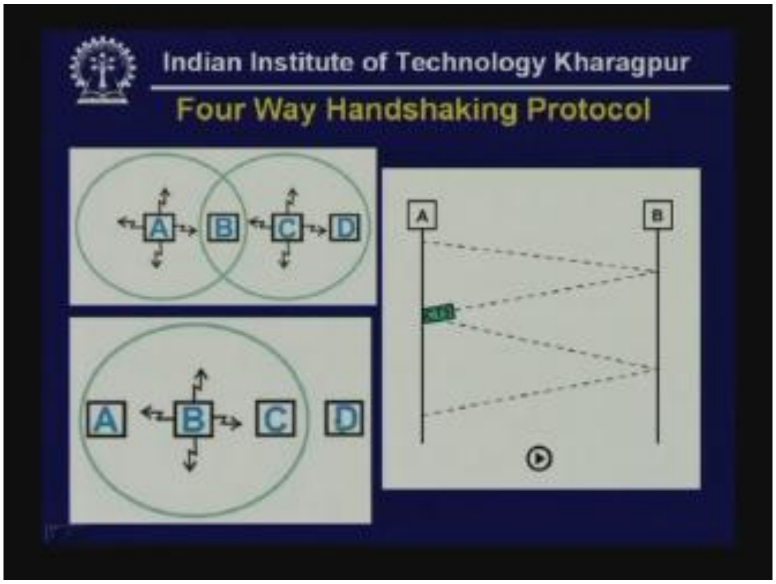

Now this signal whenever A sends to B obviously it will not be listened by B. So if C requests a clear to send to B that clear to send will not be listened either by A or by B. As a consequence if C sends a request to B then that clear to send will be received only by C, as a consequence B will be able to send to A and C will be able to send to D simultaneously. So we see that parallel data transmission between B and C and D to C C to D and B to A is possible by using this protocol. This is known as four way handshaking protocol and by using this four way handshaking protocol it means request to send, clear to send data and acknowledgement. This is known as carrier sense multiplexes with collision avoidance. Therefore the data packet does not suffer collision in any situation.

We have seen how collision is avoided in wireless communication. Particularly this protocol is used in wireless LAN as we will discuss in detail later on. Now we shall go back to the round-robin techniques. The one important approach used in round-robin technique is polling. Polling is a very common technique used in many practical situations.

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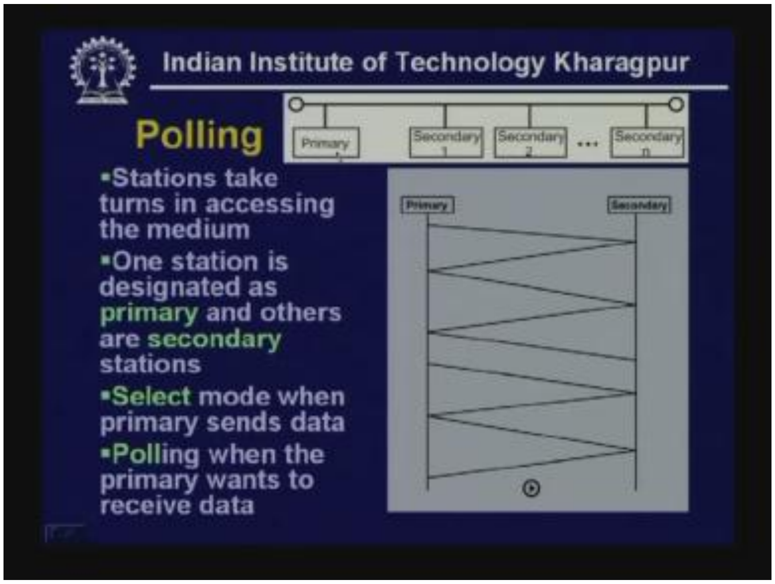

For example, in classrooms we do the roll call by polling or we ask questions to the students by using polling. The teacher calls the students one by one by their roll number or questions the students one by one and passes the answer so a similar thing is done here. Here you have got stations take turn in accessing the medium. That means in such a case one station is termed as primary, it can be considered as teacher or the chairman in practical applications and other stations are called secondary. There are two distinct nodes.

So whenever this primary wants to send data to one of the secondaries then it can be select mode, first the primary has to select a particular secondary by sending its address and whenever the secondary responds, sends an acknowledgement then the data transfer is performed. On the other hand, in the polling case data is coming from the secondary to the primary. In such a case primary will send a polling signal to one of the secondary, secondary will send an acknowledgment and then the data transfer will take place. Let us see how exactly it happens. First let us consider the polling mode. In this case the polling signal goes to all the secondary.

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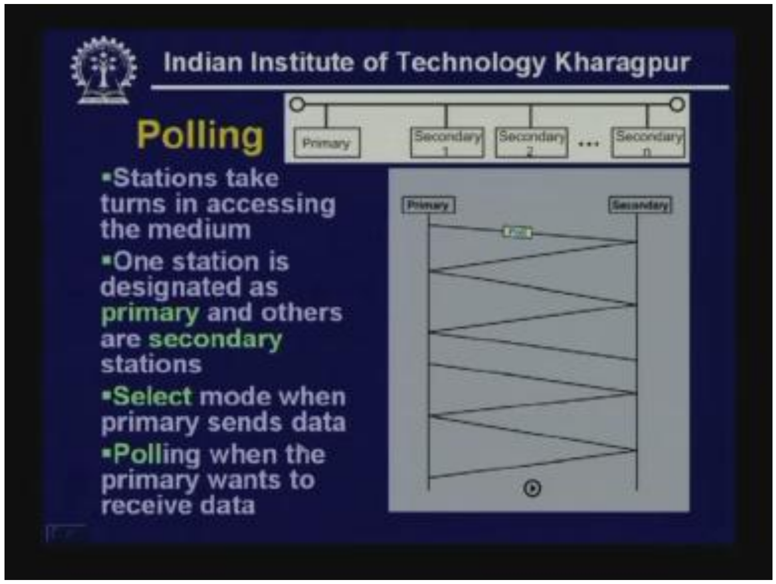

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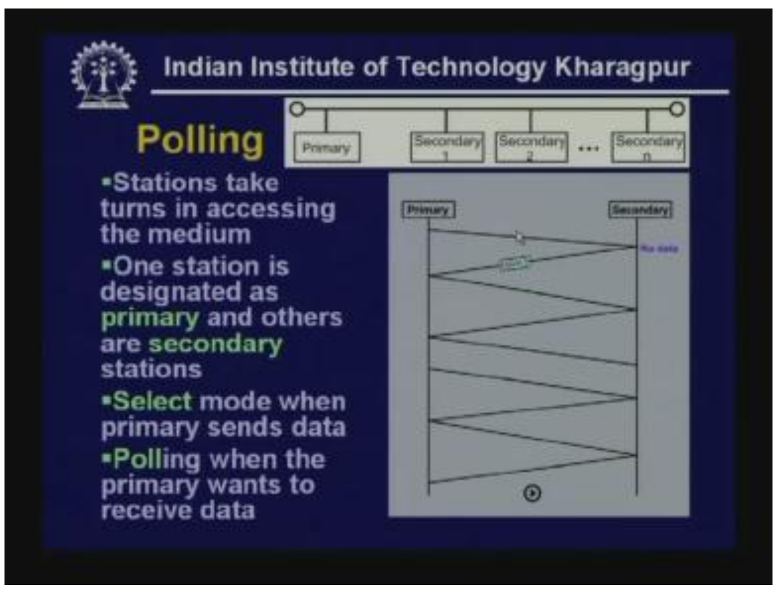

So it has got no data to which the address was given then no acknowledgement signal will come and another polling signal will be sent by the primary and if the polled secondary has some data to send it will send the data then the primary will send an acknowledgment to the secondary.

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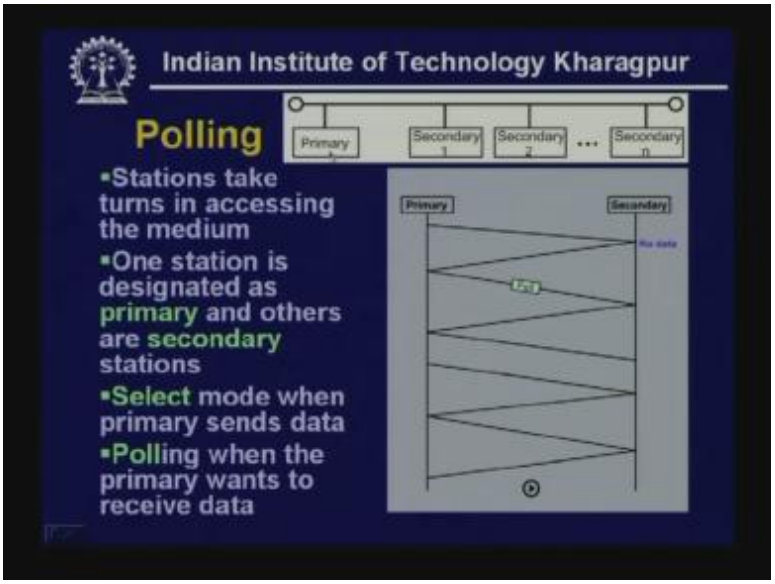

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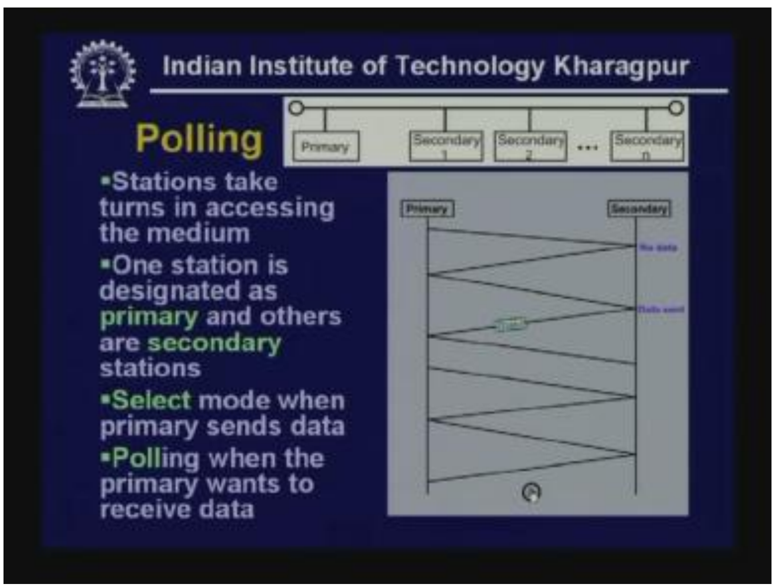

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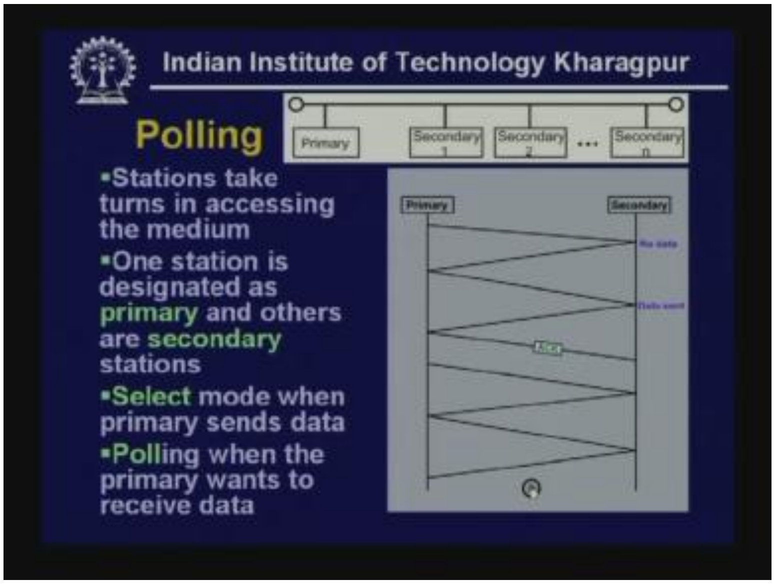

This is how in the poll mode one by one the polling is done by the primary and it gets data from the secondary in round-robin manner.

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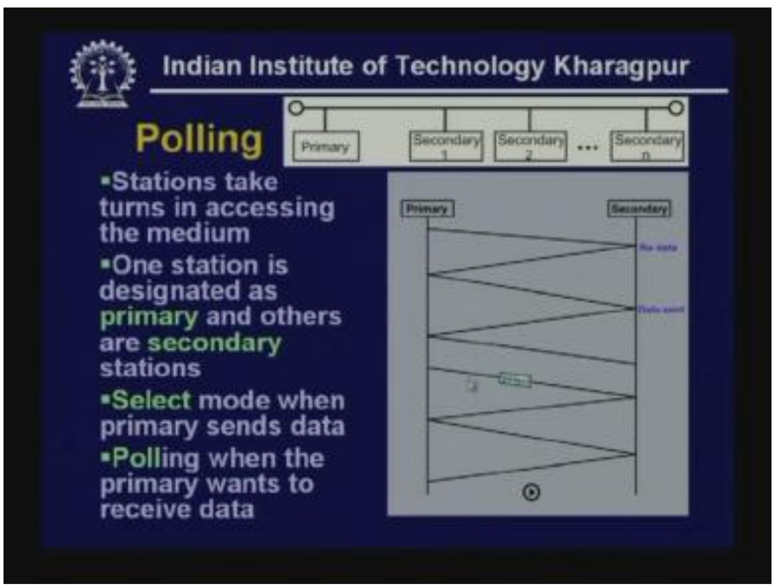

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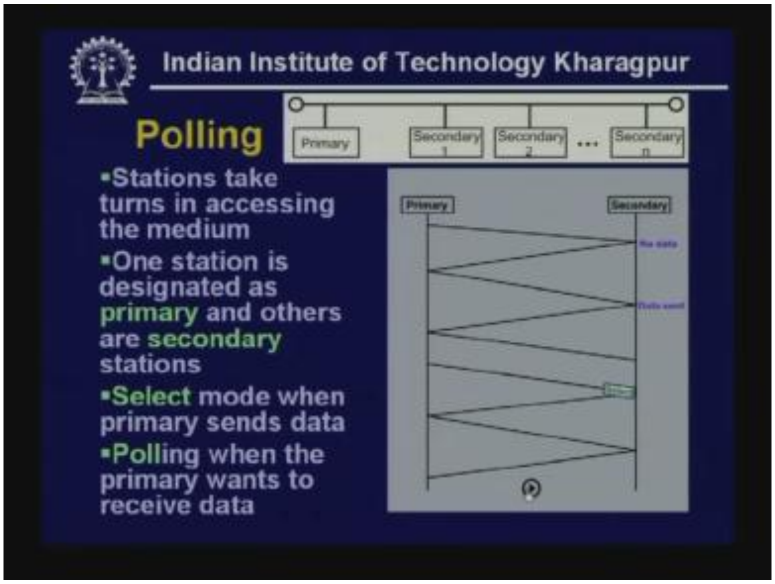

Next one is the select mode in which data goes from primary to the secondary. So selection goes with the address and that particular station and one of the secondary stations will respond will respond with an acknowledgment packet and then data transfer is data is sent by the primary to the secondary and then the secondary will send an acknowledgment.

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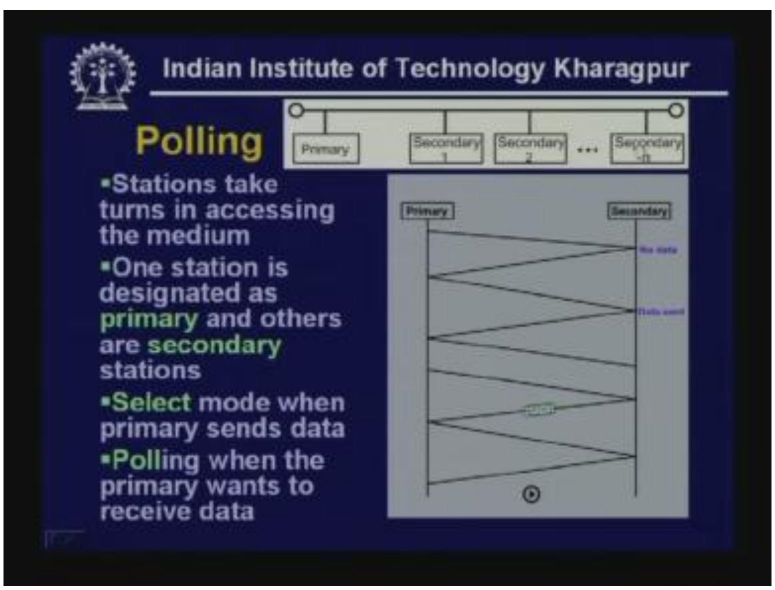

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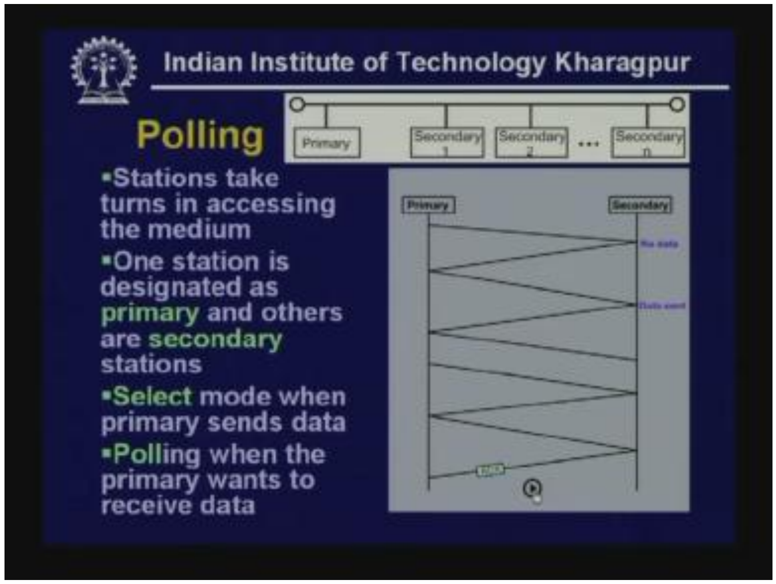

This is how the polling is performed here whenever a number of stations are connected to a bus which is shared by all the stations.

Polling can be done in wireless communication also, there can be a central controller which may use a frequency bane to send outbound signal. So you can see (Refer Slide Time: 17:36) this controller is sending outbound signals and this is some kind of broadcasting which is received by all other stations and other stations here at different frequency are to send the inbound messages. So others will send some signals which are essentially shared by all the stations.

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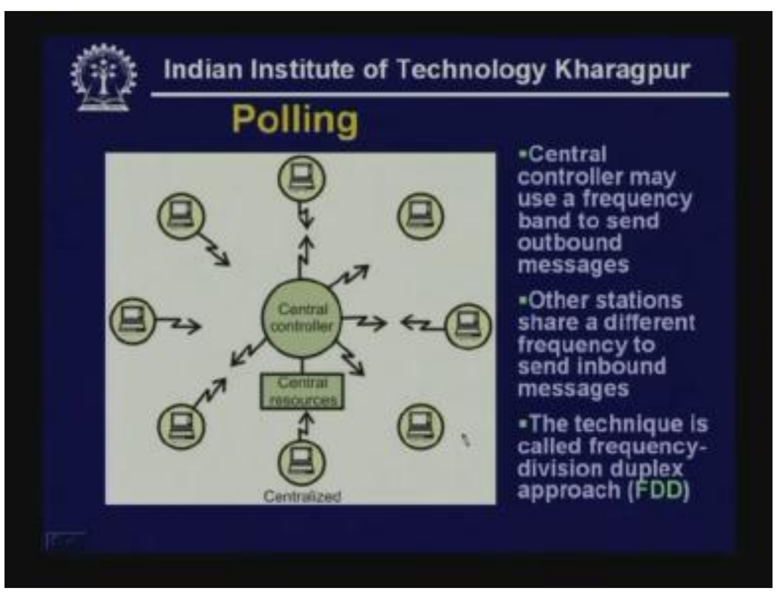

In this kind of a technique the bandwidth is divided into two parts; one is outbound and another is inbound. This is your outbound, this is your inbound and this technique is called Frequency Division Duplex approach or FDD approach. In such a case that centralized controller will send message to all other stations by using this outbound frequency band and all other stations will send message by using inbound messages and then the polling is performed one after the other the these stations will be asked to send that. Because since it is a broadcasting situation all these stations will know and only the poll secondary although it is shared will be sending the data to the central controller. So all the data transfer will take place through this central controller.

Polling can be done without using the central controller also. Here is a situation where you have got a number of stations and there is no central controller. Here all stations receive signals from all other stations. Here if this station transmits all the other stations will be able to receive it because it is some kind of broadcasting.

Whenever one of them transmits all the other stations will receive it and the stations will develop a polling order list using some protocol. The details of the protocol is not mentioned here. But in this distributed fashion all the stations will use some kind of protocol by which one station will send data to the others. Of course, only based on the address the destination station will receive the data. So in this way one after the other each station will transmit although it will be broadcasting but the packet meant for destination station will accept the data, others will ignore it. This is how polling can be done without using the centralized controller. It can be done in a distributed manner. Here it is shown in detail as how the polling messages are performed to send data one by one with the help of a central controller.

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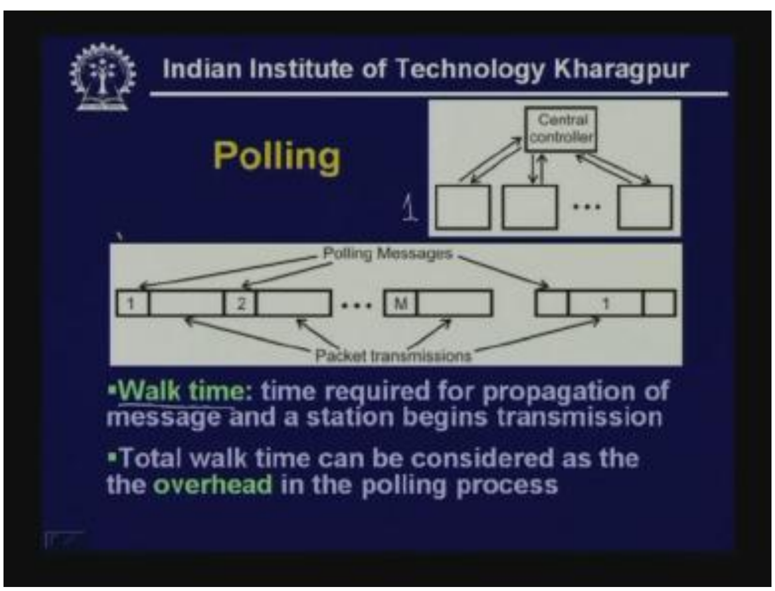

Here it is the primary station and these are all the secondary stations. This is the time; first this one is mentioned that this is the work time required for propagation of message from the central controller to reach this station one. This is the station one so this station one will receive the message and then it will respond. So it will take some time known as walk time. So, time required for propagation of message and the station begins transmission. So the duration from this to this time is known as the walk time for polling station 1. Then the data transmission from station 1 takes place then it will poll station 2 in the same manner, it will require some walk time for polling two then station 2 will transmit data.

In this way [a…m 21:18] station will transmit one after the other and again station 1 will get it start. So all the stations will get their turn for sending a message to the central controller and of course central controller can also send data in this manner. And total work time can be considered as the overhead in the polling process. that means this is essentially the overhead for transmission and you can calculate the throughput based on the total walk time required and the total time spent for sending the messages and here the overhead can be made very small because this propagation time is usually small whenever the stations are located nearby not satellite communication or of that kind so this walk time can be quite small and throughput can be quite high.

Of course there will be some transmission time involved that means propagation and transmission time of the packet coming from the central controller to the station and also packet transmission time of the stations going to the central controller, the acknowledgement or no acknowledgment packets. This time is known as walk time and total walk time is the total overhead. In this way you can calculate the total over head and find out the throughput.

Now we shall discuss the second approach used for round-robin technique known as token passing. In a token passing approach all stations are logically connected in the form of a ring.

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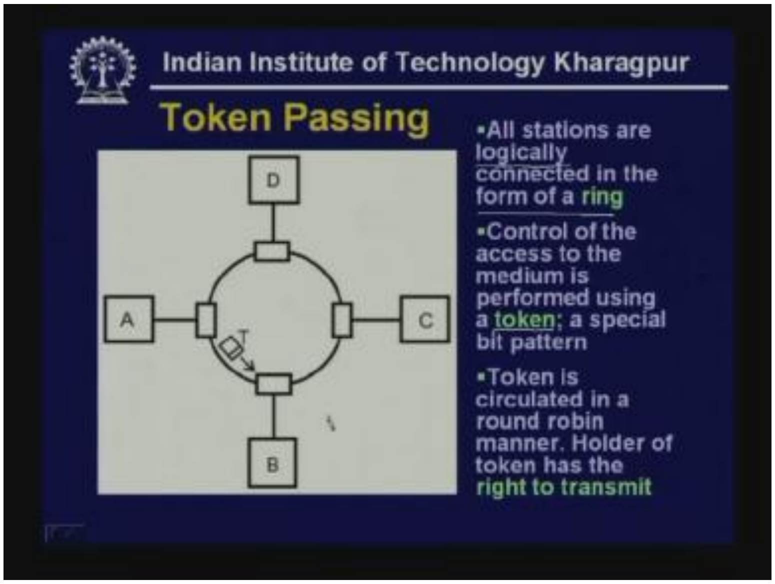

You note down this particular term logically. Here we have shown the stations are not only logical but physically connected in the form of a ring. Here for example this particular station is connected to its neighbor D and B, B is connected to A and C and C is connected to D and B so in this way all are connected in the form of a ring. This particular interface is connected to its neighbor by using point-to-point links. As I mentioned this point to point link can be either twisted pair or if the distance is very long it can be optical fiber. So either twisted-pair or optical fiber is used for point-to-point link between the stations.

Now this ring is essentially the shared medium used for communication and that control of the access to the medium is performed using a token.

What is a token?

A token is essentially a special bit sequence or it can be considered as a small packet. This packet circulates around the ring and whoever is the owner or whoever captures a token gets the right to transmit. So, token is circulated in a round-robin manner and holder of the token has the right to transmit. Here (Refer Slide Time: 24: 46) somehow a token is introduced. say suppose A is holding the token so it will send the data, data transmission will take place and it will come back to A then it will release the token it will go to B and whenever it receives the B captures the token it will then send the data, it will go around the ring, it will come back to it, it will take out the data frame and then introduce the token it will go to C. So in this way the token circulates around the ring and whenever a particular station has no data to send it simply passes on the free token to the next station. This is explained with the help of this flow chart.

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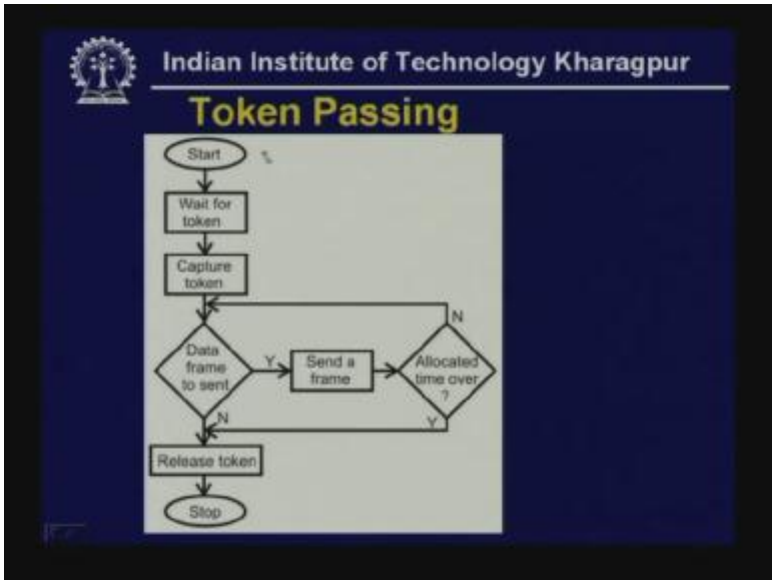

We have also sent that there is some kind of a network interface. this is a station and this is the network interface (Refer Slide Time: 25:58) so all stations wait for the token and whenever a token passes by this network interface it is then captured and it checks whether it has got data to send, if the answer is yes it sends the frame and it is now possible to send multiple frames and not one. If the time allocated is long multiple frames can be sent before releasing the token.

So it keeps on sending data until the time is over and after the time is over it releases the token and it stops. This is what goes on in a particular station.

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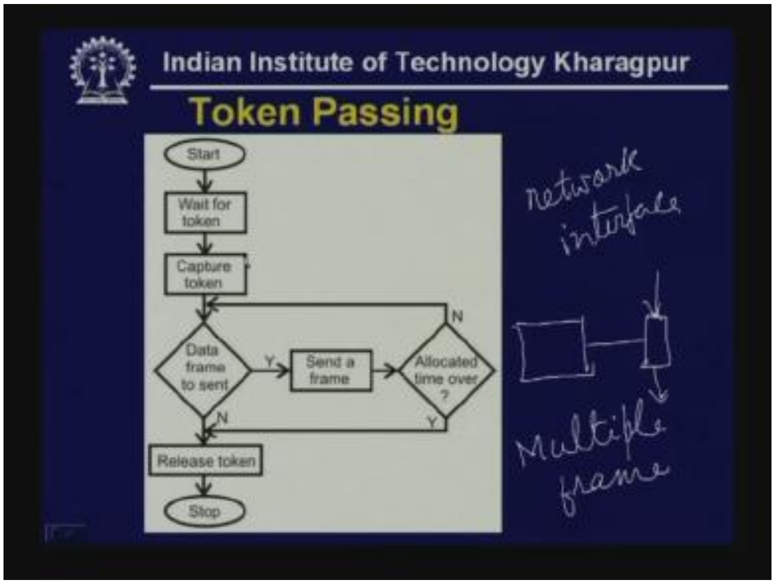

So in this way each station waits for the token, captures it, sends the data and after all the data is transmitted or the time is over it comes out of it, it releases the token and then it goes to the next station. This is how the data communication takes place in a round-robin manner in producing token passing protocol. Let us see the performance of token passing protocol.

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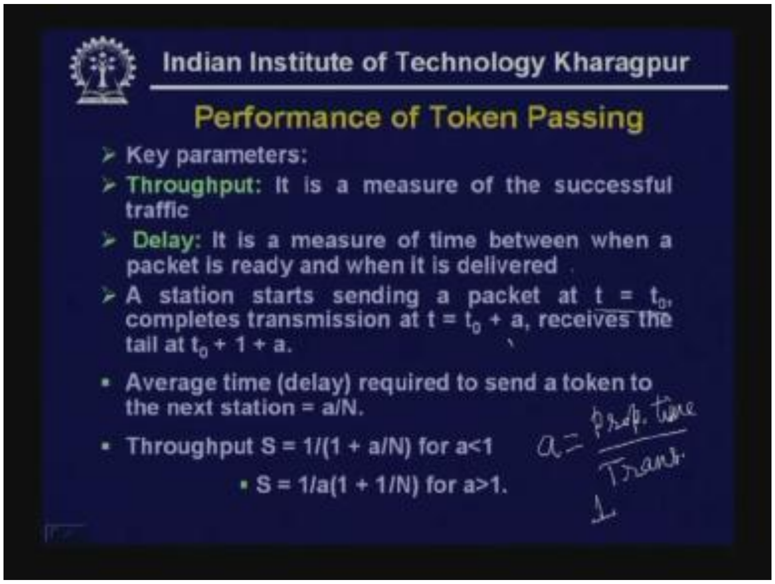

The performance can be explained by using two parameters; one is throughput, another is delay. So this throughput this is a measure of the successful traffic that means how many packets have been transmitted. As you know it gives you the measure about how many packets has been transmitted per unit time or per second, how many frames have been transmitted that is your throughput and delay is a measure of the time between when a packet is ready and when it is delivered.

As you have seen in the previous diagram it waits for a token, so what is the waiting time? The waiting time can be very long if there are a large number of stations in the ring. And on the other hand, if the number of stations in the ring is small then the waiting time can be small. So this is the measure of the delay. It is the measure of the time between when a packet is ready and when it is delivered. Let us see on what parameters it depends on.

A station starts sending a packet at t is equal to 0 t0 and completes transmission at t is equal to t0 plus 1 and receives the tail at t0 plus 1 plus a. You can see at t0 it completes transmission and then this ‘a’ is the ratio of the propagation time by transmission time. In this case transmission time has been considered to be 1. So it is normalized with respect to the transmission time and ‘a’ is the ratio of the propagation time by the transmission. So this station will receive the tail at t0 plus 1 plus a.

Now what is the average time required to send a token to the next station? It is a by N. as I mentioned this is dependent on N, propagation time as well as N. So, for larger value of N means it will depend on the ratio of ‘a’ and N and whenever the number of stations is large there can be a long delay and throughput is expressed as S is equal to 1/1 plus a/N whenever a is less than 1.

And as you know there are two situations so A has started sending the frame so it goes around the ring. Now if the total propagation time is smaller than the packet transmission time before it completes transmission the front will be reaching the transmitter. And another situation is whenever the transmission time is small and propagation time is large in that case a station will finish the transmission of a frame and only after transmission is completed the front of the frame that it has sent will reach the station. So this is being expressed by this parameter, and ‘a’ less than 1 means that the propagation time is small compared to the transmission time , so propagation time is lesser than transmission time, in that case this is the expression for throughput (Refer Slide Time: 31:00).

On the other hand, whenever the propagation time is very large in such a case s is equal to 1/a into 1 plus 1/N for a greater than 1.

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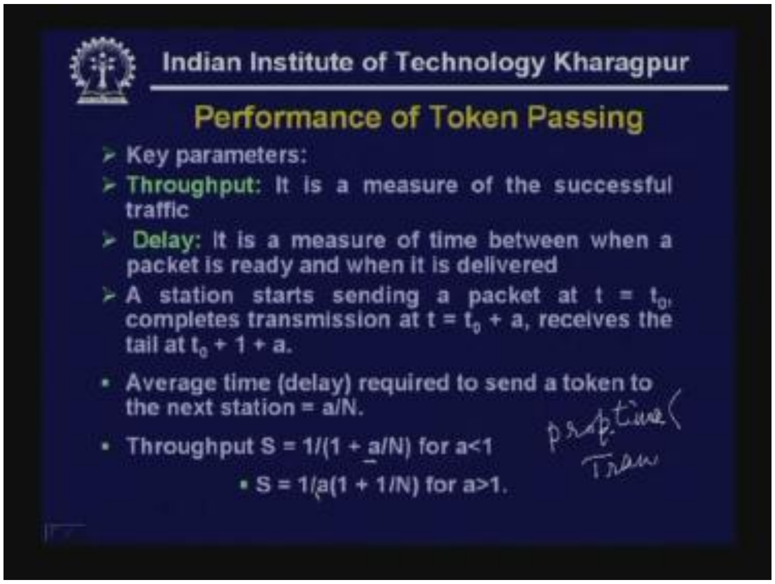

This is the situation when either the transmitter is sending very fast or the loop ring is very long, in such a case there is a possibility to have multiple token and multiple frame. Normally in this particular situation it is not possible to have transmission of multiple frames or multiple tokens but in this situation it is possible to have multiple tokens and multiple frames. We shall discuss about this technique in more detail whenever we consider the standard LANS.

We shall see that in the normal token ring based on coaxial cable the length of the ring is small and speed is small. In such a situation the propagation time is relatively smaller compared to the transmission time. On the other hand, when we are transmitting at a very high speed the transmission time is small and relatively propagation time is longer so in such a case it is possible to have multiple tokens in a single ring and parallely multiple frames can be sent. We shall discuss about it in more detail later on when we shall consider the LAN network based on token passing, propagation.

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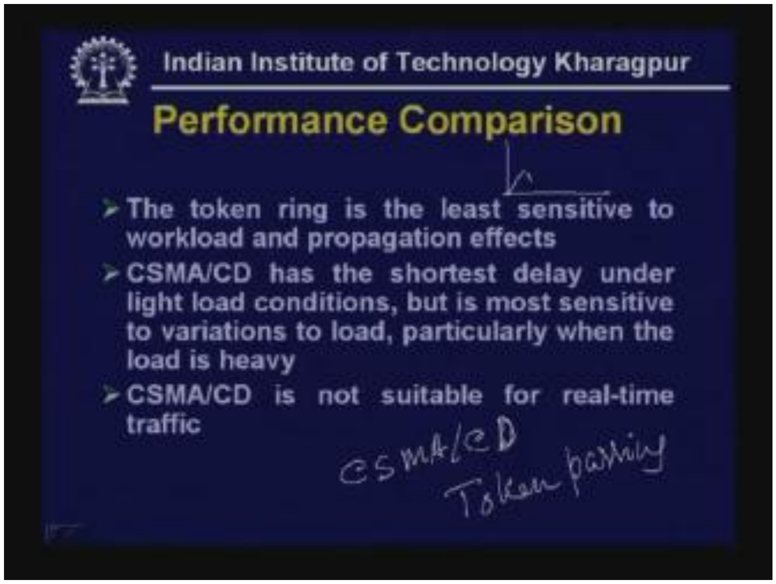

It is now necessary to compare the CSMA/CD which is one of the popular protocol used in Local Area Network with respective to token passing. So, if we compare these two we find that the token ring is least sensitive to workload and propagation effects. As you are increasing the load we have seen that CSMA/CD is affected everywhere, we have seen that curve, initially the throughput increases and after reaching a peak it starts dipping and it falls down. But in case of token passing you will see that it will increase linearly. That means there is no degradation in throughput as the load increases so it is least sensitive to workload and propagation effects.

However, whenever the number of nodes is very large the delay will be long in case of token ring. That means the CSMA/CD has the shortest delay under light load conditions. We have seen that in case of CSMA/CD if the load is light a particular station transmits a frame and if it does not suffer collision delay is very small. On the other hand, in case of token ring a particular station has to wait for a long time to get the token. As a consequence there is a long delay in the token ring. On the other hand, the delay is very small in CSMA/CD.

However, if there is heavy load then it will suffer collision and as a result delay can be long. So, CSMA/CD has shortest delay but it is more sensitive to variations of load particularly when the load is heavy. These are the two performance comparison between CSMA/CD and token ring protocol or token passing protocol.

Another important observation based on the protocol, in case of CSMA/CD you have seen that there can be multiple collisions and whenever an unfortunate frame suffers fifteen collisions it is discarded. So, in case of CSMA/CD which is based on stochastic or probabilistic technique there is a possibility that an unfortunate frame is never transmitted. In other words the delivery of a packet to the destination is not guaranteed.

On the other hand, in case of token passing protocol the delivery is guaranteed. The reason is that even when the load is very large delay can be long but the packet will be ultimately delivered, that's why CSMA/CD is not suitable for real-time traffic. In real-time traffic we cannot afford to afford to discard a packet or frame.

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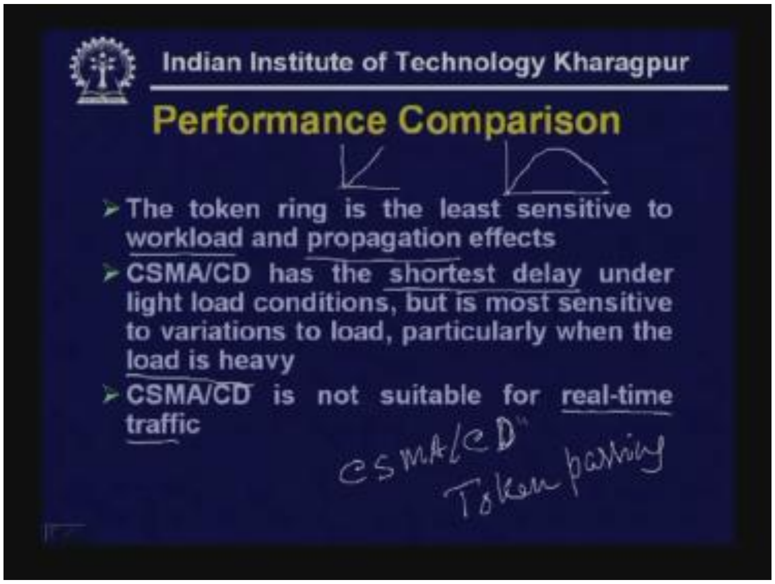

So, in real-time applications this CSMA/CD protocol is good only in burst situations when the traffic is small. On the other hand, the token passing protocol is very suitable when you have got stream traffic. So whenever you have got streams of data coming at regular intervals from all stations it is not bursty in nature then the token passing protocol works better or round-robin technique works better. These are the relative comparisons between the contention based protocol and the round-robin protocol.

Now we shall come to the reservation protocol which is essentially based on the satellite networks.

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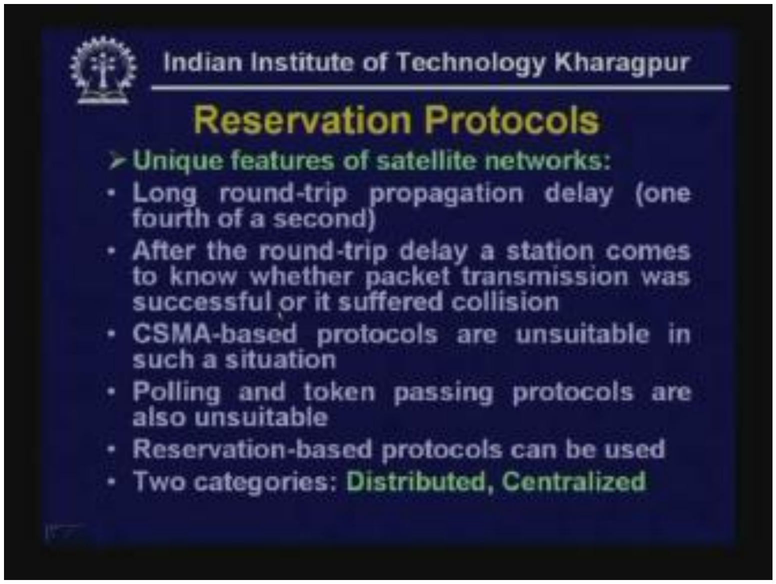

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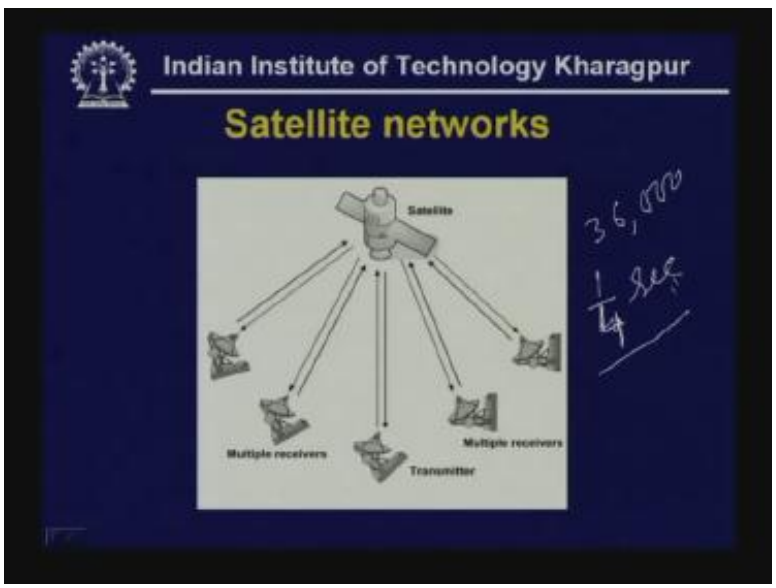

Let us look at the unique features of satellite networks. As we know there is long round-trip propagation delay which is about one fourth of a second. Here we have got a satellite and here at the ground stations the satellite is located at about 36000 Km away above the ground and the round-trip delay is about one fourth second. So round trip delay is one fourth of a second. This is relatively a very long time one fourth of a second. in today's context it is quite long time. This has to be taken into consideration when we develop a protocol. After the round trip delay a station comes to know whether a packet transmission was successful or it has suffered collision. That means if a ground station say a transmitter sends a packet then as we know the satellite will receive it and send it using the downlink frequency and it will do the broadcast. So, if multiple stations sends a packet which is essentially shared then there will be some kind of collision or the signal will be garbled and the transmitter will come to know about it only after one fourth of a second but not before that.

As a consequence CSMA/CD protocols are unsuitable in such a situation. The reason for that is in a particular station whenever a collision is detected by station it knows that actually it has happened one quarter of a second earlier and not now and as a consequence we can say that the value of ‘a’ the ratio of the propagation of time by transmission time is very large and as we know whenever ‘a’ is large then the throughput or the efficiency of the CSMA based protocol is very poor and that’s why the CSMA/CD or CSMA based protocols cannot be used in situations where the propagation delay is very long particularly in satellite communication.

In satellite communication as we have seen the propagation time is quite large and as a consequence the schemes based on collision detection cannot be used. Let us see whether we can use polling. If we use polling then that polling signal has to go from the central controller to all the stations. Sending the frame and getting the acknowledgment from the stations will take about two round-trip delay that means half of a second which is very large. That means just for polling which is part of the walk time will be quite large as I mentioned earlier and as a consequence this polling will be very inefficient.

Similarly, the token passing also will not be suitable for the satellite networks because to send the token the station will take at least one quarter of a second to send the token to the next station and as a consequence neither CSMA/CD based protocol, contention based protocol nor the round-robin type protocols can be used in satellite networks. In such a situation a new technique have evolved which is known as reservation based protocols.

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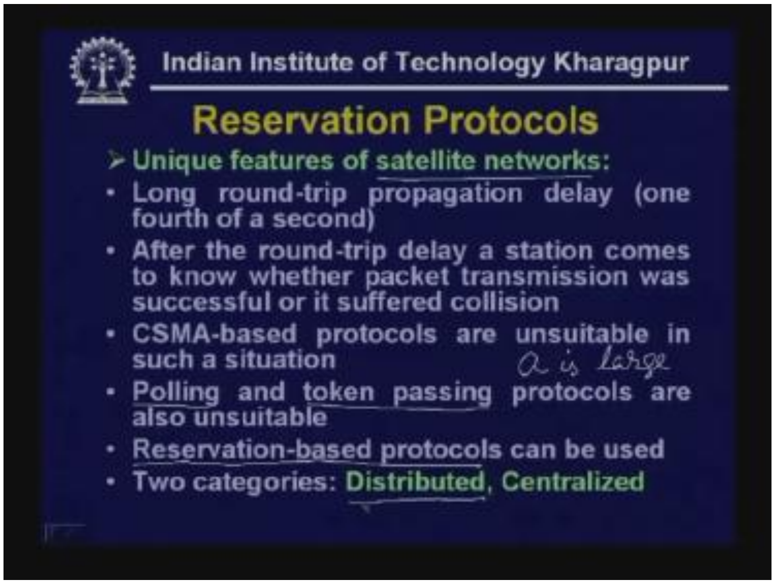

The reservation based protocols can be broadly divided into two types. The first one is distributed and the second category is centralized. We shall consider several protocols based on distributed as well as centralized techniques.

First one is R-ALOHA which essentially means reservation ALOHA.

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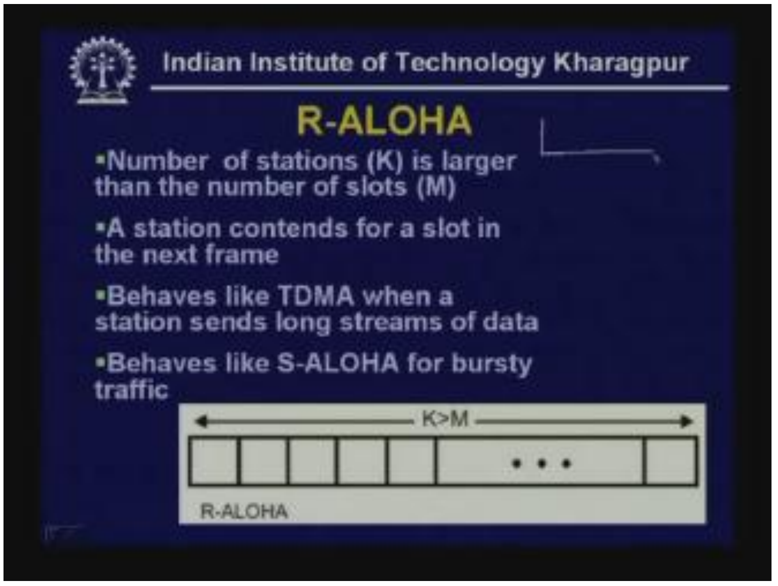

There are some basic assumptions. The basic assumptions are the time is divided into a number of slots. That means the time is divided in terms of slots and this is synchronized. Secondly there is another assumption, the round-trip delay, this is the frame time (Refer Slide Time: 42:03) the propagation time, this frame transmission time should be at least greater than the propagation time. In other words by the time one frame is transmitted this time should be longer than the propagation time. These are the two assumptions which is made.

In reservation ALOHA frame length must be at least as long as the bit length, bit length is essentially the propagation time. That means this time should be more than one quarter of a second that is the propagation time. This is known as the bit length. So, bit length should be more than the frame length.

Now here a station contends for a slot in the next frame. So here the situation is, the total number of frames, here the number of K is greater than the number of slots that mean the number of slots is larger than a number of slots smaller than the number of stations. K is the number of stations is larger than the number of slots.

It works in this manner. A particular slot that means a particular frame is transmitted and each station is receiving whether a particular slot is empty or shielded. So whenever a frame is found to be empty then a station sends a frame to transmit in that particular slot to book it. However, it may suffer collision or it may not suffer collision.

Let us assume that there are eight stations and four slots for simplicity and let's assume initially that station 1 is transmitting here, this is unused (Refer Slide time: 44:12) and this station 2 is transmitting here and this is also unused. Now this will be received by all the stations. Now station three wants to decide in this slot so in the next frame station 1 sends here, station 3 sends here, 2 sends here and let's assume 4 and 5 decides to send in this slot so there will be some collision here. So we can see here that collision will occur in this frame.

Now the third frame can happen in this way. One will send transmission here and three may continue and suppose two has finished transmission then it will remain unutilized and this frame again will remain unutilized because of collision.

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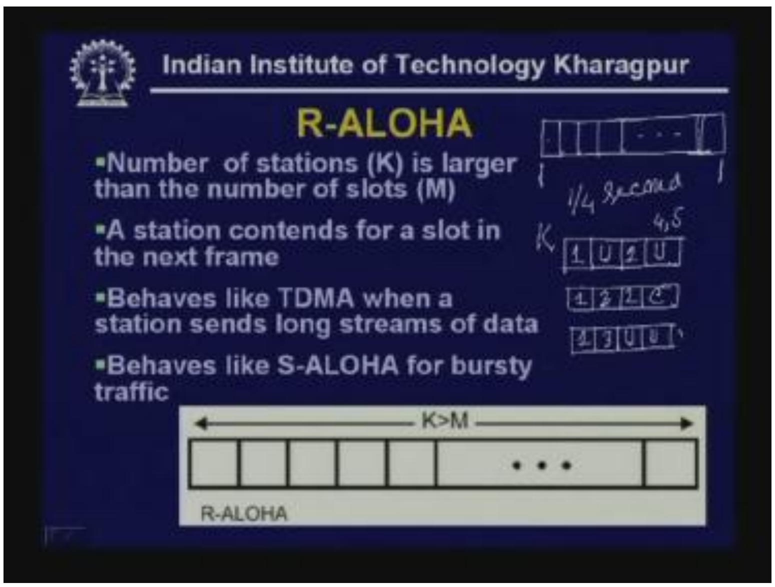

So we find that there can be three situations, a particular slot may be used in this case or a particular slot may be unused, remains unoccupied or there may be collision.

Now if a particular station keeps on sending continuously then it may behave like a TDMA Time Division Multiple Access when the station sends long streams of data. This is the situation of the slot, as you can see in this slot the station A is continuously sending signals.

On the other hand, if the traffic is bursty and the number of packets sent by different stations is small in that case it will appear to be slotted ALOHA. This particular slot (Refer Slide Time: 46:06) it is 2 and then unutilized and then 1 so in this way alternatively different stations can transmit in different slots so it may appear like a slotted ALOHA. Hence this is the reservation ALOHA protocol used and here it has been assumed that the number of slots is smaller than the number of stations.

Let us consider another situation.

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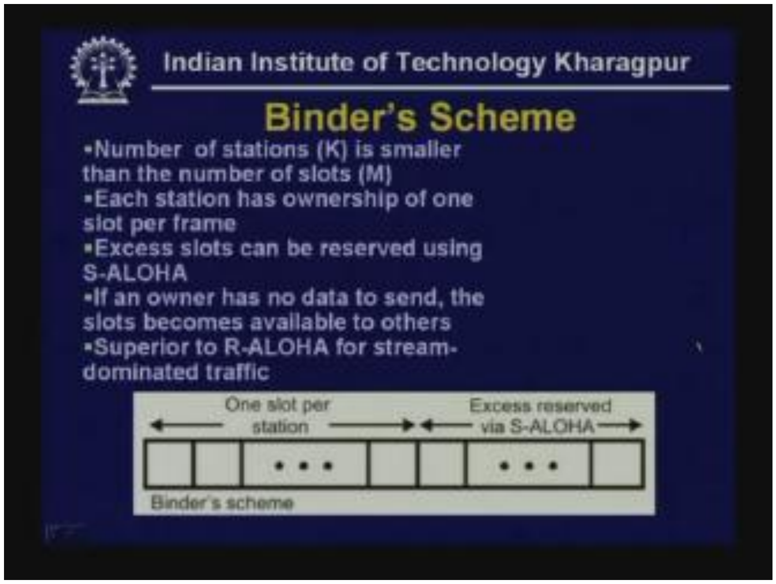

In binder's scheme the number of stations is smaller than the number of slots. So in this case the number of stations is smaller, earlier the number of stations were larger than the number of slots. So in this case since the number of stations is smaller than the number of slots you can see each station is allocated a particular slot. That means here some kind of implicit reservation for slots are provided because the number of stations is smaller and extra slots are available in which transmission can be reserved using that slotted ALOHA.

So let's assume there are only four stations and there are six slots. So we have got six slots and four stations. This is reserved for 1, this is reserved for 2, this is reserved for 3 and 4 and (Refer Slide Time: 47:30) these two are unreserved, these two are free. In the first frame a particular station 1 sends her, 2 sends here, if 3 has no data it remains unused so it is unused and 4 sends here and now if station 4 has got more data to send it may send here by sending data using the slotted ALOHA and station 2 also can send here.

now in the next frame what can happen is, since this is unutilized a particular station may capture it by sending frame in it, 1 can send here, 2 can send here, and this column although it is allocated to 3 and since 3 has no data it was unutilized so another station 4 can block it and send data here. So in this way the transmission can go on. So here you see it is superior to reservation ALOHA for stream dominated traffic.

However, whenever the nature of traffic is bursty then of course it is not very efficient. So here you see, we are doing some kind of implicit reservation here, it is a mixture of implicit reservation and it is a combination of implicit and explicit reservation. So, for these stations the reservation is implicit and these excess slots the reservation is explicit and explicitly it has to be done by using slotted ALOHA.

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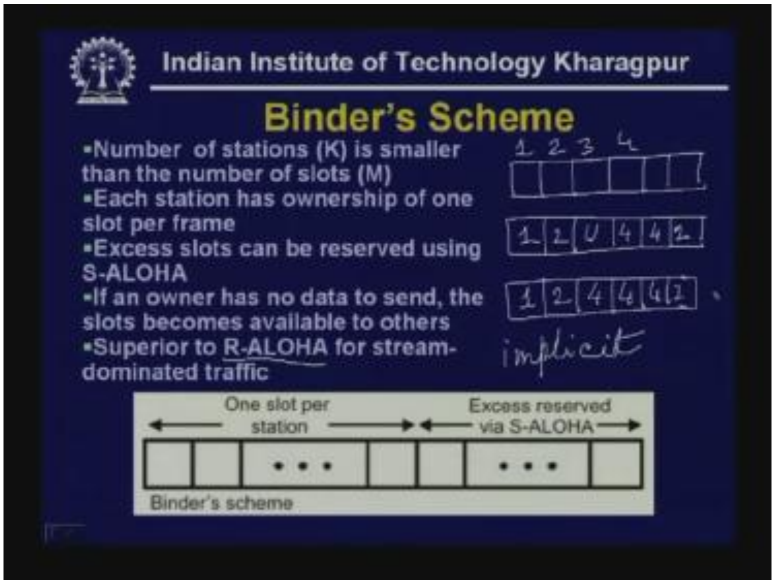

So this is binder's scheme and as I mentioned it will perform better when the traffic is stream dominated.

There is another interesting stream proposed by Robert and here explicit reservation is necessary by sending request in a minislot which acts as a common queue in each frame.

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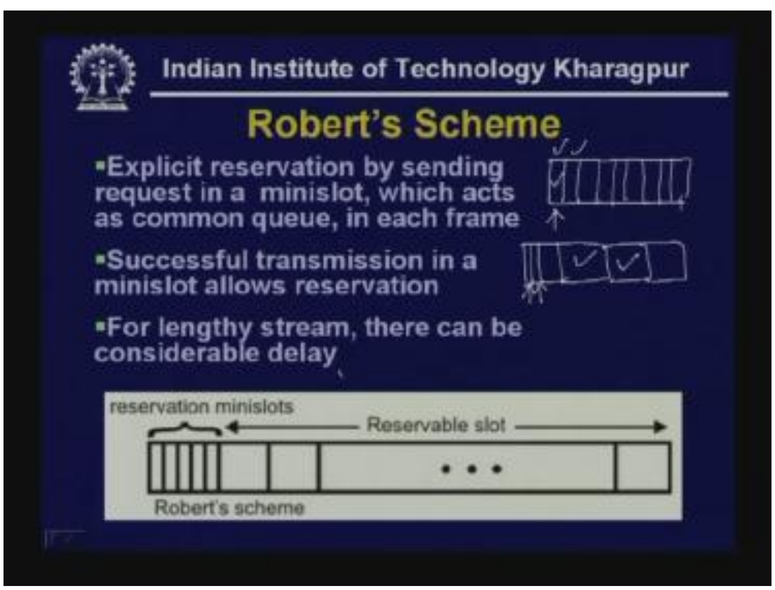

So here we see this is a frame. Now this frame is divided into a number of slots and not only it is divided into a number of slots but one of the slots is divided into a number of minislots. So it is divided into a number of minislots. Now in these minislots the stations can send data and reserve the transmission. Suppose the number of minislots is equal to the number of senders, so if it sends here then this is blocked, if it sends here then this is blocked in this way blocking can be done that means successful transmission in a minislot allows reservation. That means it is not explicitly for a particular station.

If a particular stations is successful in transmission of a particular minislot, suppose in minislot 1 a particular station is transmitted then it books it for slot number 1, this is the minislot and here are the other slots let us assume, so if a station is successful in sending a minislot 1 this is reserved for that station, if another station is successful in sending in this minislot it is reserved for this station, in this way by sending reservation frames in the minislots the reservation can be done explicitly for the subsequent frames.

Now, for lengthy stream there can be considerable delay. Why there can be considerable delay? Because we find that in this case each station has to explicitly book for sending a frame and each time it has to be done. So, for each frame explicit booking is necessary.

Now, if a particular message is divided into large number of packets it can suffer long delay because to send this packet explicit reservation will be necessary and to send next packet another explicit reservation will be necessary likewise in this way for each of these packets there will be a need for explicit reservation which will lead to a considerable delay. This is the disadvantage of this Robert's scheme.

These are the distributed schemes which we have discussed in detail where we have seen the stations are doing their reservations by sending packets by using slotted ALOHA.

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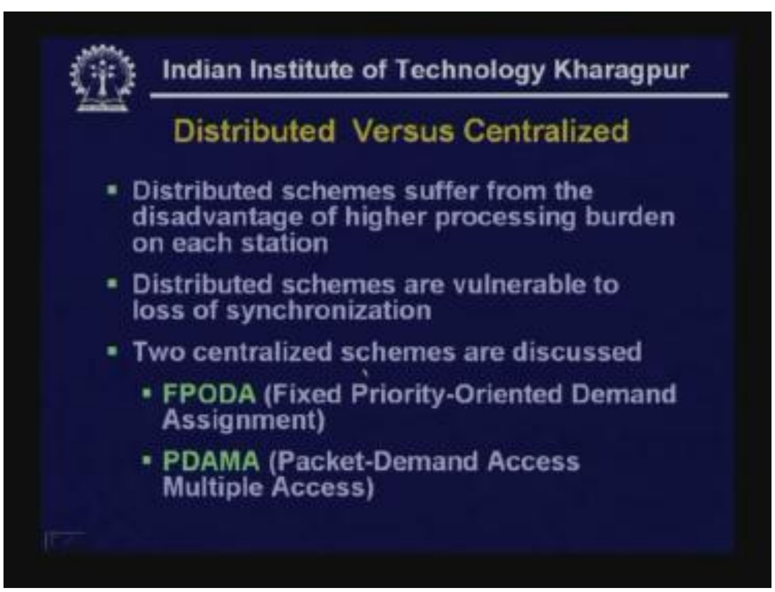

The distributed scheme suffers from the disadvantage of higher processing burden of each station. That means each station must have the processing capability, they should be able to send data and reservation packets, as a result the high processing burden is necessary.

On the other hand, distributed schemes are vulnerable to loss of synchronization. That's why centralized scheme can be used. We shall discuss two centralized schemes. One is known Fixed Priority-Oriented Demand Assignment and second one is Packet Demand Access Multiple Access. This is centralized FPOMA Fixed Priority-Oriented Demand Assignment.

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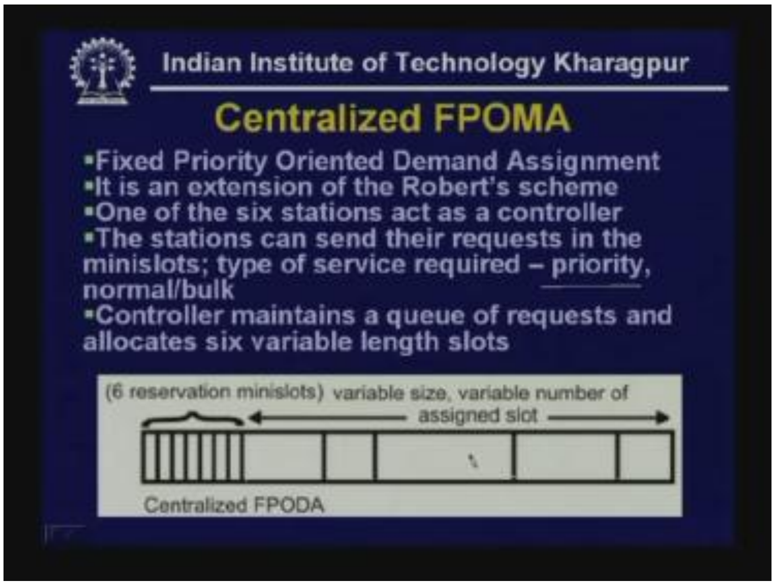

It is an extension of Robert's scheme. It has got six stations and one of the six stations acts as a controller. Here it is a centralized scheme. So there should be a controller, the stations can send their requests in minislots, here there are minislots, we have assumed that there are six stations so these are the six minislots in which request can be sent and the priority of that packet whether it is interested in sending a normal packet or a bulk data that also has to be specified and the controller maintains a queue of requests and allocates six variable length slots.

As you can see (Refer Slide Time: 54:11) here the slots are not fixed, so based on this request the controller will allocate the slots of variable size and all the six stations will be able to send variable size frames in these slots. This is your centralized FPOMA.

And this PDAMA has got four different types of slots. There is a leader control slot, a guard slot, a reservation slot and data slot. The leader control slot is used by the master station to communicate acknowledgement.

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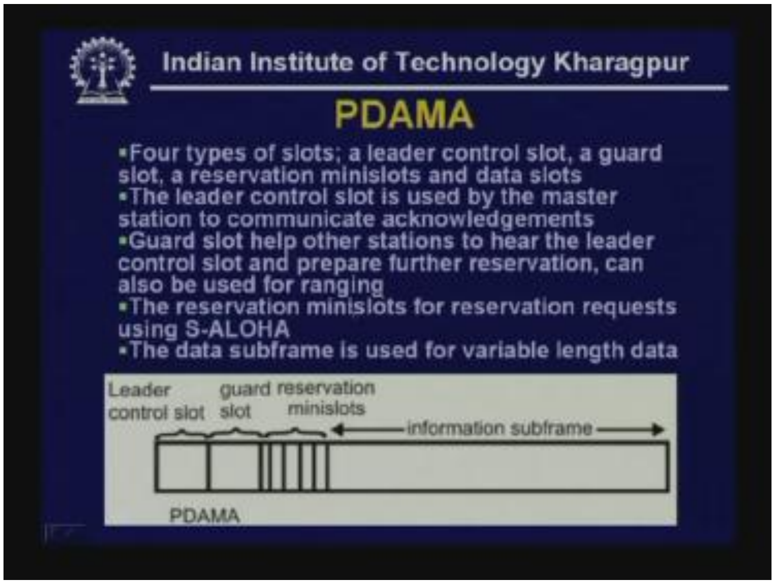

So this is used for communicate to communicate acknowledgement to all the other stations and guard slot helps other stations to hear the leader control slot and prepare further reservation and also it can be used for ranging. The minislots for reservation are used for reservations. Here the other stations can send their request using slotted ALOHA and the data subframe is used for variable length data so this subframe is used for sending variable length data by other stations.

So this is a centralized scheme.

Therefore, we have discussed different types of reservation protocols. Here are the review questions.

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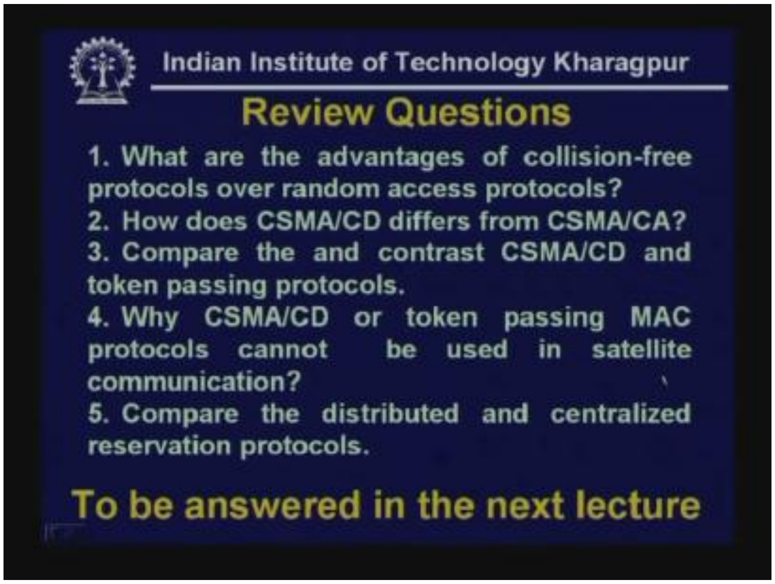

1) What are the advantages of collision-free protocols over random access protocols?
2) How does CSMA/CD differ from CSMA/CA
3) Compare CSMA/CD and token passing protocols
4) Why CSMA/CD or token passing MAC protocols cannot be used in satellite communication?
5) Compare the distributed and centralized reservation protocols

Here is the answer to question 1 of lecture minus 25.

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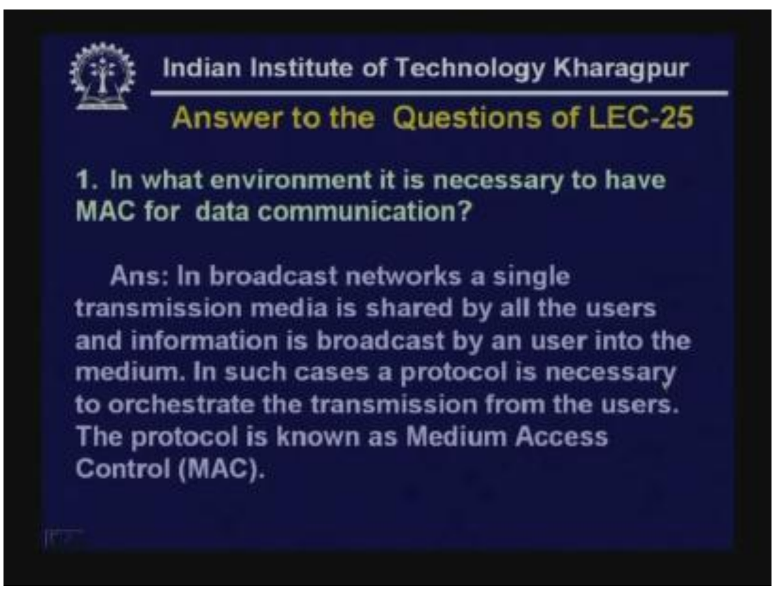

1) In what environment it is necessary to have MAC for data communication?

In broadcast networks a single transmission media is shared by all the users and information is broadcast by an user into the medium. In such a case a protocol is necessary to orchestrate the transmission from the users. The protocol is known as Medium Access Control (MAC).

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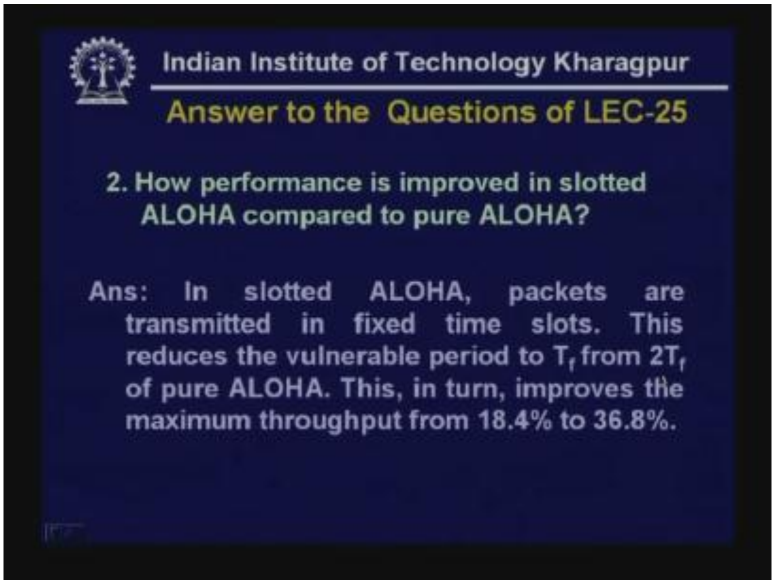

2) How performance is improved in slotted ALOHA compared to pure ALOHA?

In slotted ALOHA packets are transmitted in fixed time slots as you have seen. This reduces the vulnerable period from T_f from $2T_f$ of pure ALOHA. This, in turn improves the performance of throughput from 18.4 to 36.8.

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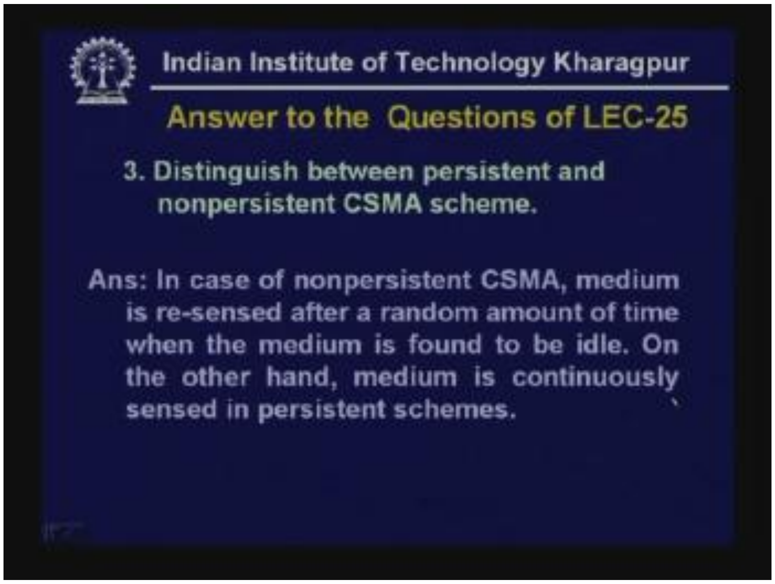

2) Distinguish between persistent and nonpersistent CSMA scheme.

In case of nonpersistent CSMA medium is re-sensed after a random amount of time when the medium is found to be idle. On the other hand, medium is continuously sensed in persistent schemes.

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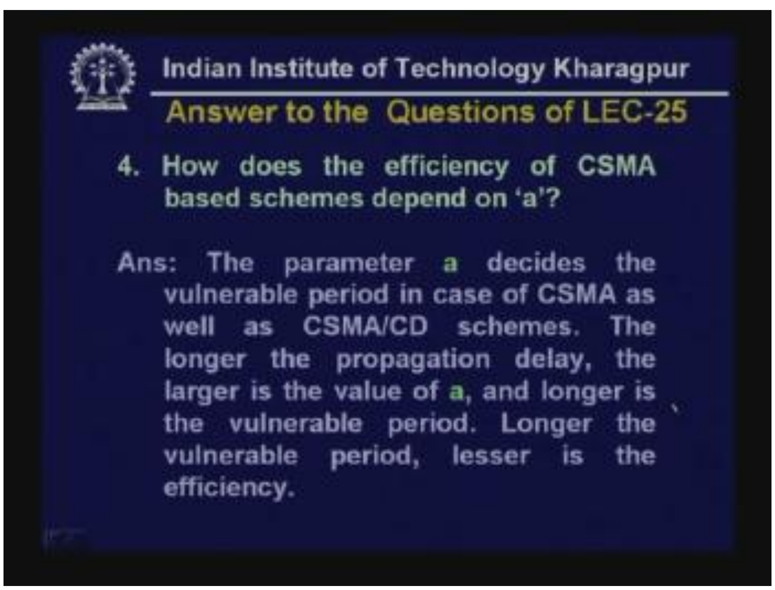

3) How does the efficiency of CSMA based schemes depend on 'a'?

The parameter ‘a’ decides the vulnerable period in case of CSMA as well as CSMA/CD schemes. The longer the propagation delay the longer is the value of ‘a’ and longer is the vulnerable period, longer the vulnerable period lesser is the efficiency, as we have seen.

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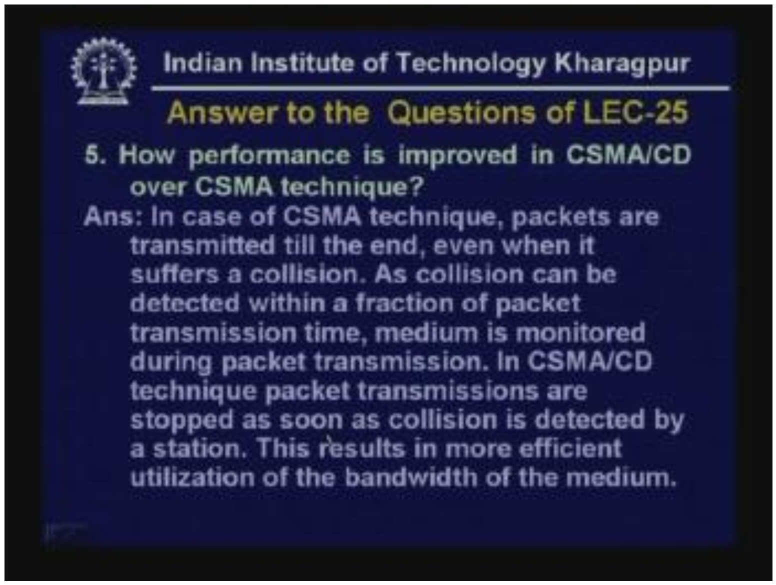

5) How performance is improved in CSMA/CD over CSMA technique?

In case of CSMA technique packets are transmitted till the end even when it suffers a collision. As collision can be detected within a fraction of packet transmission time medium is monitored during packet transmission. So, in CSMA/CD technique packet transmissions are stopped as soon as collision is detected by the station. This results in more efficient utilization of the bandwidth of the medium.

This concludes today’s lecture. In the next lecture we shall discuss about the generalization technique of Medium Access Control, thank you.