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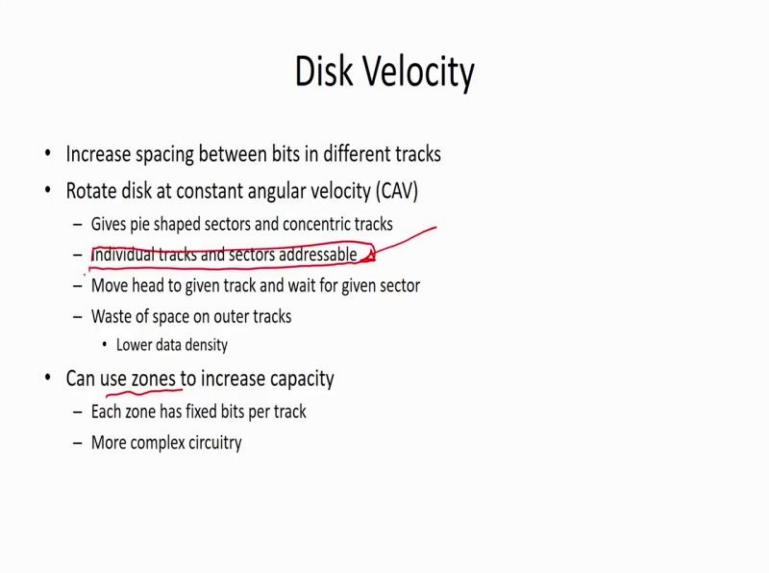

Secondly disk rotate in a constant angular velocity. Now you just see since it is rotating a constant angular velocity, so the time required to cover this particular length will be equal to time required to traverse this particular length, because it is rotating in a constant angular velocity. So, this angular velocity is constant same. So, this since it is angular velocity is same. So, this cone will be traversed in a constant time so that means, this information will be retrieved in lesser time and that information also retrieved in the same time ok. But here we are traversing more amount of time, so it is traversed in a constant angular velocity.

So, time required to retrieve the information from a particular sector is same whether it is an inner track or a outer track ok, so it works on constant angular velocity. So, give pie shaped sector, and concentric track, you can see it; individual track and sector addressable. Now we see why we say that individual tracks and address of sector rule. Move head to give track and wait for a given sector then waste of space in outer track because already I have mentioned that it is having a lesser bit density. So, we are wasting some space at that time.

So, for that to reduce it to reduce the wastage we can use the concept of zones; that means, tracks will be different zones, and we are coming to the zoning concept then tracking density or bit density same in all the track. So, we are storing less number of information in inner track and more number of information in the outer track, so that density bit density will remain same. But here the control circuitry will be a complex one.

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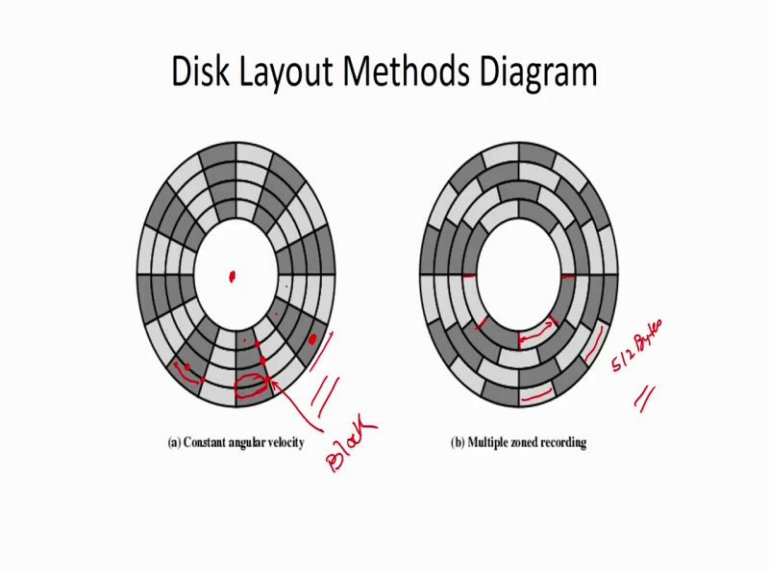

Now, you just see that here what will happen? We are having concentrating ring and we are dividing into different sectors. So, we can access the information from those particular sector, but here what will happen we are creating zone, the length of those zones are your same ok; that means, we are storing some information and we are keeping same number of space to store the information, so like that we are also we are having this thing.

So, you just see that if I am storing 512 byte over here then same 512 byte will store here also in one zone, so in same area we are storing the same information, so bit density is same. And in that particular case you just see that in the inner track we are having less number of zone in outer track we are having a more number of zone; that means, in outer track we are storing more information. But when we are having a concentrating ring we are storing same information in all the track, same amount of information in all the track. So, that's why bit density is more in inner track and bit density is less in the outer track. So, this is one advantage we are getting.

Now, we can store more information, but to store information and retrieve information the circuitry that we are going to design will be a more complex one, but for this particular organization we are going to get a simple circuit because again that designing and implementing a complex circuit is going to cost more. So, this is the trade off where we are going to have in most of the cases we are going to use this one only.

Now what is the characteristics of this particular disk? Now here we have mentioned one thing that individual track and sectors are addressable; this is one important point. Why you are saying? You just see that I know the track number, and I know the sector number ok. Then I can go to a particular track and in that particular track we can go to a particular sector. So, this is basically we can say what is the track number and what is the sector number, but straight away I cannot go to this position because this is some position where we are storing one particular bit. We can go to it provided again we can have this is addressable.

So, in that particular case to make it simple what will happen? We give the we are going to identify those particular track and sector junction and we can go to a particular sector. After coming to this particular sector what will happen? Sequentially we have to access this information; whether it is read information or write it; what is it is a read operation or write operation.

So, I am going to work with this particular entire information. So, this is basically known as my block of the disks, so we are going to work with the block of a disk. Straightaway I cannot identify this particular position and I go to that point I can very well come to the start of this particular sector and from that I am going to access the information. So, it is basically a block access mechanism we are going to access block wise not an individual bitwise or byte wise.

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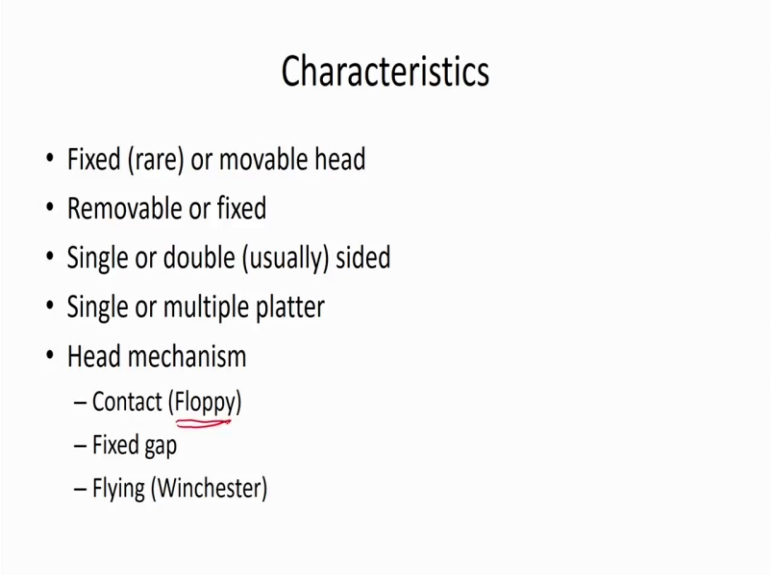

Now, what are the characteristics it says that fixed or removable head, movable head removable disks, or fixed disks, single or double sided disks, single and multiple platter head mechanism. We are having say different way of having the head mechanism one is contact fixed gap and flying. I think nowadays I doubt whether you have seen floppy disks or not, but earlier days this is also a kind of your storage devices which is your basically removable disks we can just put into a CD floppy drive write it and take it back

Nowadays, that you are using CD drive so this is magnetic in nature. So, these are different head mechanism it is a contact, fix gap and flying we will just learn about the fix gap. So, what are those characteristics one is saying that fixed head/ movable head.

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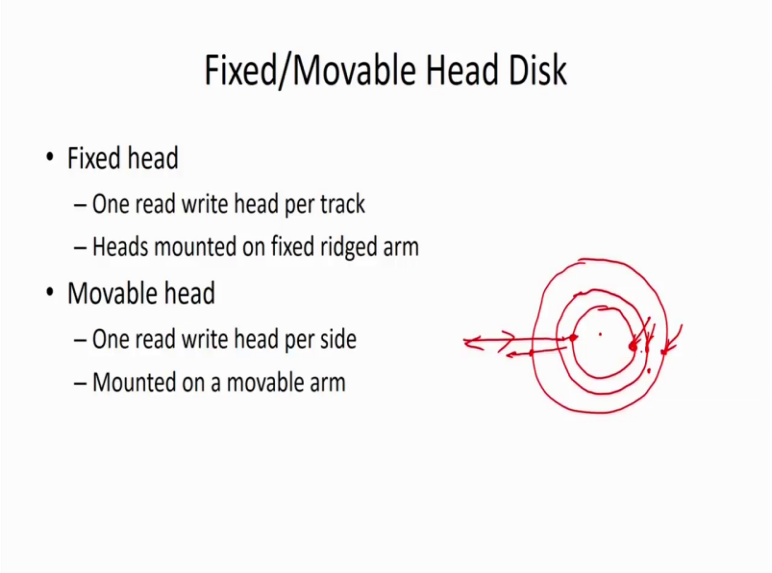

Now in that particular case now say I am having concentrated track now I have to read information from those particular track. So, in case of fixed head what will happen I am having separate head for each and every track this is talk about the fixed head. So, for each and every track we are going to keep one head and that head is responsible of read information or write information from that particular track.

But in case of movable head what will happen that we are having one particular head ok, that head will move outward and inward. So, if it is moving inward then we are coming to the innermost track and when I move outward then it is coming to the outermost track. So, this is the movable head; so that means, we are having only one read write head and that read write head is responsible to read and write operation or doing the read and write operation in each

and every track. So, it will move from track to track, but in case of fixed head for every track we are having a separate read write head.

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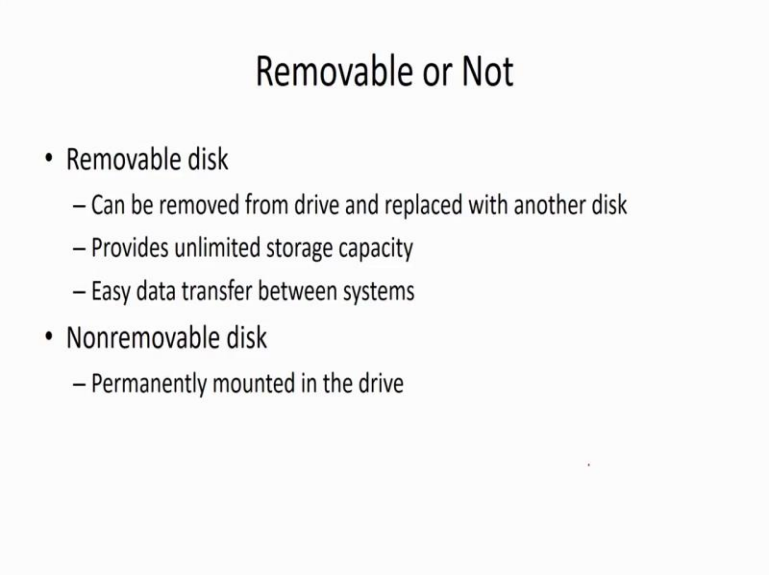

Removable or not this is basically a disk property. So, in case of your removable disk what will happen? We are having a disk drive. We can put one disk, you can do work with that particular disk or we can remove it place another one. So, like that your record player we are going to place different record like that, but in case of your fixed your disk things, if it is not removable then what will happen? It is will be a permanently mounted.

Nowadays say whatever laptop you are using or whatever desktop you are using this disk is basically not removable, so it will remain in that particular drive and we are going to work with this disks. But in case of removable one what will happen? Drive will be there, we can remove the disks that storing surfaces.

And you can put a new disks over here, but don't confuse with your portable hard disk. Portable hard disk is slightly different. It is whole drive will be portable whole drive will be different, but in case of removable one drive will be there, but only disks we are removing it. So, multiple platter; so basically we are talking about one particular surface, we are going to store it.

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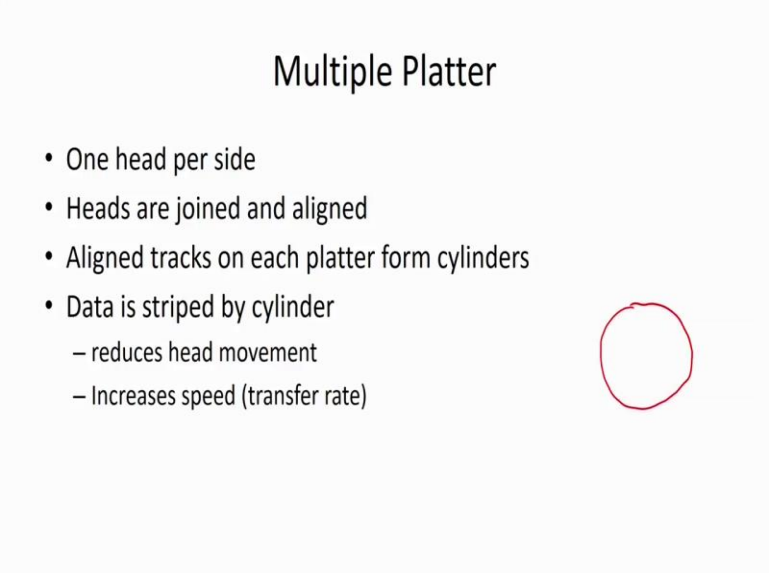

So, what will happen? We can have a pile of platters. I am going to have one drive; so that means, you are having multiple platters and we are going to store our information in multiple surfaces.

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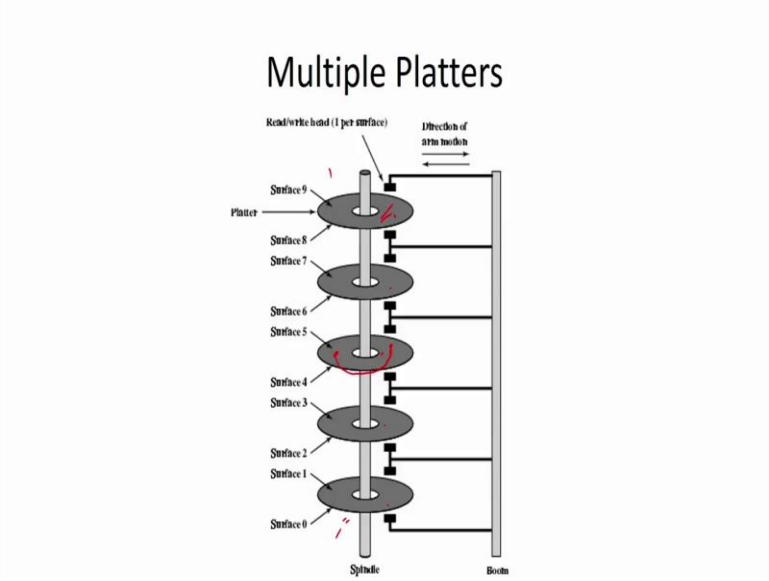

So, this is basically the complete scenario, so the way you are showing this is the read write head. So, in that particular case this arrangement is that we are having it is your not fixed, but movable. So, this head will move inward to outward to go to a particular track ok. So for one head is used to read and write for a particular track. Now these are the several platters ok. So

we are having several surfaces to store our information generally, those platter also we can use either both the side or one side. In most of the cases it is both the side, but top surface and bottom surface platters basically we are using one surfaces, for safety reason; top is not used and here the bottom one will not be used, but intermediate platters will be used in both the side there.

So, for every side we are having one read write head but for one particular side one particular surface we are having only one head. So, this is movable it moves up and down and this is the spindle, so that spindle will help to rotate the disk. So, if I want to read the information from that particular point then what will happen? First it will rotate it and bring it to the bottom of this particular read write head then we are going to do a operation over here. If it is a read operation we are going to retrieve it, if it is a write operation we are going to write a new information over here.

So, this is the some scenario about the hard disk. So in that particular case I am talking about the fixed and removable. So, in case of fixed those platters will remain fixed it will come inside a cabinet and we are going to work with it. In case of movable what will happen this disk pack can be removed and you can put another new disk pack over here to work with it. Now when we are talking about the tracks now there is a concept called cylinder also. Now what will happen? We are having concentric track and we are having several surfaces. If we are going to consider particular track then what will happen all the track of that particular position is going to form a cylinder just see that.

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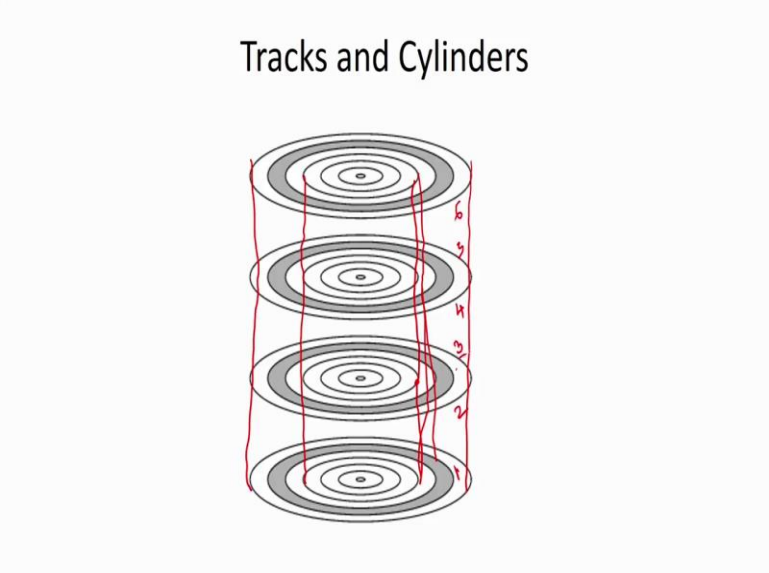

If I am going to consider about this particular track, this particular track ok, I am taking the same track of all the surfaces, so you can consider this as a cylinder. So, like that if I am coming for that outer track then those outer tracks are forming a cylinder. So, this is basically nothing but the collection of tracks of the same position of all the disks and we are going to treat these things as cylinder.

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Now how to finding a sector? I am saying that when I am going to store information in a disks then what will happen? It is divided into several sector and you are going to work with

these particular sectors. So, somehow we have to identify this particular sector then only we can work with this thing. So, main emphasis is to finding a sector and already we are finding the starting of the sector then what will happen I have to access all the information of this particular sector ok.

So, in that particular case now we are having that block transfer and we are going to transfer the entire information of this particular block. If it is a read operation I am going to take the information of the entire block I am going to bring it to the disks. And when it is a write operation I am going to take it from the computer I am going to put in this thing. Now, generally we are having some idea about the file we say that we are storing some file in hard disks and we generally access those particular file.

Now to indicate the completion of the file and of the file there is a called end of file marker. Now when we are storing it say I am starting from this particular point and storing our information of the file you just say that it is taking complete two sector, and say somewhere it finishes, so this is the end of the file marker and I have stored it.

Now, in that particular case when I am going to store another file I cannot start from this particular point because I cannot address that particular point. So, maybe next file I am going to store start from this particular sector, so in this particular portion we are not storing any information. So, these are some sort of intermediate wastage that we are having. So, this is we have to sacrifice because we cannot identify this thing we may have mechanism, but why unnecessary complicated design we should do. So, to make it simpler we are going to do this thing.

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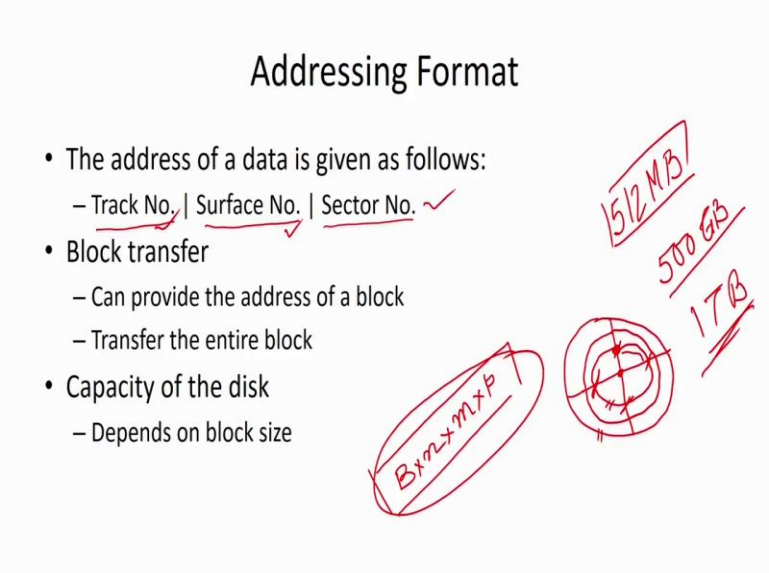

So, our emphasis is now I have to identify this particular position then only I can work with read write operation. Now for that we have to give the address. Now what is the addressing format? You just see that we are having the format like that it is talking about that sector number, surface number, and track number. So, this is the format say now what will happen say I am having several surfaces are maybe this is the first surface, bottom one is second, top one is 3rd, 4th, 5th, and say this is the 6th surface.

So, I can think these are the 6 surfaces; top and bottom we are not storing it because this is will be exposed, so say these are the 6 surface. Now where I am having my data; say if it is having in some position over here and then I have to first get the surface number in which surface we are having it. Then once I get the surface number then in that particular surface I have to say in which sector we are storing it and we must know in which track we have store it because we are having several tracks.

So, now, you just see that if I know the sector number, surface number and track number then we can go to that particular point. So, this is the addressing format of this particular disk. Then after that after coming to that particular starting position then it is basically block transfer, I am going to transfer the entire block. So, because you can provide the address of a block, so this is transfer is your block and what is the capacity of the disk?

So, it depends on the block size. I am saying that if the block size is B, then we have to say how many sectors we are having in a track say block size is B, say they are having n sector in

a track. So, I am going to store BXn and if I am having m track then same amount I am going to store in those particular m track and if I am having say p surfaces then same amount will be stored in each and every surfaces; so this will be the total capacity of my disk.

So, here what will happen? I am storing in a sector form but if we are going to use the concept of zone then capacity will increase because in this particular case packing density is more over here but we are storing very less information into the outer bit ok. So this is the way you can calculate what is the capacity of a hard disk. Now you say that now you are having a hard disk of say 512 MB, sorry this is too less nowadays we can say that you are having either 500 GB disks or you can say that 1 TB, 1 terabyte disk.

Basically I think most of you have nowadays possessing that portable disk and the capacity of portable disk is like that 500 GB or 1 terabyte like that. So, by looking into it now we can find out or you can see that it is basically organized in this particular way. How many surfaces we have? How many sectors it is divided? How many tracks we have and secondly, what is the block size how many bits you are going to store in a particular sector? So, by looking into this thing we can find out the total capacity of the disk.

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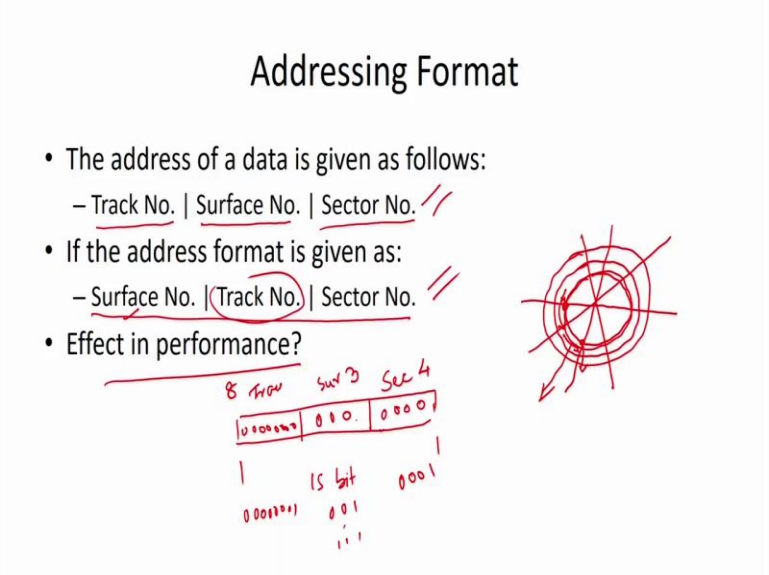

Now here we are saying that when I am saying it what is the addressing format? This is your sector number, surface number, and track number. So, in that particular case what will happen? First we are identifying the sector say we are going to work with this particular sector. Then we are going to look for the surface in which surface we are? Then I am giving

that track number ok. So, this is the way that I am going to say this is my address now the simple things I am going to say this is the sector number, surface, sector, surface and say track. Just say that this is I am storing 4 bit, in surface I am storing 3 bit, and say here I am storing 8 bit of information.

So, what is the total size of the address? 8 + 4, 12; 15 so total 15 bit address. Now say this is sector, so I can use any 4 bit, so whatever say 0000, surface is also 000, track is also so 000. So, this is the address; that means you are coming to the zeroth sector of zeroth surface and zeroth track, so you are going to start it from here. Now after that you just see the after coming completing this particular sector then what will happen? This sector number will move from 0001; so that means, we are going to the next sector.

So, like that we will complete this particular track. Once you complete this particular track, then what will happen? Now surface number changes. Now from 000 it will become 001; that means, we are changing the surface. Now like that if I am going to all the track of all the surfaces then what will happen? So it will go from 000 to 111, then it will be going to change the track from 000 to 001; that means, now it will from this particular track it is moving to this point, so this is one issue.

Now, in this particular case what will happen? First we are going one particular track. Now after completion of this particular track if I complete all the sectors then we are going to change the track number; that means, we are going to outer track. So, like that I am going to complete all the tracks of this particular surface, once we complete all the tracks then we are changing the surface number then from this surface we will go to the next surface. Now this is the two way different way I can give my format; whatever you like you can use it. But you have to see the effect in performance, which one is going to give a better performance we have to see.

Now, how we can measure the performance once we know the access time? The time required to access the information from disk ok. So, in that particular case we are having some component over here to measure the performance, basically look into the speed of data transfer. So, one is talking about the seek time. What is the seek time?

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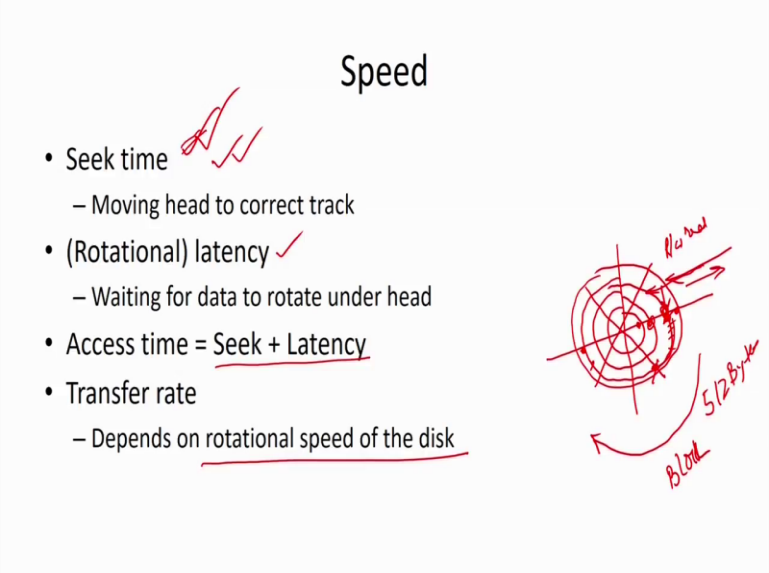

It says that moving the head to correct track. So, now what will happen? I am having this particular track, now here I am having the read write head. It can go from the outer track to the inner track. So, now what will happen? When I give an particular address say address is coming in this particular format sector number, surface number, track number. Then we know from which track we need to get the information so that read write will have to place into the appropriate track; that means, either it will move inward, or we will have to move outward to place it into the appropriate track.

So, this time required to put the head into the appropriate track is known as your seek time. Because once I am going to read a file; that means, I have to provide the starting address of that particular file; that means, what I have to give track number, sector number and surface number. So, once I know the track number then what will happen? I have to place the read write head into the appropriate track. So, this time required to move this head to the appropriate track is known as your seek time ok.

Now once I identify this particular track then what will happen? Now I have placed the read write head here, but my information may start from say this particular sector ok. Now what will happen? Now I have to bring this particular appropriate sector beneath this particular read write head, so it will take some time.

So, this time is known as your rotational delay, or rotational latency or latency time. So that means, to bring the appropriate to bring the head to the appropriate track is known as your

seek time, to bring the appropriate sector below the read write head is known as your latency rotational latency. And the total access time is known as this seek time + latency; that means, we are going to access the starting point of that particular file or particular address.

So, this is the basically access time seek time. After that after placing the appropriate track and sector which load this particular head. Then what will happen? Now we have to transfer it then this disk will rotate in an angular velocity, constant angular velocity. So, it will take some time to cover from the starting position of this sector to the ending position of this sector.

So, during that time I am going to transfer the information in this particular way. So this time is known as my transfer time. And this transfer time depends on the rotational speed of the disk, so if rotate in a particular speed because it will take a particular amount of time to traverse this particular distance complete sector. So, this is the time required to transfer the whole information a whole block; that means, if in a block if I am storing 512 byte, then we can transfer it and which depends on the angular velocity of the disk. So, this is the transfer rate we are going to say and this is the rate at which you are transferring a information which depends on the angular velocity of the disk.

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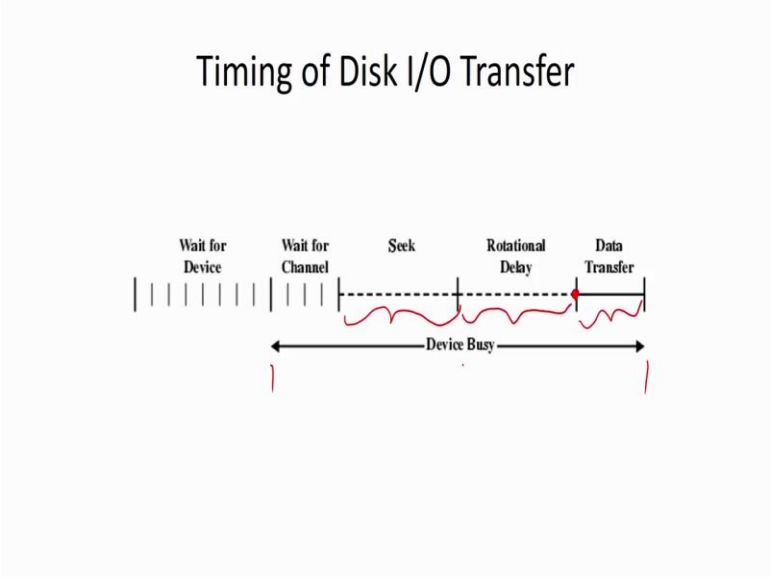

So, finally, this is the timing diagram just we are saying transfer; this is a wait for device basically say and it is looking for the device then wait for channel basically. Now what will happen that basically you can think about that I am going to get that system bus. So, in case

of DMA controller, then what will happen? DMA controller will get hold of the system bus from the processor, so this is basically waiting for getting this particular channel to transfer? Then first point will come sometime is required for seek time to place the head in appropriate track, then some of the time will be needed to bring the appropriate sector below the head.

So, this is basically seek time, and rotational delay is known as my access time. I am going to access my sector, then depending on the rotational delay its angular velocity it will take some time to transfer the entire block. So, this is the time required to transfer the information and this is the portion I can say the device is busy during transfer bus; getting hold of the channel then place a appropriate position seek time and rotational delay and transfer it. So, this is the time required to transfer the information, and we say this is the device busy period.

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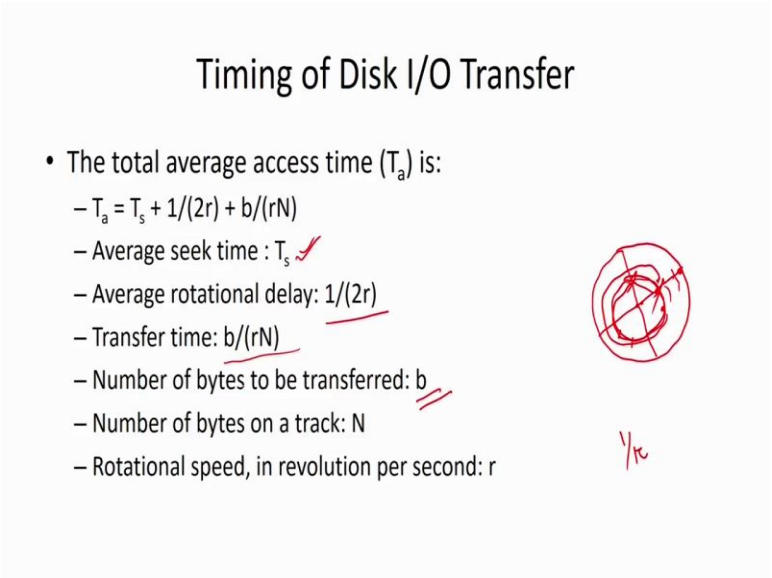

Now what is that timing of I/O transfer? So, it depends on angular velocity. So, it says that the total average access time is T_a. So, what is that T_a basically? T_a is nothing but $T_s + 1/(2r) + b/(rN)$, so this is a disk, it is rotating in constant angular velocity. Now, what are those parameter T_s is saying that average seek time. So, what we are saying average seek time? Basically it will sometimes you have to move from outer track to the inner track or sometimes you have to simply move one track only; say it is my head is here, but I have to go to this thing.

So, just I am taking a average. So, this is average seek time is your T_s; now average rotational delay is 1 by T_r. What is r over here? This is the rotational speed in revolution per second. So,

if I am having say r revolutions per second to make one revolution it will take $1/r$ second, so this is $1/r$ is going to give me the revolution for 1 cycle. So, now when I am going to bring the appropriate sector below the head and what will happen sometimes it have to rotate from this point to this point.

So, in that particular say in some time it is in the appropriate sector or in sometimes it is the very far sector. So, we have to rotate everything and bring it to here; that means, rotation of the entire disk. So that's why you are taking it is a average. So, if this from 1 to $1/r$, so it is $1/2r$ average 1. So this is the transfer rate if I am going to number of byte to be transferred is b, so in case of and number of bytes on a track is N. So, it is b/rN is going to give me this particular transfer rate transfer time ok. So, basically in r, $1/r$ is time required to rotate one particular these things; now the number of bytes in a track is your N.

So, total in one revolution I can access those entire information and, but in one track sector I mean say b bytes per sector. So, we need we want to transfer only this b byte, so this is the transfer time b/rN. So it depends on the rotational speed of this particular disk, secondly the number of information that we are storing in a particular sector ok. So, this is the I/O transfer rate. Now, for that we need one when I am going to work with these things while need an hard disk controller also. So, what is that hard disk controller does basically? It is going to handle the mechanical movement.

So, you have to rotate the disk, you have to move the read write head; to do all those things we have to initiate it, we have to give the signal from the processor and we are going to do all those mechanical information, then convert one from the other form. Now you just see that in hard disk what we are doing? We are storing information in magnetic form. So, when I am going to store it I am giving electrical signals, so 0s and 1 will be either stored as a 0 volt and some high volts. So, this electrical signal will be converted to magnetic property I am going to magnetize this particular disk. So this is your writing. In case of read that magnetic property will be converted to the electrical one that electrical signal will be transferred to this thing.