Computer Organization and Architecture: A Pedagogical Aspect

Prof. Jatindra Kr. Deka
Dr. Santosh Biswas
Dr. Arnab Sarkar
Department of Computer Science & Engineering
Indian Institute of Technology, Guwahati

Lecture – 39
Storage Devices

Hello everybody, welcome back to the online course on Computer Organization and Architecture. We are in module, input output subsystem and today we are in unit 4 and we are going to discuss about storage devices ok. As usual, now let's see what are the objective for this particular unit?

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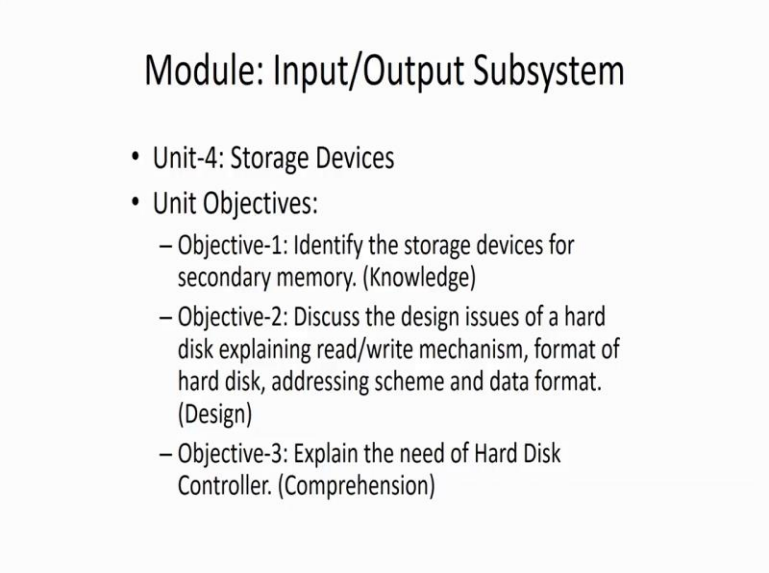

So, I have stated three different objectives for this particular unit. Objective 1: Identify the storage devices for secondary memory. So, we are going to just give idea about in knowledge level. What are the different storage devices we have? Discuss the design issues of a hard disk explaining read write mechanism, format of hard disk, addressing scheme and data format. So, this will be in the design level. So, we will see what are the design issues that we have for an hard disk.

Objective 3: Explain the need of hard disk controller. So, why you need them? Why you need a hard disk controller? We are going to just give idea about it, so it will be in the

comprehension level. So now why we require hard disks or storage devices? We know that computer works on Von Neumann stored program principle and processor is going to work with the data available in the main memory.

So, main memory is a semiconductor memory or semiconductor device. Again we know that it is volatile in nature. So, once we switch off the machine information will simply go from the memory, so we need some permanent storage devices ok. Secondly, we know that in main memory we are having a limited capacity; it may be either 2 GB or 4 GB, in the current scenario earlier it was very less.

So, in that particular memory we have to load operating system, many more application software along with that our program and data, so it is not sufficient, so we need the secondary storage devices. So, one of the most common secondary storage devices is your hard disk. So, in this particular lecture we are going to briefly explain about the hard disk.

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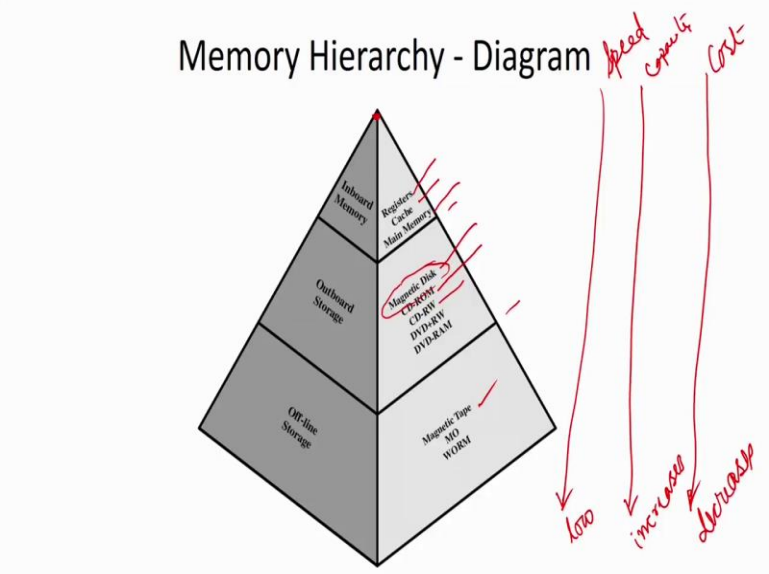

So, if you look into the memory hierarchy, so, in this case we are going to say that in the in board memory; that means, maybe it is inside the processor or it may be in a motherboard, because all indicated component of a processor or that computer will be put in a board and you say this is the motherboard. So, in board memory you are having the registers, we know these are the temporary working space inside the processor. Then next level we are having the cache memory we know that to increase the performance, to increase the speed of the processor, we used to put some high speed memory between processor and main memory.

So, we say this is the cache memory and after that we are having main memory which is basically RAM random access memory, it is a semiconductor memory, and processor is going to work with the information available in the main memory. So, this is the memory that we are having in board then already I have mentioned that we are having a limited memory space, or storage space inside the processor or in main memory.

So, for that we need some other memory element which are permanent in nature. We are going to store all the information on those particular devices and we say these are your out board storage and from that particular storage unit we are going to keep we are going to first bring the information to the main memory. So, in that particular case one is your magnetic disk or the hard disk that we used to say, most of you say that in your machine you are having either disk or hard disk of capacity say 500 GB, or 1 terabyte like that. So, this is the magnetic disk and it is started working principle is on magnetism.

We are having CD-ROM also, you know about compact disk; this is your CD ROM read only memory. So, CD ROM basically it works on optical property. Similarly again we are having CD it is again a read write; that means, you can write and you can read it also later on. So, sometimes you can store our information you can first write the information in the disk then from that particular disk we are going to retrieve it or we are going to delete. But in case of ROM CD ROM only we are going to have the information in the particular ROM we can just retrieve it. So, like that we are having DVD, DVD read write or DVD RAM like that.

So, these are basically out board storage or we can say some up to some extent we can say that this is these are online storage also because that processor is going to access those particular devices and while working with the processor, processor can take information from those particular devices also like that when we are going to do some data processing my information may be in a file that file will reside in this particular hard disk.

And processor is going to take the information from hard disks and bring it to the memory. On the other hand we can say that many a time we used to see a movie and that movie is in your CD. So, we are having a video player or MP3 player. So, in that particular player it needs data to display or display a movie, so it is going to take the information from those particular CD and process it and accordingly it will display in the monitor, so that's why sometimes we say these are our online memory also online storage.

So, one more memory we are saying about that offline storage these are basically used for backup purposes. So, one type is your magnetic tape or do you having deformities we say WORM write once read more ok. So, this is the way we can say so these are basically offline. Why we are saying these are offline? We are going to keep information also this is for keeping the backup of our data.

So, whenever we are going to work with those backup copies processor may not directly access the data from those particular devices. Somehow you have to bring it to some online devices and from online devices processor is going to access this data. So, in our computer system this is the total memory hierarchy ok. So in this particular hierarchy what will happen? If you go down speed decreases. So, this is your low speed if you go from this top to the bottom of this pyramid. So, that registers is having a higher speed than cache memory and after that main memory like that we are having the speeds.

So, if you are go from the tip of the pyramid to the bottom of the pyramid that speed decreases, so this is the higher speed and here we are having the lower speed. Secondly, if you look into a capacity then capacity increases when I go from this top to bottom. So, we are having we know that we are having very limited number of registers maybe 8 or 16, but cache memory you may have in the tune of your megabyte, if you are going to talk about main memory it is in a gigabyte.

So, like that in magnetic disk now we are going to get around say terabyte capacity like that; capacity is increasing in that particular case. Also if you go from this tip to bottom then if you consider about cost that cost also decreases. Since these are high speed more performance better, so we have to pay more cost.

Like that if I will go there then what will happen that cost gradually decreases and we are going to get a low cost memory devices in this particular case. So, if we are going for better performance then we have to pay more cost, so this is the way we can look at it. So, this is the total memory hierarchy in a computer system and today we are going to discuss about the working principle of this particular magnetic disk.

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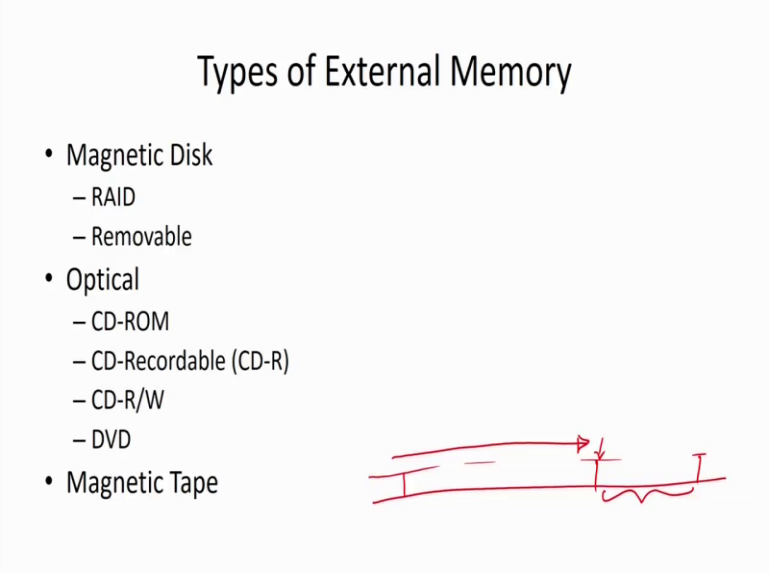

So, these are the type of external memory that already I have mentioned. So, the magnetic disk we have RAID, and removable. RAID stands for redundant array of independent disks. So, generally nowadays in most of the server and most of the computer system we use the RAID configuration, it is a redundant; basically we are keeping the information in a redundant way, so, that if something fails if one hard disk fails then we can retrieve it from the second hard disk. So, that is why you say this is a redundant array of independent disks.

So, just we are making some redundancy on the data so that if there is some problem with one particular disk then you can retrieve it from the other disk. Again it is talking about a removable; that means, what will happen? We can remove the disk from the system and you can put it somewhere else or you can take this particular disks to some other system. So, it will help us to port the data from one system to other system, so they are magnetic in nature.

So, other one is optical already I have mentioned that CD compact disk. These are basically optical in nature and you just see that in most of the cases these are removable in nature we just put the CD on a CD drive, we will operate it then we can take it out, so it can be taken to another.

And another one is your magnetic tape this is basically offline devices which works on magnetic in nature and this is basically tape. So, now if you compare like that what will happen? You can see about a magnetic disks and magnetic tape; this tape is something related to your audio tape or say video tape.

So, here if we are going to access a information then what will happen since it is a continuous tape then what will happen? So, if I want to retrieve the information that is stored in this particular portion you have to skip those particular position and we can come to this particular point. But in case of your magnetic disk it is random in nature like your record player; we can put the head in a particular track, and we can start playing the song from that particular track. So, this is like the random in nature and then only we can go to a particular position and you can start reading information from that particular point.

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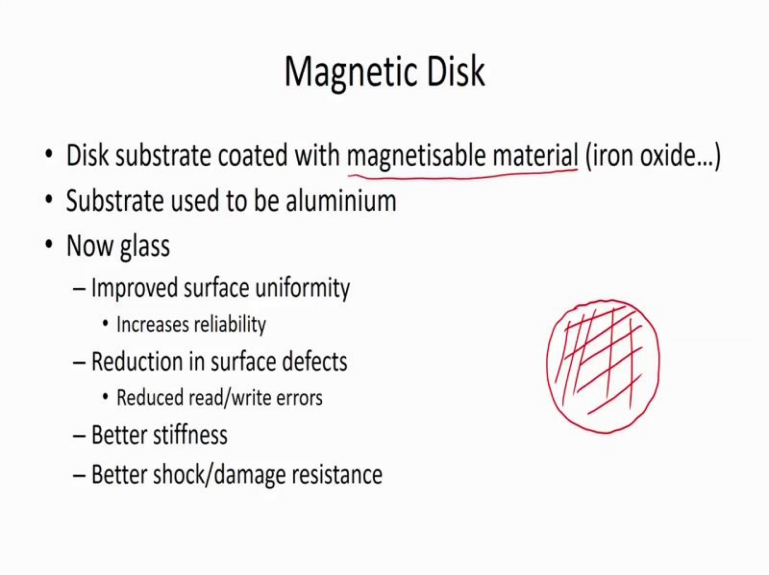

Now, what is the basic things about magnetic disk? Just I am mentioning over here it is we are having a disk substrate coated with magnetic materials. So, basically in most of the cases you will find that this is some sort of your circular plate and the surface of this player will be coated with magnetisable material magnetisable material or say magnetic material, so that we can magnetize it in some polarity. And initially that substrate that the material used for preparing a substrate was a aluminum, but nowadays we are using glass.

So, when we are using glass basically this improve the uniformity of the surface. So, increases the reliability, so it is reduces the read, write errors. Because now it is going to reduce the defect, it is better stiffness and it has better shock and damage resistance. So, nowadays most of the substrate or most of the disk circular plate that we are going to use is glass and the glass will be coated with magnetic material. So, that it can be magnetized in

some polarity and we are going to store our information as a magnetic property in the disk. So, that's why I say it is a magnetic disk or in hard disks is basically magnetic in nature.

So, here we should have two operations basically one is your read, and another one is write. So, in case of read we are going to retrieve the information from disks, I am going to bring it to the processor inside the computer while they are bring it to the computer means we are going to put it into memory. Second is your write operation; in case of write operation, whatever data processing we are doing in our computer that is residing in our main memory because it works on Von Neumann stored program principle, and from main memory we are going to store it in our hard disk, so this is the right mechanism.

So, when you are storing it into the hard disk then it becomes permanent ok. So, if we now modify it then only contents will get changed, but when it is in the main memory this is not permanent it is polygonal in nature. I think you have experienced many a time say you are doing some work in the computer suddenly something happens to the computer maybe there is a power failure, then system is going to shut down immediately it will switch off. When we switch on it then what will happen? Some of the recent information may not be available because we have not stored it in a permanent devices.

So, whatever you have stored in a permanent devices till that point we can retrieve it, some of the decision modification cannot be retrieved because it was in the main memory and it has gone up as soon as we have switch off the machine or powers goes off. So that's why we need these two mechanism; one is your read and write. So, what read is doing recording and retrieving via conductive coil called head.

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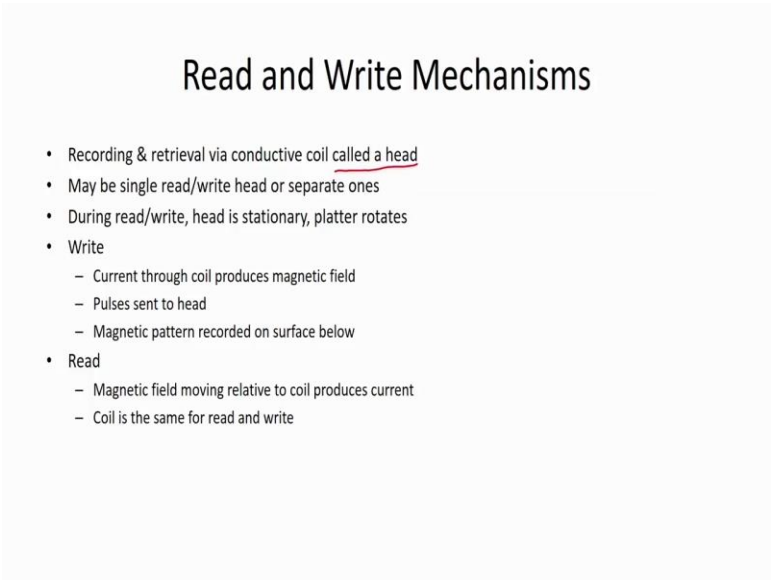

So, we are using a read write head and through this particular head we are going to either read the information or write the information. We will see how we are going to do it, but it is basically magnetic in nature we are storing information is a magnetic polarity. Maybe single read write head or separate one. So, it depends on how we are going to construct a going to construct it? We may have one read write head or we may have several read write head. During read write head is stationary, platter rotates. We will discuss it how why it is required and how it has going to access it.

So, in case of write what will happen? We are going to pass the current through the coil, which produces a magnetic field and that magnetic field we are going to capture in a magnetic material that we are having in the particular platter or particular disk ok or particular surface. Pulses sent to the head, we are going to send some current pulses to the head and it is going to create the magnetic field and that magnetic field is going to be recorded in the surfaces magnetic surfaces; magnetic platter recorded on the surface below, so this is the write mechanism.

In case of read mechanism magnetic field moving relative to the coil and it produces current and by looking into the direction of current we are going to change it and we are going to say that we are retrieving some information and along that same coil may be used for both read and write or we may use to define mechanism for read and write. So in that particular case so you just see that we are having a surface platter, where we are going to coat it with magnetic

material and we are going to store information as a magnetic polarity and to this to store information or retrieve information we need an mechanism and we say this is the read write head ok.

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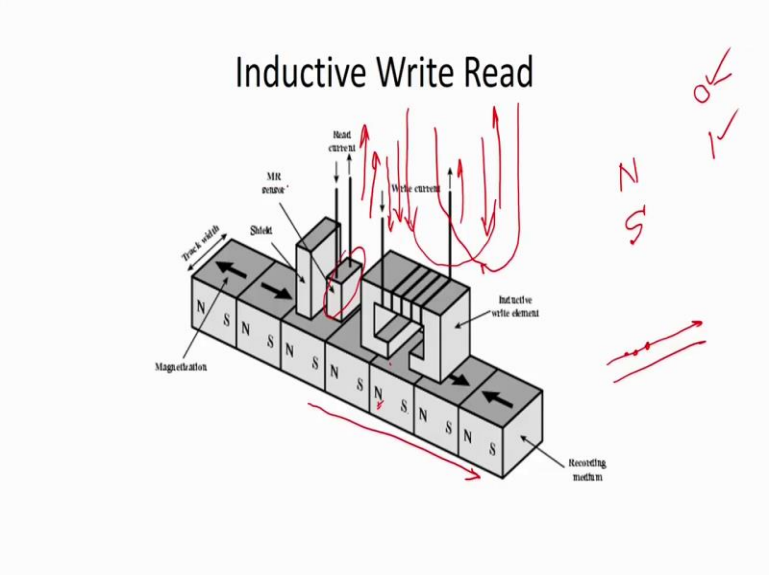

Now the read write head will look something like that. So, this is basically you can see that we are having a mechanism like that some iron or coil iron substrate inductive write element. So, here we are going to have a coil, we are going to put a coil. So, it is very much similar to I can tell you some sort of your DC electrical motors or electrical generators.

So, here we are having a shaft and we are having a coil. So, this is basically shaft and this is coil. Now what will happen? If we are going to pass current through this particular coil then current will move in that particular direction. So, due to that due to this flow of current it is going to generate an magnetic field.

So, depending on the direction of the current that is having a particular polarities. I say that this is the polarity and on North Pole or north polarity. Now once we change the direction of the current say now I am going to give the current for the different direction again this substrate is going to produce a magnetic field but this time the polarity of that field will be different, so it will be in a South polarity ok. Now simply changing the directional current we are changing the polarity of the magnetism, and whatever magnetic field it is general producing that will be stored in this particular magnetic material. So, now we have to just simply change the direction.

Now what will happen? We are having two kind of information one is 0, and second is 1 or maybe in case of 0 it is low voltage and in case of one it is high voltage. So, depending on the information we are going to give the direction of the current; say for 0, if I am having this particular direction then for 1, the current will move in the opposite direction. So, whatever information we have in memory depending on that we are going to produce the appropriate current for appropriate direction and depending on the direction of the current what will happen? It is going to produce magnetism and that magnetism will be stored in this particular magnetic material ok.

Now, once we store one bit of information then this particular platter will rotate. So, it will move, so if I am storing one bit of information over here then second bit will be stored in the next position, third bit will be stored in the next to it like that it will move we are going to rotate the disks. So, depending on the rotation of the disks we are going to store the information in this particular position, so this is the way we are going to write information.

So, now read; what will happen basically in read? So basically you just see when we are writing it now it is we are giving the current. So, it is going to work as a some sort of electrical motor it will generate the magnetic field and depending on the magnetic field our shaft rotates in a motor. So, it is some sort of the principle that we are using a motor. But what is the write mechanism? In case of write mechanism what will happen we are going to move this particular magnetic surface. So, when we move the magnetic surface then what will happen? It is going to generate current on this particular coil that we are having the shaft.

So, the principle is similar to your current generator. So, when we are moving it depending on the polarity of the magnetism it is going to generate current. So, in for say one particular polarity north polarity if current produces say in this direction for the south polarity current will be produced in the other direction. So, in case of one polarity it will generate in this particular direction, but for second one current will be generated in the other direction. So, now, by depending on the direction of the current we are going to interpret it is either 0 or 1. Basically we are storing two kind of information one is 0, and 1.

So, when we are going to store it in a magnetic material for one case say for 0, we are going to store it as a North Pole; for 1 we are going to store it as the South Pole. So, while we are retrieving it so in that particular case for North polarity it is going to give me current in one direction, we are going to interpret as 0, and for South Pole we are going interpret as 1. So,

this is the write read write mechanism of our hard disks and we say this is the read write head. On the other hand in some cases we are going to use say it can be used as a write head and read head may be different one.

So, this is some magnetic resonance sensor basically. So, magnetic resonator can be used for retrieve the polarities of this particular magnetic surface and depending on that we are going to have current in different directions. So, either we can use one particular head for both read and write purposes, but we can use two different mechanism also. So, this is the basic principle, how we are storing in our magnetic surface. Now we have to know what information we have store, where we have stored. So, we are going to see those particular issues also.

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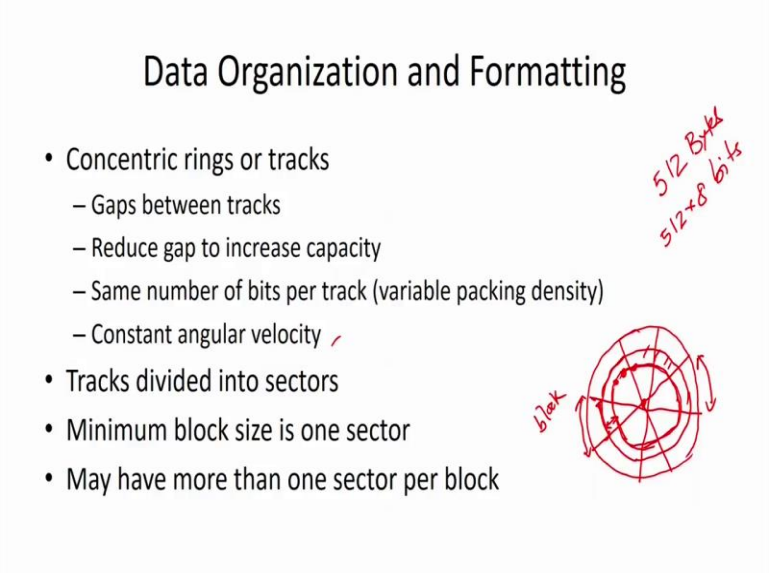

Now, how we are going to organize the data organization and formatting. Now what happens? You are saying that basically we are going to have a circular disk. So, we are going to make concentric ring and on those particular ring we are going to store our information and we are having a gap between two ring, just to remove the interference, so, this may be gap we are not storing it. So, we may reduce this particular gap to increase the capacity. Again we are having a limited capacity. So, we are going to store a particular number of bits in a particular track and this will move in a constant angular velocity, so you have to rotate it in a constant angular velocity.

So, why you have to rotate it? When we are going to read it when we are going to write it then first bit we are going to write it over here, second bit I am going to write in the next position like that, so we have to rotate it. Secondly, when we are going to read it we have to move this particular magnetic surface to generate current. So, whatever is there between the head it is going to change this particular polarity and depending on that we are going to have some current and we are going to work with the current. So, this is the way we are going to store it.

Again it says that tracks we are having some tracks and those tracks will be divided into some sector maybe we can put divide and you can say this is a sector in that particular disk. So, minimal block size is your one sector, will come to distance of whatever information we can store in a particular sector is known as your block ok. If I say that block size is your say 512 bytes, then what will happen? In this particular block I can store 512 bytes of information; that means, 512 X 8 bits; 1 bytes is equal to 8 bits.

So, that many bits can to be stored in a particular sector and this is the minimum block size in one sector. And this is have being some importance in subsequent slide I am going to show it what is the importance basically why you should know what is the block size or how many information you can store in a particular track; may have more than one sector of per track of course.

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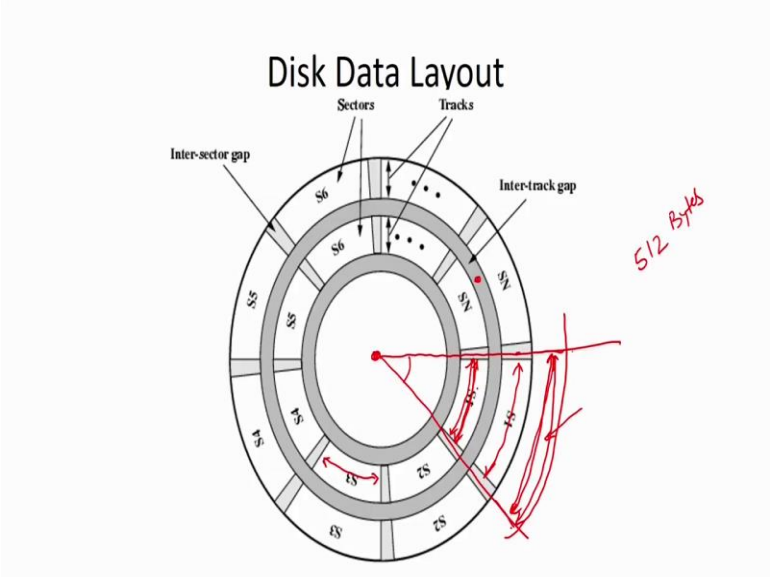

Now, this is the whatever I have discussed whatever I have explained in the last slide this is the diagram neat diagram that we are having. So, these are basically Inter track gap, these are the inter sector gap and these are the different track and tracks are divided into different sectors. So, this is a sector 1, sector 2, sector 3, like that we are having several sectors and total n sectors which is going up to SN, this is a track 1, then this will be track 2, so we are having several tracks. So, this is the organization of our disk and datas are organized in this particular way. So datas will be stored in this particular sector.

So, now to have this things what will happen? Increase the spacing between bit in different tracks I think now you understand. What will happen say I am saying that is the same block size? So, I am having 512 bytes; that means, in this particular position I am storing 512 byte because this is a sector. So, similarly this is another sector in the next track we are storing 512 bytes, like that if I am going for the next track then what will happen now I am going to have store 512 bytes here also.

Now, you just see the area, circumference that we are having in this sector is less than the circumference area of this particular track. So, when we are moving out from the center then what will happen? The sector size is more and we are coming near to the center then sector size is less, but we are storing the same amount of information in a particular sector. So, we can say that bit density is low in the outer track and bit density is more in inner track; that means, in a small sector we are storing more information. So, bit density is more here, but in the outer track bit density is less, so this is one.