Digital Voice and Picture Communication

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Lecture - 38

ISDN Video Conferencing

Today we are going to discuss about the elementary concepts which are there for the video conferencing. We will first give you some elementary look at the typical video conferencing systems and the standards which are in existence today. I made a mention in one of the earlier lectures perhaps the last one where I was mentioning that there are basically two different approaches towards the video conferencing.

One is the most classical one which is the oldest and the video conferencing systems started that way that is the circuit switched video conferencing and the circuit switched video conferencing that is possible through the ISDN link ISDN's full form as you all might be knowing that it stands for the integrated services digital network and it is actually a full digital communication for both the audio as well as the video and it is in the circuit switched domain which means to say that it is essential that an endpoint to endpoint connectivity is absolutely established.

Before any transmission of video packets any transmission of video streams can begin. I wrongly mentioned packets because it is not packet based at all, it is purely based on the end-to-end connectivity. Once the connectivity is established it is up to you to utilize the full bandwidth but the bandwidth will be available at your disposal all the time; you do not have to worry about the bandwidth. But of course you have to incur great amount of cost because if you belong to an organization which has deployment of video conferencing facility then that organization has to hire some leased lines from the telephone companies some high bandwidth leased lines are needed and in that they have to provide the service. So, for that much of time or rather dedicated links has to be established so that the circuit switched video conferencing can take place. It has to be necessarily digital because all this technology evolved after a good amount of maturity of the digital technology because the good old good old analog systems are not very friendly for processing because..... since we have learnt so

many things about the video compression, the audio compression etc we had seen that everything is possible after you have the digitized samples store it somewhere and then you use it for further processing. Therefore, naturally everything came after the digital domain.

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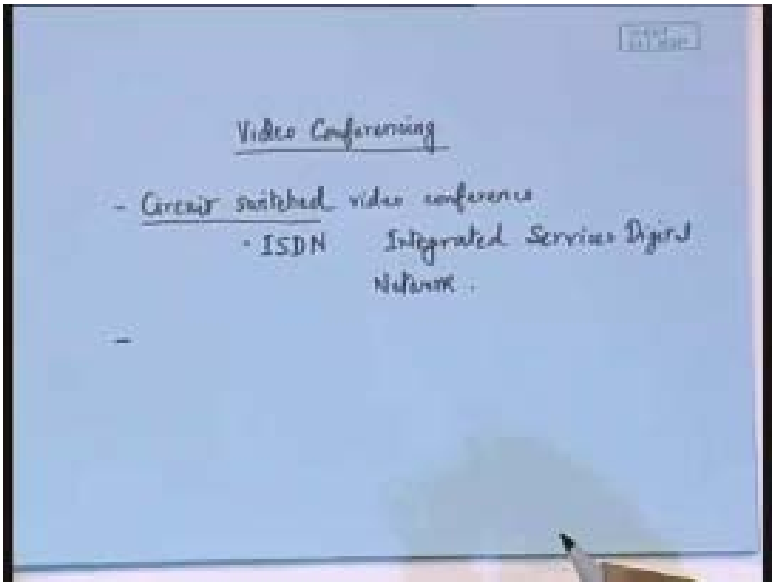

The second approach which is certainly not the classical approach but which has started lately and is picking up at a very a rapid base and perhaps it is going to replace the circuit switched video conferencing in the next few years and that is the IP-based video conferencing. And as you can clearly understand that the concept of IP-based video conference is completely different, it no longer uses the circuit switching rather it uses packet switching. So just like the way we talked about the voice over internet protocol similarly for the IP-based video conference one has to send the video streams from one endpoint to other in the form of packets.

So the packetization has to be done and then the packets could be sent according to the communication requirement, it could be a multicast that means to say that one packet may be dispatched to several endpoints together; it could be unicast on a complete one-to-one basis so that depends upon the requirements. But once we dispense with the circuit switch and go in for a packet based video then there are advantages as well as there are disadvantages. The advantage is definitely the cost because there you are using the internet backbone the LAN bandwidth you are using but essentially there is also an unreliability component which we are

introducing in the form of quality. Because once we send the packets the packets are subjected to any attack by noise so the noise immunity and moreover what happens is that some of the packets may be altogether dropped and in case the packets are dropped in that case we will have some very disturbing effect on the video conferencing that takes place.

Hence, there are advantages and disadvantages. But even going by..... so one thing one can say is that in IP-based video conferencing one cannot exactly guarantee what is called as the quality of service. QoS it is written in the short form. So QoS certainly cannot be guaranteed but it is very cheap; much cheaper as compared to the circuit switched technology; just like the way we are good last time that the voice over IP happens to be much cheaper as compared to the usual PSTN telephones. The IP telephones happen to be happen to incur much lower cost

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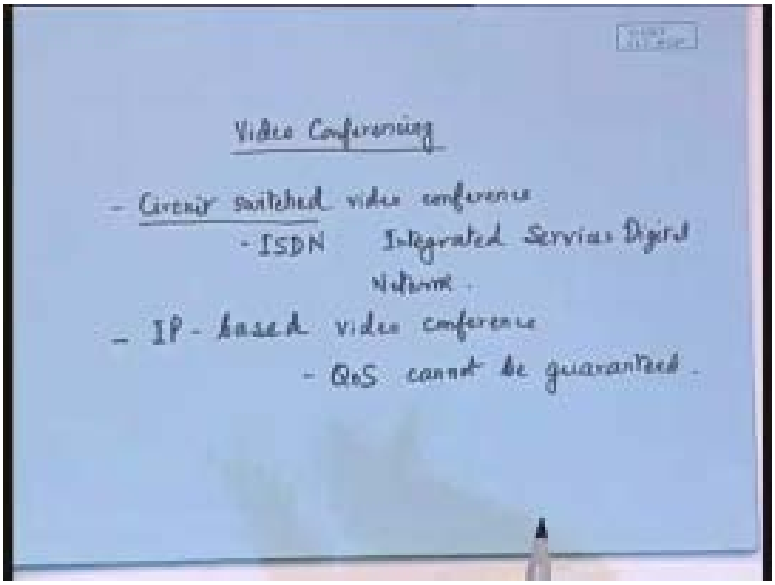

Today both these systems are in existence. but perhaps still even today in 2006 I can tell that most of the commercial video conferencing systems which are in existence at the large establishments especially they are still using the circuit switched video conferencing based on the ISDN, they are still preferring the older technology because the IP-based video conferencing has to reach a better state of maturity; means essentially the QoS problem that should be addressed through the research more vigorously.

Essentially there are... I mean, not that people are not doing research or nothing is possible for QoS that we leave it to the chance that whether the packet arrives or not; it is possible that some sort of a connection establishment may not be in the exact circuit switched way but some kind of a connection establishment may be possible in the sense that one can reserve some resources and one can follow a routing scheme. a routing scheme which Because once you are sending from packet from one endpoint to the other there are different routes through which the packet can be diverted and if in the routing we follow a path where we are encountering the minimum number of hops or we have or a-priori estimate the bandwidths of the channels which we are going to use for the complete path and reserve the channels accordingly then some amount of QoS can of course be guaranteed. So there are some works for that.

In fact, I will also be talking about the IP-based video conference. But to give you a better idea let me start with the very classical approach that is the circuit switched video conferencing. So today I will be discussing about the ISDN video conferencing mostly.

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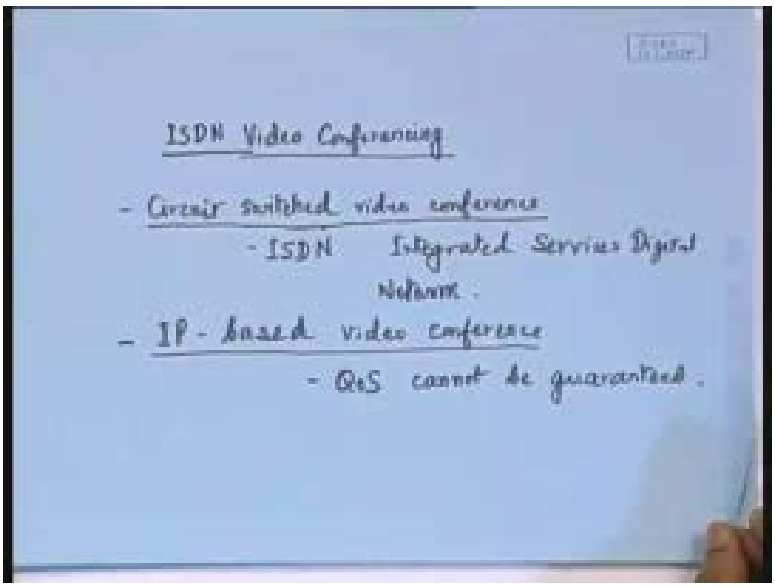

Before I go in to the ISDN video conferencing we should have an overview of the video conferencing standards which are in existence as of now.

Again the main body for any telecommunication standards as you know is the ITU the International Telecommunication Union. So in the video conferencing standards one can make a mention about the H dot 320 this is the oldest standard which is for the circuit switched narrow band ISDN and its bit rate goes from 64 kilobits per second this is the minimum; at the lowest end it is 64 kilobits per second and at the highest end it can go up to 2 megabits per second.

Now H dot 320 this being the standard has to use an umbrella of standards so that full technological solution can be offered because H dot 320 mostly tells you about..... H dot 320 then has to include all the aspects like the video codec, so, for the video codec it uses the H dot 261. H dot 261 as I mentioned that H dot 261 happens to be one of the older video compression standards in the initial days; it used to be it was used to be referred to as the P dot 64 Kbps the reason being that..... I mean, P actually is an integer and this integer can take on the values of 1, 2,..... etc; so if you take P as 1 you get the minimum that is to say the 64 Kbps which I mentioned is the minimum bandwidth that is specified by H dot 320 and you can go up to higher values of P.

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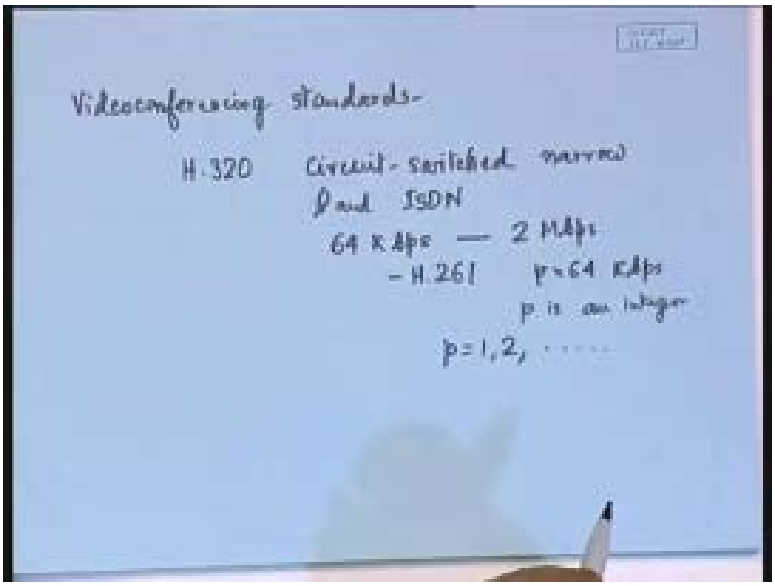

But typically just to tell you just to give you an idea about the commercially deployed ISDN video conferencing systems which are in existence they use a value as typically P is equal to 6. So P is equal to 6 if you take then it leads to 384 Kbps; 384 Kbps is considered to be quite

an acceptable quality of video conferencing with P is equal to 6 that means to say at 384 Kbps and also it has to use the different signaling standards and in fact H dot 320 that uses the ISDN signaling standard that is the same Q dot 911 I think..... 9? 931 sorry; so Q dot 931 which is the signaling standard that we have followed in the H dot 323; even in H dot 320 it is followed but of course that takes care of the ISDN signaling and there are umbrella of other standards which are there under the H dot 320; I am not making a mention of all those.

Then in the video conferring we have yet another standard which is H dot 324. This is also a circuit switched video conferencing standard and this is the plain old telephone systems; this uses plain one telephone system so H dot 324 is a standard for video conferencing over that. Then of course came the very popular H dot 323 which we have already mentioned.

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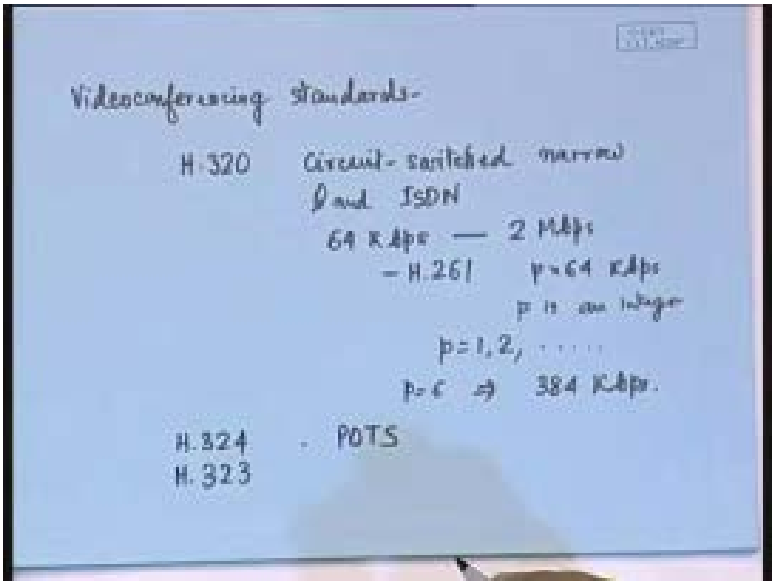

Now H dot 323 we made an extensive mention in connection with the voice over IP but definitely the H dot 323 standards and the protocols is also applicable equally to the video packets. So H dot three two three But H dot 323 unlike H dot 320 or 324 is not the circuit switched standard but rather it is a packet based video conferencing standard because H dot 323 essentially uses the LANs as the backbone LANs for the transmission of the video packets. And also another standard which is in existence is the H dot 310 which uses the ATMs as the backbone; the asynchronous transfer mode or the ATMs.

These are the video conferencing standards in existence. And today since we are going to talk about the ISDN video conferencing we will be following that what H dot 320 has to say for that.

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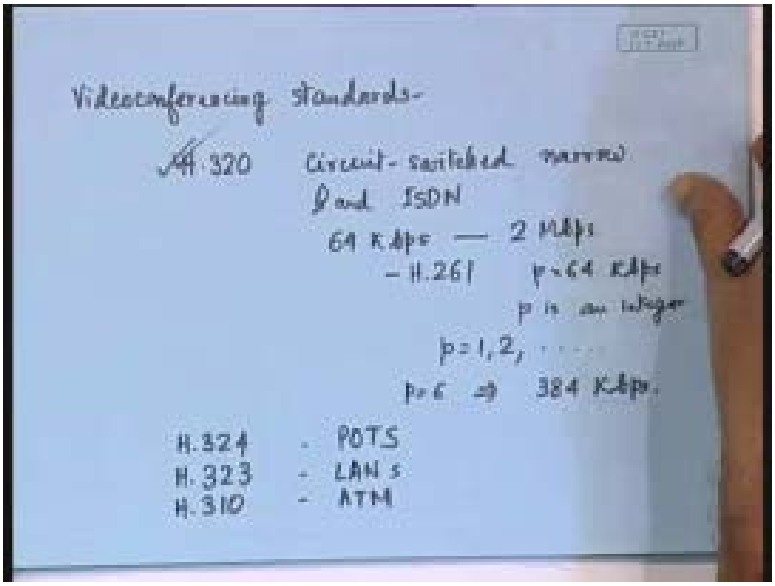

Now, as per the H dot 320 standard one of the essential blocks which is there for the video conferencing is what is known as the multipoint control unit. I think I made a mention about the multipoint control unit again in connection with H dot 323 when I was showing you the configuration; Multipoint Control Unit or what is more popularly in short form it is written as the MCU.

MCU is defined under the H dot 320 and the MCU serves as the central conference server central conference server and this server essentially permits a..... so it allows multiparty conference. Multiparty means once we exceed the number of conference participants as the number of conference participants to 3; 3 means that more than three stations are existing; do not think that we are only talking about person because in one station may be that 4 persons are entered in a video conferencing mode, in another station another 4 persons, in the third station 3 or 4 more persons are there so they are all in the multiparty conference mode. But essentially we are calling it as a three party conference; essentially it is each individual stations taking part in the conference.

Hence, an MCU is needed; Multipoint Control Unit is needed for the multiparty conference and MCU acts as a central server. Essentially this is the MCU which controls the conferencing. Essentially an MCU you can well understand that an MCU has to contain a good amount of switching circuit into it.

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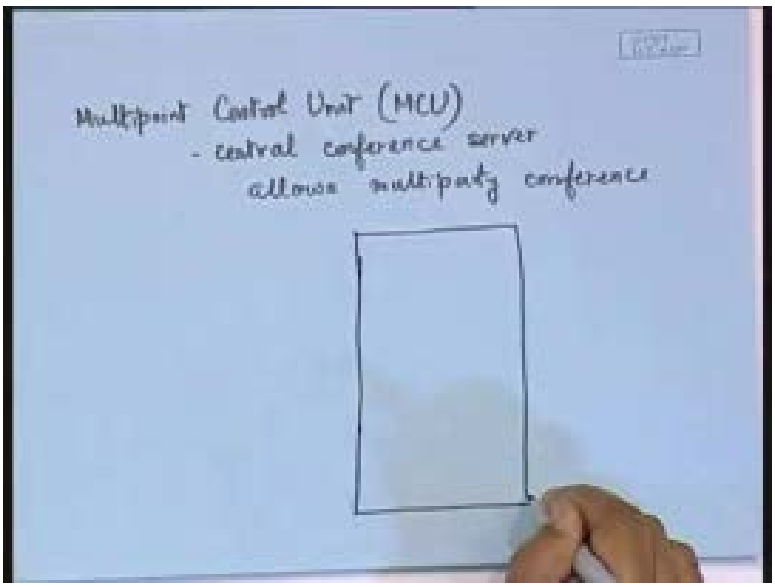

So we can have several ports for the MCU. So to each one of the ports one can assign one incoming user or incoming participant. Let us say that we have got a station or rather one terminal endpoint is there so the terminal endpoint is generating the audio and the video output. This is the audio and video output (Refer Slide Time: 19:38) which will be generated that means to say that we assume that there is an encoder which is present over here and likewise there must be a decoder where the audio/video in has to come in and then the decoded audio and the video will go to the different playback units: to the speakers and to the TV screen monitor whereas this audio/video output will be coming from the camera; I mean, this encoder will take from the camera and from the microphone so here the direction will be this and here the direction of the data flow will be from here to here (Refer Slide Time: 20:23).

Now between this; this will be connected. This being one such station will be connected directly to the MCU; may not be directly because this is one configuration that I am showing using a direct connectivity. You may use several MCUs in between of which one could be the

central MCU that controls the conference but there could be other sub MCUs also to which the connection will be routed. So the essential idea is to establish the connection and that is done in this MCU.

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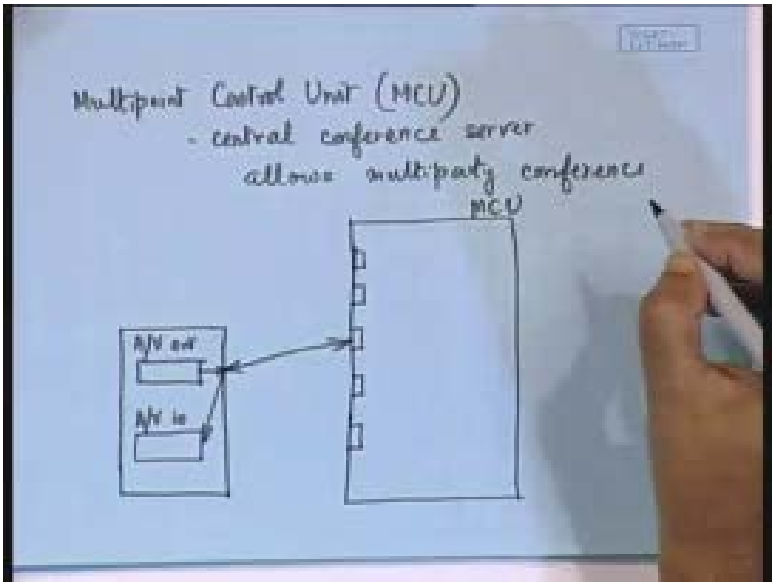

This is the overall MCU block. Now just like this there will be other terminal endpoints which will be connected. I am just showing this with the circle. Each circle essentially contains the AV out and the AV in internally and here also we will be having another terminal endpoint, another terminal endpoint and so on. Let us say that we use a single level MCU. Single level MCU means that essentially; say here in this diagram I have indicated five different terminal endpoints and let us say that these five terminal endpoints can enter into the conference with each other. So this is the facility.

Now what happens is that MCU will have a switch plus mixer type of a circuit let us say that in general we call it as mixer and it is an audio/video mixer. So essentially what happens is that it will go from here to this mixer circuit and the outputs of that mixer can come back like this. Because again here the communication has to be a bidirectional communication between this point to the terminal endpoint (Refer Slide Time: 22:55). now this is the So when..... Supposing this party is in conference with this party then we will be having a a the then the MCU has to make a connection from here to here so that the video that is coming from here

can be routed to this; it has to be routed, it has to be physically routed that is from where to where the endpoint connection has to be established once for all.

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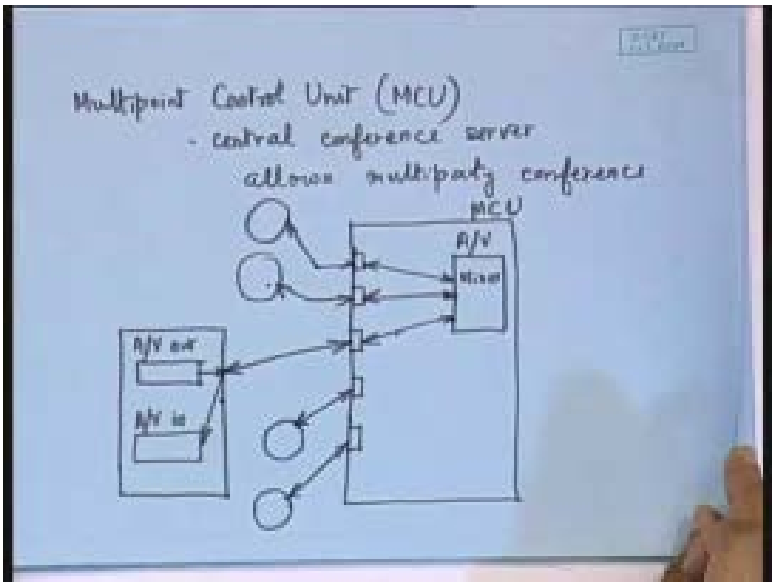

Now, what type of a switching the MCU does?

MCU can have different types of switching that may be possible. So in MCU configurations we can have four different connections which are possible. One simplest form that I can show you is something like this that supposing from the source we have these many connections, so there are n number of sources over here and here I show a multiplexer which can select any one out of these sources and all the destinations may be connected together. Therefore, it is shown like this. So you can see that the same thing; the same video stream, audio and video streams will go to all the destinations simultaneously. So this is basically choosing one out of the source. So choosing one source and broadcasting that to the entire destination. So we can say that this is single video select and broadcast mode.

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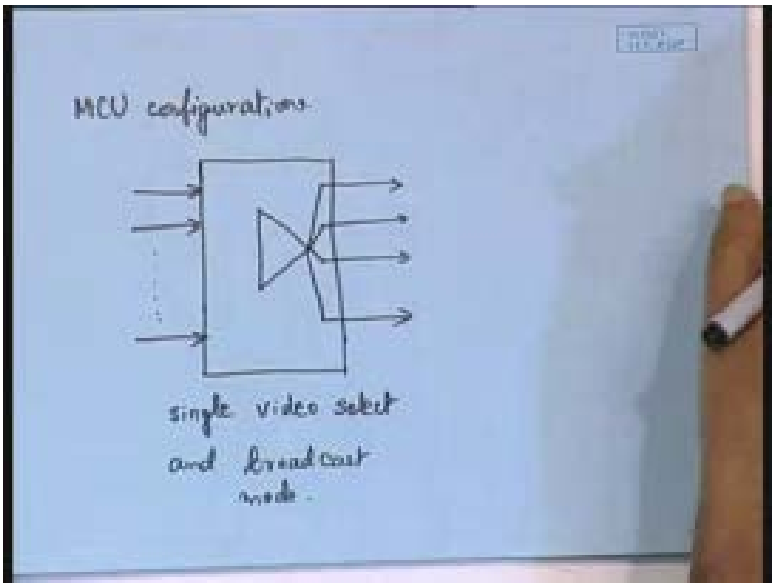

Of course, we sometimes require broadcast and sometimes we may be requiring just a direct one-to-one connectivity. Say for example; in a distant learning classroom, there, one source that is to say from the speaker it is being transmitted to all the different participants who may be located at different locations and it could be broadcast simultaneously because all of them are simultaneously listening to a distant education lecture. So this is in the broadcast mode that one can have.

Now one may also have a one-to-one connectivity. And to have a one-to-one connectivity what you can do is that this MCU..... now here (Refer Slide Time: 26:43) this is a kind of a broadcast mode in which the MCU is configured. But the same MCU you may configure just like a switch. So you can think of it as a switch and the switch can accept several inputs; inputs from the different sources and the destinations there and within that there may be switching so there will be a connectivity; like if this one wants to communicate with this one (Refer Slide Time: 27:19) then the switch has to make a connection like this; if this wants to communicate with this the switch has to make a connection like this and all these connections may be rerouted means depending upon that who wants to connect to whom the switch may be reconfigured so this is a switching where the destination video is selected. This is the destination video select; the source can select its destination video on a one-to-one basis.

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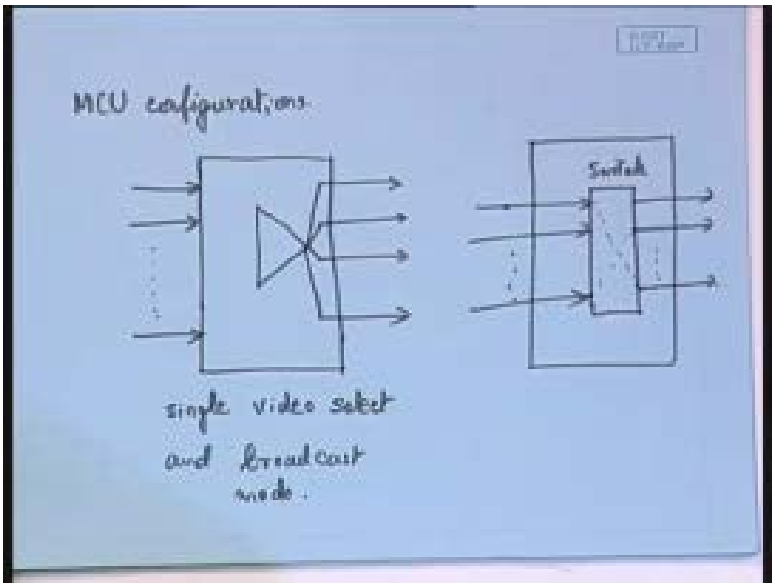

There are some situations where several videos may have to be combined. I will just give you an example that supposing four parties are involved in a video conference say A B C and D. Now all of them A B C and D all of them are having a camera in front and also a monitor. Now what is displayed in the monitor? Who is displayed in the monitor because there are four participants.

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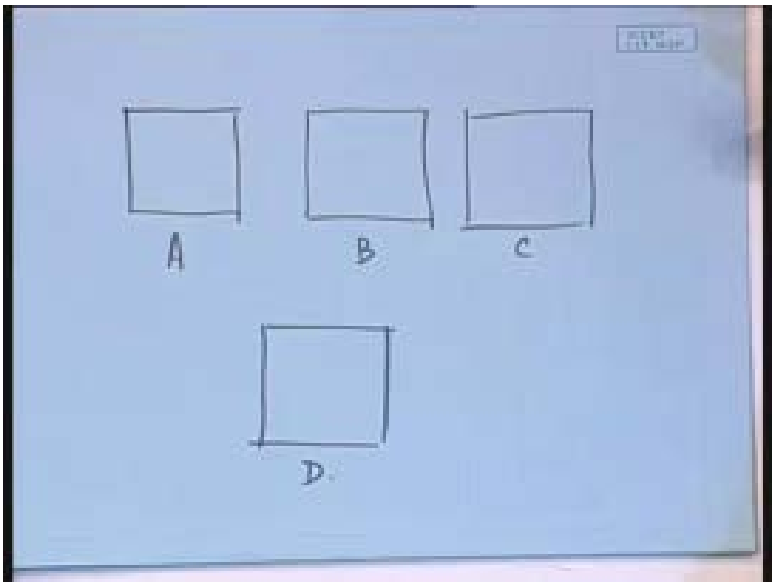

One of the mechanisms which people often adopt is that it is a voice activated switching. Voice activated switching means that, now supposing B is talking something then by seeing that from the channel of B the voice has been activated; now B's video will be broadcast to all the participants. So when B is speaking then A is seeing B, B is seeing himself, C is seeing B, D is also viewing B and then when B finishes maybe A replies and then A will be shown in all, so then A will be multicast to B C and D and things like that. But all the time it is not very welcome because when you are showing B talking you are not showing that what kind of reactions are being expressed by C and D; could be that B is making a point but C is not in agreement with that point, D may be in full agreement with B so B will be really saying that yes my support goes for this and C says that no; I am totally in disagreement, so you have to show that in the screen otherwise you are missing the real genuine benefits of a conference. because when you are in an actual conference environment yes; four persons having a conference together having a meeting together you are simultaneously seeing the reactions of all and that is why ideally to each of these participants the screen should be split into four; the monitor should be split into four and to each of these screen partitions one should be able to display all the four participants. So this part will be for A, this is for B, this is for C, this is for D; to all.

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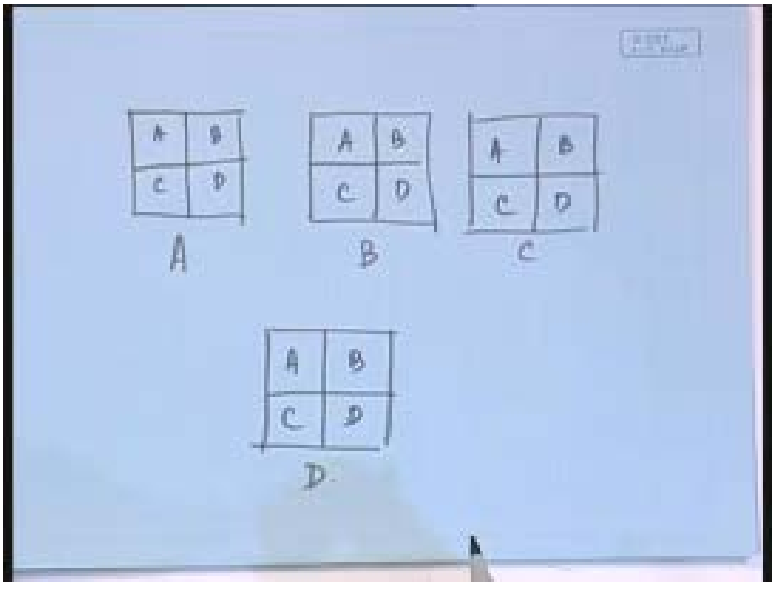

Hence, now the real involvement could be felt in a better way that everybody is able to see all the participants simultaneously. Of course, to do that what you have to do; now definitely you

have to have some kind of a mixing arrangement because you are in A and your video stream is containing only the outputs of your camera; it is not containing B, it is not containing C, it is not containing D individually they are coming and they all if A B C and D all are connected to the MCU then what MCU should do is to combine these four videos and make into one.

Now you can see that in order to do that there will be some bandwidth problem because if we have a bandwidth equal to B for each of these encoded video output; supposing each of the encoded video outputs has a bandwidth equal to.....; let us say W kilobits per second is the bandwidth that we have for each one of these but when you combine these four together then you are having a combined bandwidth of 4W so you are essentially transmitting each of these conference participants each of these endpoints will be transmitting the video at W and receiving the video at 4W so that much of bandwidth may not be available or there is an asymmetry in the bandwidth that happens that is to say the incoming and the outgoing bandwidth happen to the completely different.

In fact, I mean, that is what happens in the asymmetric digital subscribers loop also that the input bandwidth and the output bandwidth they happen to be different so it is possible. But how would you combine?

Now you know that how the bit-streams will be generated from A; A will be having an encoder because definitely nobody will be able to transmit the signals from the camera directly in the digitized form because that will contain lot of redundancy so to make efficient bandwidth utilization one has to go in for some kind of a compression scheme. So naturally it is a compressed video which will be going. So naturally what one has to do is that at the MCU one should be able to decode that and then convert them in to the pixel domain and then combine the video in the pixel domain and then once again you encode and send to the individual users, I think that is possible.

So one can have it like this that either ..... or there is no harm if you want to combine everything in the compressed domain. So, video composition in the compressed domain there the MCU should be configured in the add mode. So it is add means not the arithmetic addition rather to say that a split screen mode of addition or rather appending one stream with the other like A's video bit-stream, B's video bit-stream, C's stream and D's stream they are

appended together and then sent in a combined form to all these users. So to all these participants A B C and D in the combined form it will be sent so there one can combine in the compressed domain itself. This is one (Refer Slide Time: 35:10) this is second, this is third, this is fourth four is just an example in fact it could be a multiparty conference more than four is very much possible. So this is video composition in the compressed domain in the compressed domain. Then one can have the video composition in the pixel domain also.

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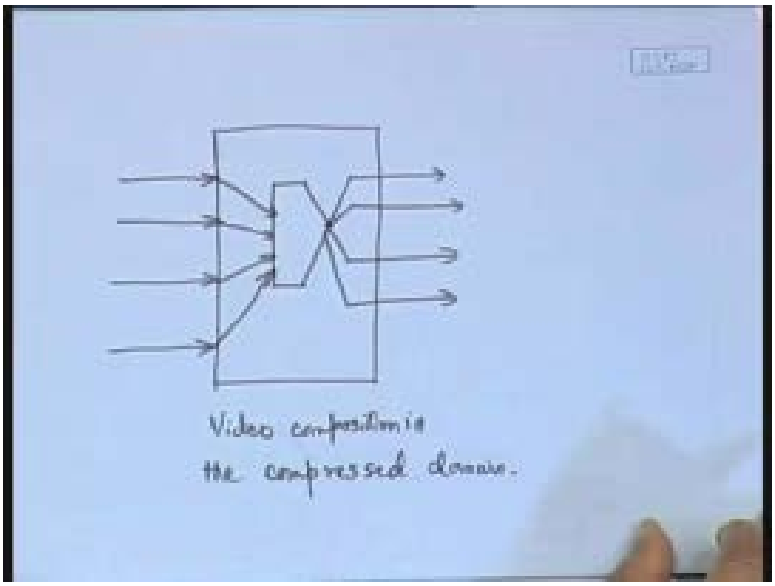

If you want to do it in the pixel domain then what you to have to do is that you have to with individual streams you have to provide a decoder. So the decoded stream that means to say the pixel information will be coming to the combiner so everything will be.....D stands for the decoder and typically it could be encoded individually or encoded once and sent to all. but in general I am showing that there are different encoders because you see, I tell you that in what situation different encoders may be needed; again these participants A B C and D they may not be having the same bandwidth availability because availability of bandwidth will depend upon how much of cost each is incurring.

If one has got a high bandwidth lease line in an organization then that organization will get a more bandwidth and there the quality will be better and that organization will require an encoder where the encoding is at a much higher bit rate with better quality whereas some other parties may be constrained to receive a very low bandwidth bit-stream where the

encoder will compress the video very significantly. So there could be different encoders associated with each one of the bit-stream or if it is found that it is in the broadcast mode that all the destinations are having the same bandwidth, in that case there could be one encoder and then it may be broadcast to all. So everything is possible under the MCU.

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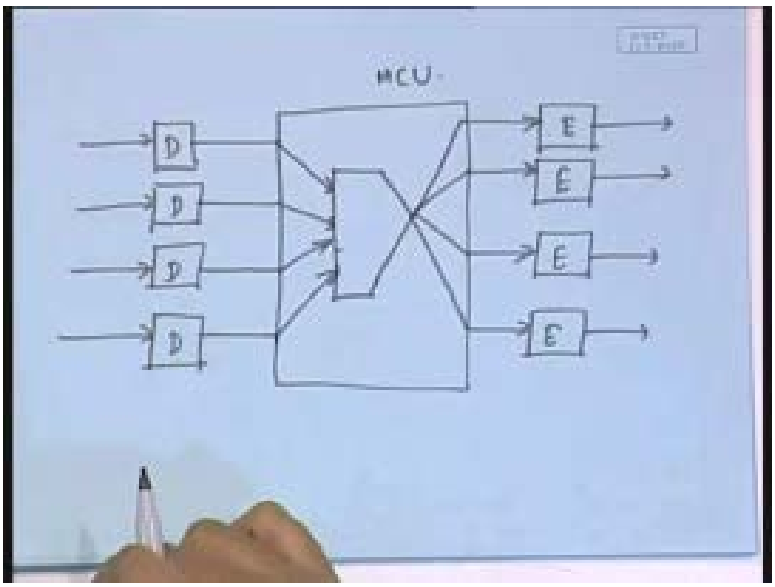

Therefore, what I wanted to say is that MCU is an essential component and MCU is a very versatile component in the video conferencing domain because MCU essentially permits us to reconfigure it in any manner we like. This is an example of video composition in the pixel domain. How it does is that you decode each of this bit stream, now you form a screen where you partition that into A B supposing these are coming from different sources A B C and D so A B C D you just partition into four so you compose these individual subimages here into one combined frame like this (Refer Slide Time: 39:09) and this ABCD in a combined form could be sent to all so that the real multiparty conference effect can be created so this is possible in this manner.

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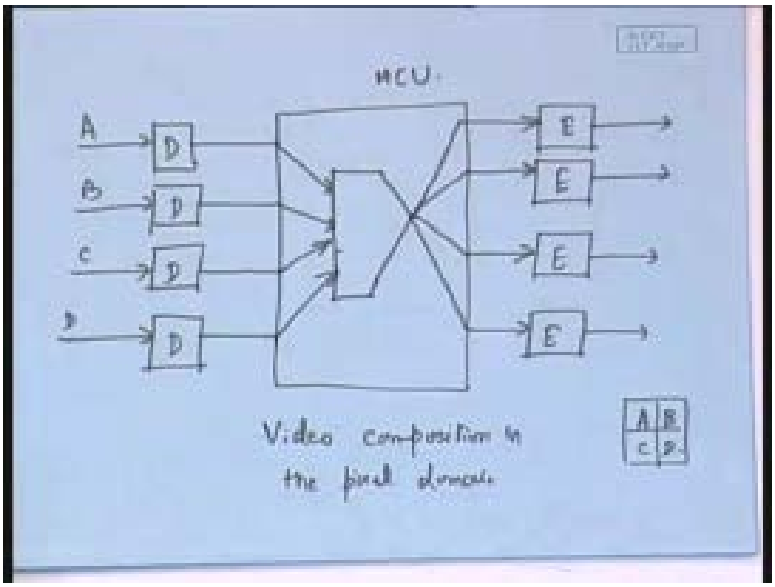

Having known this..... definitely MCU as it stands is a centralized server that is permitting you either the video combination composition or it permits you a simple switching or it permits you a simple broadcast kind of connection all these things are very much possible and there may be multiple MCUs where one can have distributed control mechanisms like it could be the central MCU may be connected to several other MCUs and individually those MCUs may be controlling their local connections that either one can have..... I mean, even within a building also one can have one-to-one video conferencing or whenever any end user wants to have a video conferencing from one building to the other then it has to go through its output link and then that goes to the centralized MCU of the organization, so like this one can have different configuration arrangements. But to just to talk to you more about the ISDN video conferencing let me give you some information pertaining to the ISDN video conferencing.

ISDN video conferencing essentially has two basic building blocks. Its basic building blocks are: one is what is called as the bearer or the B channels. In B-channels each channel provides 64 Kbps bandwidth Kbps bandwidth for voice, video, data and then one can have and then another building block is what is called as the data channel or it is also referred to as the D channel. The D-channel carries the signaling and the control information. So it allows call setup, call tear-down, call hold ... etc.

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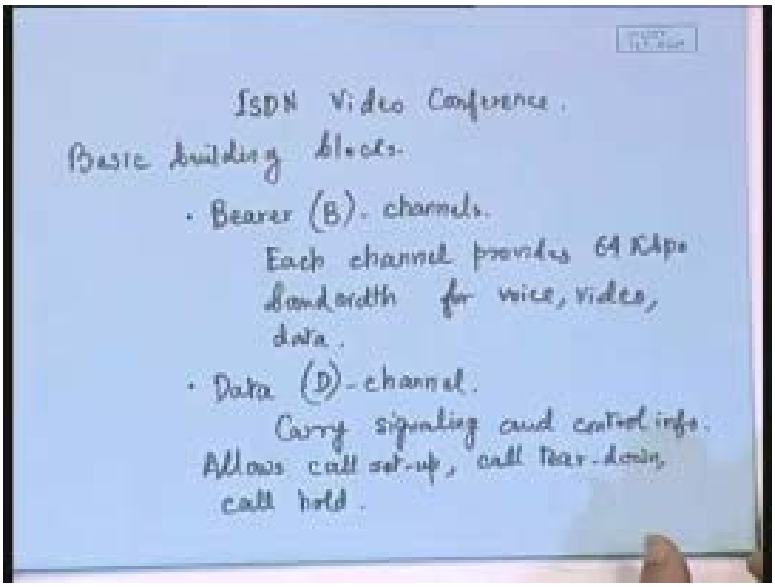

Now, using these B-channels and D channels B-channels are having different bandwidths, some D channels are having 16 Kbps bandwidth because if you are using it for the signaling you do not normally require a very high bandwidth requirement. Now the actual data will be sent through this B channel. But the signaling and the control information that will be sent by a separate channel which is a 16 Kbps data or the D-channel which could be a 16 Kbps or may be as high as 64 Kbps also. But using these B-channels and the D channels two different types of interfaces are possible in ISDN.

The kind of interfaces that it supports are: one what is referred to as the Basic Rate Interface or what is referred to as the BRI. There are two B channels; in the basic rate interface we have got two B-channels so it is 2 into 64 Kbps each one being 64 Kbps plus one separate D-channel and that is 16 Kbps so totally 2 into 64 means 128 plus another 16 over here so 144 so the total bandwidth is 144 Kbps for the BRI. Now this is certainly not suitable for the business quality video conferencing because the bandwidth is inadequate.

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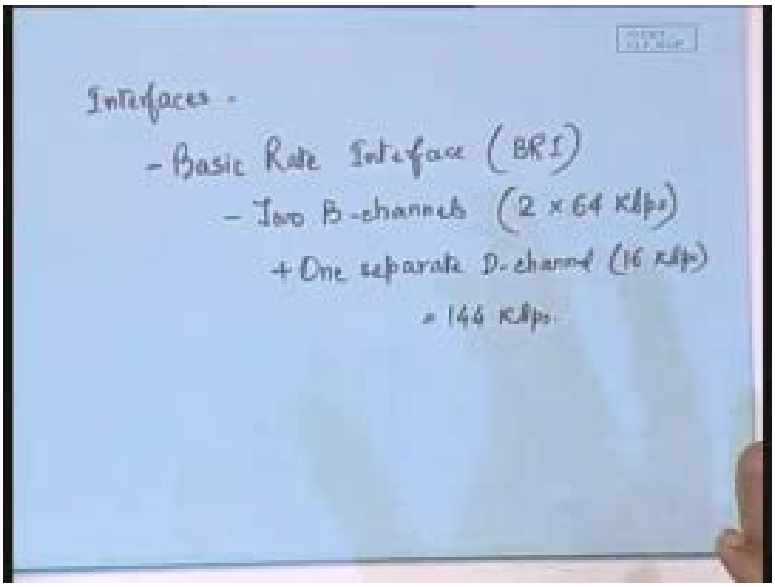

In fact, two B-channels 2 into 64 Kbps by 2 into 64 Kbps is used is the reason being that you use one for the incoming video stream, one you use for the outgoing video stream and dedicatedly absolute dedicated links but the bandwidth is poor and instead of this if one uses three such BRIs simultaneously so this is so as such a single BRI is not suitable for business use but to make it suitable for business use where you are going to use something in the tune of 384 Kbps which I was mentioning now to make it 384 Kbps you can use three BRIs simultaneously.

Now other than the basic rate interface one can go in for what is referred to as the primary rate interface. Yes any questions? [Conversation between Student and Professor: 00:46:41] See we are we referring to the data bandwidth only; leave aside the signals because 2 into 64 means that it is 128 and you are using three BRIs so each BRI is supporting 128 Kbps and three BRIs together will make 384 Kbps for the data so we normally mention in terms of the data rate.

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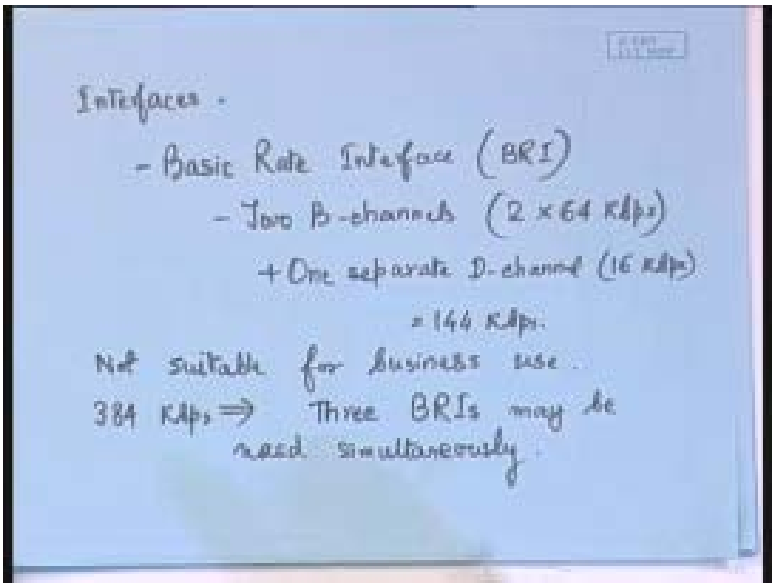

Now other than the basic rate interface or the BRI the other kind of interfacing which ISDN supports is the primary rate interface or the PRI. Now what happens is that BRIs are actually dedicated even to the endpoints. Means; supposing I am in an organization and I am having one video conferencing terminal with me then up to my terminal one BRI or if you want more than one BRIs that should run. So the link has to be all the time connected to me and the difficulty is that if there are multiple number of users in that case one has to deploy a large number of lines in this process; means to everybody we are using three number of. I mean, one BRI has a dedicated link. But instead in the case of primary rate interface what happens is that one PRI circuit that uses a large number of B channels. In fact, each PRI each PRI circuit includes 23 B channels 23 B-channels so 23 B-channels if you just multiply this number 23 by 64 you get total 1.472 mbps 1.472 mbps or 14072 Kbps that is there. So 23 B-channels and one D-channel and in the case of the PRI because 23 B-channels are used, they provide the D channel bandwidth little higher the D-channel bandwidth is kept at 64 Kbps.

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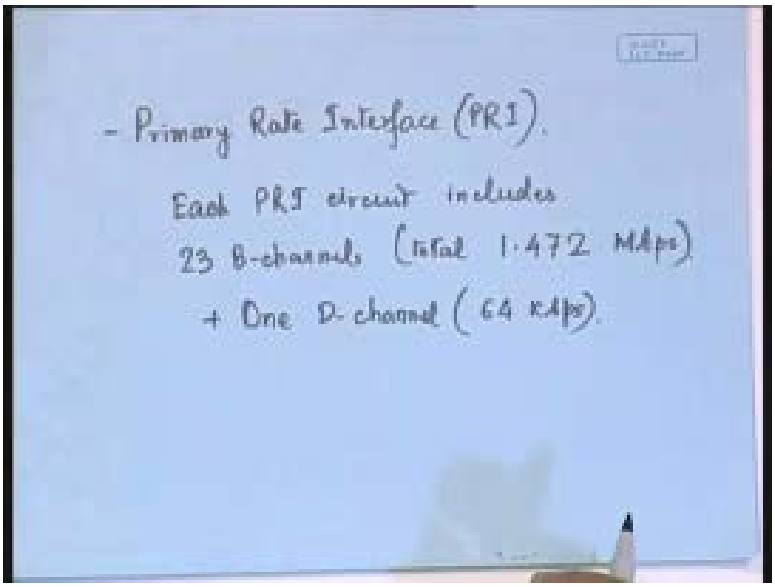

In fact, this sort of a mechanism is very much useful for a multiparty conference situation where there could be dynamic allocation of the available bandwidth. Now in this case you see; to calculate the total bandwidth that each PRI circuit will be able to give you 14072 plus another 62 which means to say 1536 so 1.536 mbps and if you are using if one has a least T1 line T1 line is 1.544 mbps so that can have 23 B-channels and one D-channel or you can use all the 24 as the B channels.

Therefore, using one T1 line one can transmit..... now here the available bandwidth is 1.5 megabits per second which is considerably high. Now, depending upon how many participants are there how many people are making video conferencing calls at a time, the bandwidth may be readjusted between the endpoints. If no other party is involved; if no other endpoint is involved in the conferencing in an organization where a PRI connection exists in that case the full 1.54 mbps bandwidth could be given for that video conferencing. This is one advantage. Only thing is that, okay the initial installation cost for having the PRI is high but the PRI is actually shared between all the users.

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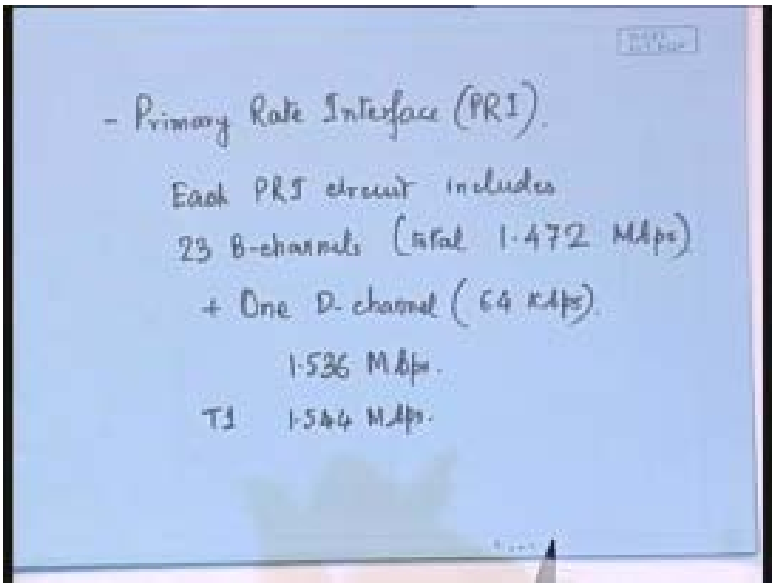

So it is something like this that if we just to draw the configuration it would look something like this that in a very small office configuration small office configuration we can have let us say we have a terminal and from that terminal we have three lines why three lines because 2 into 64 plus one data channels so two B-channels and one data channel so we are referring to as a BRI interface with the terminal. So this is the terminal endpoint (Refer Slide Time: 53:00) and we have got another terminal endpoint another TE and another TE also will have three dedicated BRI lines and this BRIs and this BRIs they will go to the block which we are calling as the demarcation point.

Demarcation point means that the ultimate end of the office building to which these BRIs are connected and then three from here and three from here so these six lines will go directly to the PSTN network, so this is connected to the PSTN. So it is a small office configuration which is deploying the BRIs dedicatedly to each of the terminal endpoints.

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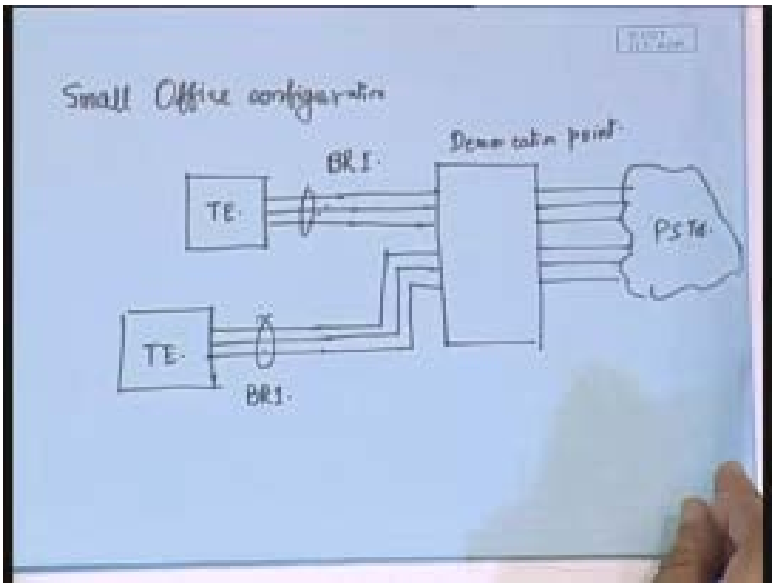

But an alternative configuration which one can realize using the PRI could be like this that.....; now here (Refer Slide Time: 54:14) I have shown two but if you want more there what you have to do is to have; all the different TEs will be connected each TE will use its own dedicated BRIs and so many lines have to go to the PSTN.

Now in this case what you can do using the PRI is that yes once for all you have a large bandwidth which is 1.544 mbps and you can connect that to the PSTN network but only within the organization you have to..... so this 1.544 of course this is the PRI so it includes the 24 B-channels or 23 B plus one D but we have what is called as the access switch over here and these are the different terminal endpoints 1 2 3 let us say; TE1 TE2 TE3 TE4 there may be many more TEs.

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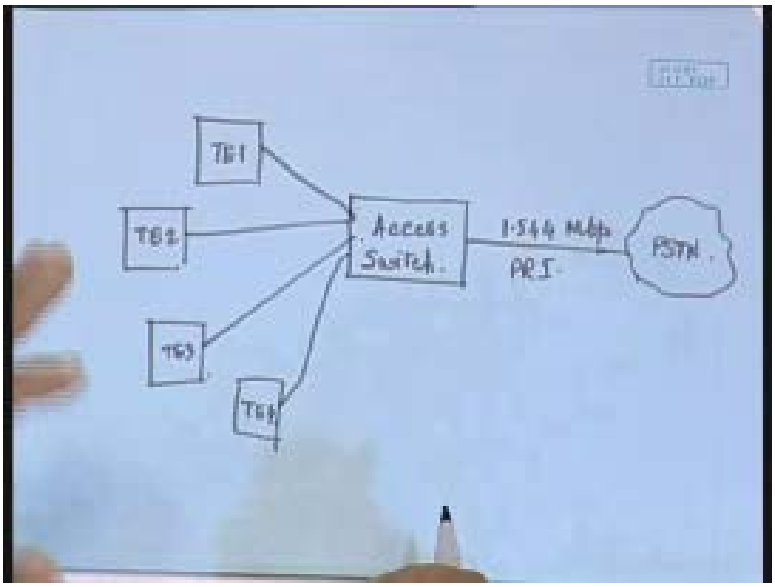

Now there will be some internal PRI connections which will be there and the access which will allow the access based on the available bandwidth. Now the bandwidth allocation is a dynamic allocation. Now supposing we have a total bandwidth of 1.544 mbps and out of this let us say that 768 Kbps is required for one video conferencing.

Supposing TE1 wants to have a video conferencing with some other remote party and he has a requirement that it should be a 768 Kbps bandwidth reservation for me, so to have 768 Kbps bandwidth reservation what he has to do is what the system has to do is that say every line every B line has got 64 Kbps bandwidth. So to have 768 we will be requiring how many 768 by 64 that means to say 12 B lines will be reserved for that communication. So 12 B lines will be a dedicatedly assigned to TE1 and the remaining eleven lines will be available for use by the other terminal equipment. Now out of that one terminal equipment may use only 384 Kbps so still another 384 Kbps should be available for usage by terminal 3 terminal 4 or if there are more terminals; one can have a combination of high bandwidth video conferencing and low bandwidth conferencing so depending upon the requirements the availability will be assigned so that is the job of the access switch.

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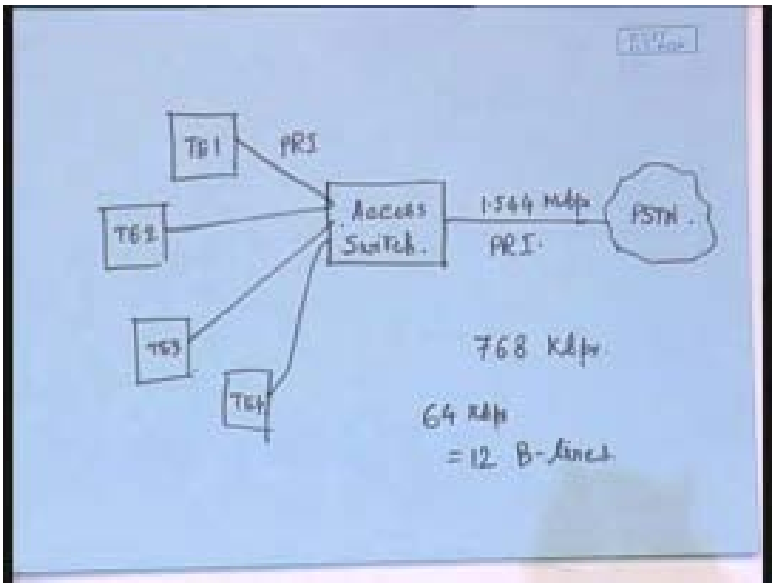

Using this access switch one can use the bandwidth very efficiently. So PRI ultimately the PRI connectivity that leads to more efficient bandwidth utilization. It is this much for this lecture and in the next lecture we will be showing you some more configurations of the ISDN video conferencing and then we will also talk about the IP-based video conferencing which is going to be the state-of-the-art, thank you very much.