Satellite Communication Systems
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Lecture - 29
Multiple Access-4

Welcome back, we were talking about multiple access system higher satellite and already we have covered that common frequency decision multiple access; FDMA and then we continued the discussion on time division multiple access; TDMA have satellite and in that we were trying to see how the burst from the individual station reaches in proper time at the satellite with respect to reference burst of the TDMA frame and then we received that person, what is the characteristics of the burst? How do we receive that?

We discussed about the beginning of the burst there is a unique word how to detect unique word if there is an error what is a probability misdetection and probability of falls detection those estimates we have just seen. So, will go back to this synchronization of the city TDMA burst on the satellite transponder.

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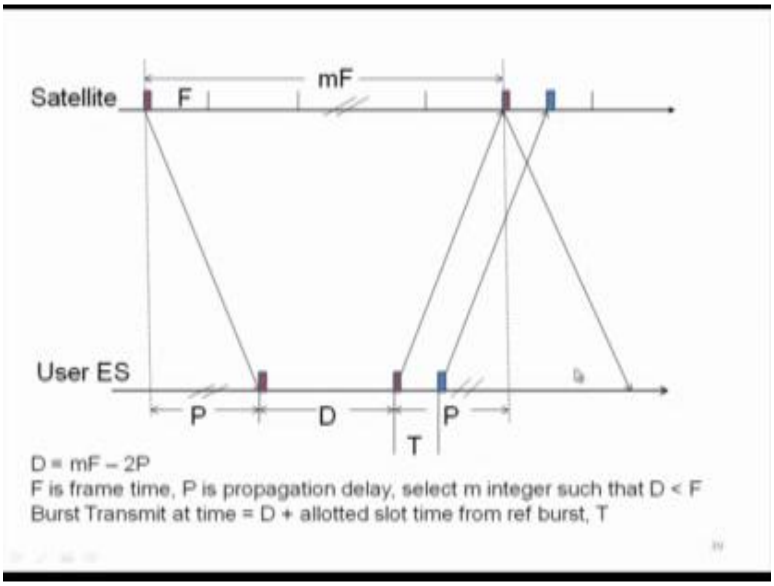

Let us look at this slightly older slide, this we were estimating that when to transmit that was the unknown factor d, we try to find now. We have calculated and this term the estimation of integer number m we calculated and found out, what is the d and the times slot t is all we known with respect to the reference burst. So, we transmit with respect to this now that is only better transmission the it has been properly transmitted or not or estimate of d is a correct not for that particular station will come know after this burst reaches the satellite and then from the satellite it is broadcast down.

So, will be receiving the same burst, we come to know after reception of that whether this time t with respect to the beginning of the reference burst and we start of the burst for these particular station has transmitted this t has been properly maintained or not now; that means, we are transmitting and receiving back and if it is not properly maintained, we slightly adjust it will advance it in terms of time or return it in times of time for the next time transmission which expect to a the reference burst reception that is another d can be transmit that.

Now, this is forming a closed loop. So, this is called closed loop synchronization it takes some time or some number of frames which is multiple of the proposition time up and down as well as some estimate time of d. So, that it will take to properly place the burst in the right place in the frame. So, the total use the data in the beginning of the synchronization is not sent only a preamble is sent somewhere a giving some gap of few bites both sides, so that you do not by mistake you do not fall into the previous burst a time; that means, previous stations time your allotment times.

Sometimes is transmitted middle of the allotted burst and the drift is calculated and solely it is drifted out. So, this close loop synchronization takes some time, but there is no ways we have to know, what is the burst clock? We have to find out burst clock for that this is referenced, but sometimes the stable clocks available and if the burst sizes are clearly known using that is stable clock we can do it. So, let us go forward and this is called open loop synchronization.

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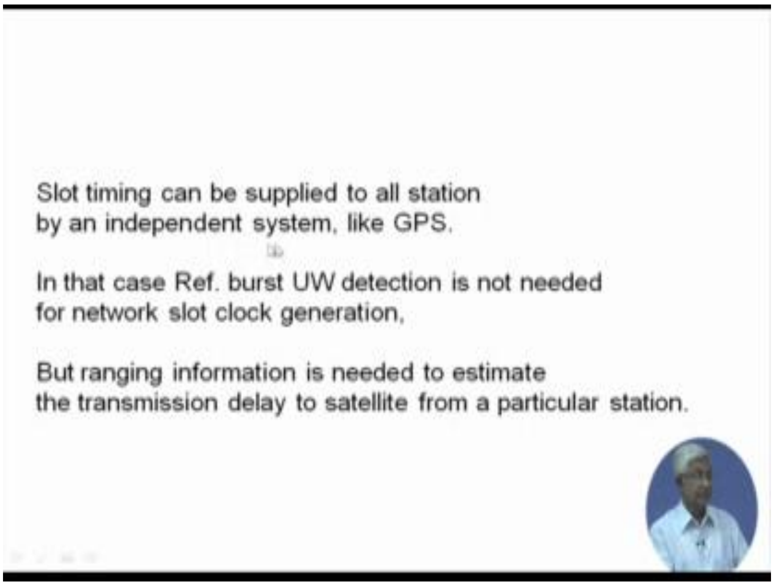

If the slot timing can be supplied to all station by an independent system like GPS, GPS in addition to position it can give at time also which is very precise it is stability is very high because the GPS satellites are carrying the atomic clock. So, in the high stability and all the stations are receiving the same clock from the satellite. So, therefore, all of the stations are synchronize with respective the GPS clock, so that means, the whole network is synchronize with respective GPS clock.

If we can do that way then the burst clock timing at just meant you do not have to worry in that case reference burst detection is not needed find out the slot clock generation time, but you still have to know the face you still have to know where the reference burst is with respect to that you have to transmit and you need to know the ranging information that is a proposition time p for upping and downing. So, with some additional information you can manage with open look synchronization. So, in that case it will be much faster to start transmitting actual data in close loop synchronization you have to synchronize a couple of proposition time and frames, whereas in these case open loop synchronization it is much fast, but it depends on this slot timing by the independent system how stabilities of course, GPS is quite stable.

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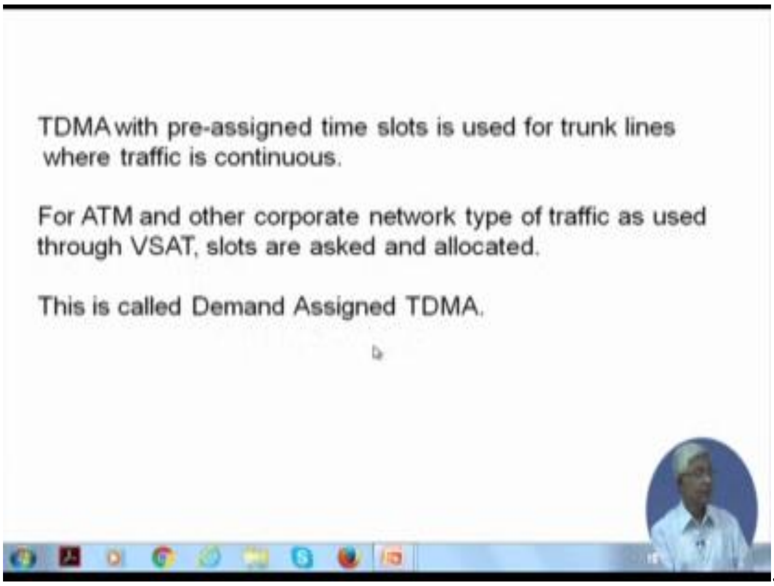

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Now, let us where, who are using it and what is the problem? Let us see like FDMA, the frequency slots are allotted there here time slots are allotted to each individual station. Now, if you not having a continuous traffic from that station. So, those time slots will be wasted just like in a DMEA website that if it is a non continuous traffic your band width is wasted here, the time is wasted and obviously, let us see like VSAT operation using our automatic teller machine, that is ATM in the bank in that you have a traffic, which is busty, sometimes the ATM is empty, nobody is transmitting and sometimes some queue is there people are transmitting from couples of couples of minutes.

So, therefore, in this type of a VSAT network if it is operating in TDMA for each VSAT, if it is the slot time slot are allotted pre assigned and allotted permanently that will be underutilization. So, now, what is done is these slot VSAT they ask the central station that you give me a times slot and central station based on the availability of times slots they allot the time slot. So, it is a demand assigned type of time division multiple access is called demand assigned TDMA. So, you ask for it and you get it so that means, more number of VSATs can be a brought into the network assuming that all VSATs are not simultaneously on asking they are on, but they not asking for that times slot, they do the traffic is not continuous in those cases the demand assigned TDMA, where the traffic is continuous were of course, the previous TDMA is the best solution for that.

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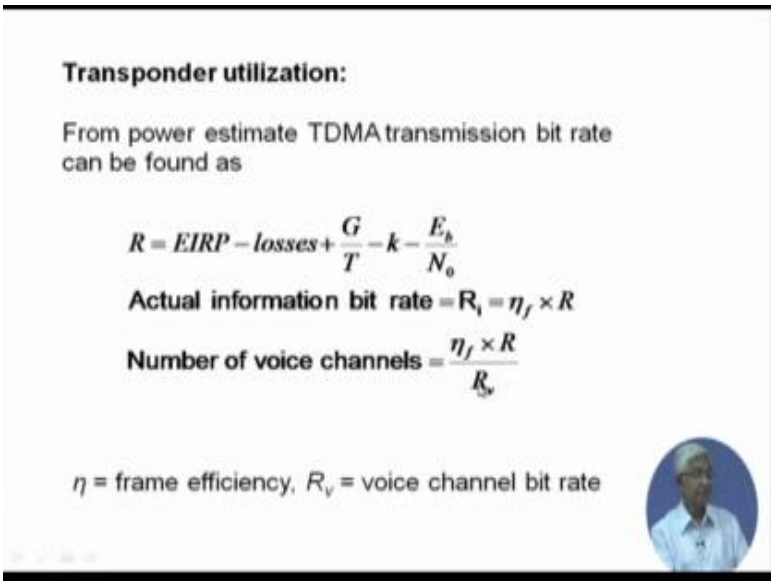

Now, let us do a transponder utilization calculation that is based on the first; you can calculate what is a transmission bit rate. A transmission bit rate and information bit rates are different. We have seen that efficiency calculation in TDMA, information bit rate is actually useful bit rate I should say useful bit rate is excluding the overhead bit and transmission bit rate at the rate each bit is transmitted. So, TDMA transmission bit rate can be found from the power estimate. We remember this expression that is c by naught is EIRP plus g by t loses minus k and c by n naught is e b by n naught plus r.

So, keeping the bit rate r in the left hand side, we bring the e b on the right hand side. So, in e b expression becomes the transmission bit rate is equal to EIRP from the satellite minus the downlink losses and g by t of the receive station minus the constant minus e b by n naught, but this actual information rate which is I should see useful bit rate or actual information bit rate is much less because overhead bit are there. So, if we call it R i, R i is some efficiency time the transmission bit rate. So, let us call this be the f. So, number of voice channel if the R v if we say voice channel bit rate. So, it becomes the R i by R v that is it eta f into transmission bit rate by R v, where eta is a frame efficiency eta f is a frame efficiency and R v is a voice channel bit rate.

So, if we have all these parameters available in the EIRP losses g by t etcetera, and if we know that the efficiency that is the useful bits how many we are overheads bits how many they are. So, from the transmission bit rate we can find out the information bit rate or useful bit rate and voice channel, assuming all of them are using voice communication and at a constant bit rate each of them then that is the number of voice channel that can be supported.

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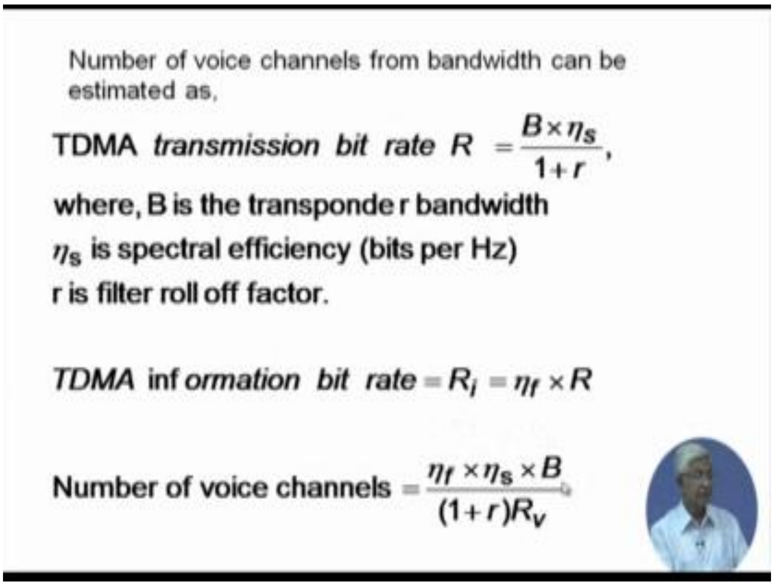

So, number of voice can be found out from the bandwidth that is from the power by from bandwidth also you can find out number of voice channel. Let us see how it is transmission bit rate is a total TDMA transmission bit rate is the transponder band width I assume the full transponder is being used. So, transponder band width multiplied by the spectral efficiency the type of modulation what you use that is a how many bits per hertz is being used that multiplied by the band width and divided by the filter rule off the whole transponder a bandwidth even if we will use a filter because the spurious thing should not found into adjacent channel.

So, there will be filter and there is a definitely filter roll off factor, one plus r. So, transmission bit rate r equals to transponder band width b into eta s, here eta s is spectral efficiency for the modulation divided by one plus r and then information bit rate as we have seen earlier is a is eta f time that is frame efficiency time the transmission bit rate which you have just now got in times of bandwidth from the bandwidth and filter roll off and type modulation that is used and then we can find out the number of voice channel that is R i by R v is eta f into R and R is eta s into b divided by 1 plus R and R v is already there in the denominator.

So, by knowing the frame efficiency and the spectral efficiency and the bandwidth that is available and the filter role off and the bit rate of the voice channel we can find out the number of voice channel that can be supported assuming all voice channels are transmitted at the same rate. So, that earlier expression was in terms of power from the power you can found find out and here we can found out from bandwidth.

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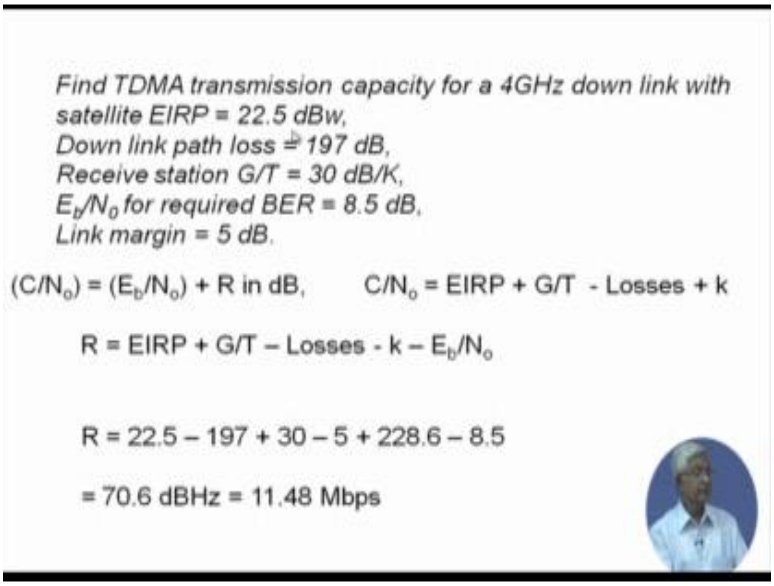

Let us take some example as have done earlier. Let us take small, small examples that you can good get into familiar with the numbers as I always say that it is better to just do not copy or calculate on the numbers, we try to understand the meaning of this number. So, implication will be much more clear you will enjoy that the satellite communication find TDMA transmission net capacity for a 4 gigahertz downlink with satellite EIRP of 22.5 db w down link path loss, path loss is 197 db as I just now said that if you just doing to take this number as it is, but look at the meaning of this number 197 db and 4 gigahertz downlink, you remember the path loss calculation that is in terms of lambda and the distance the roughly the distance will be more than 36000 kilometer here and we can calculate that.

Therefore, we generally get 197 db at the downlink and the receive g by t of 30 db k again 30 db per k receive g by t is a larger station g is very high that is why you got 30. We have seen similar numbers earlier in FDME examples, e b by n naught required for the required b e r is 8.5 db here. I did not specify the BER for a particular BER, it is 8.5

db depends on what type of modulation is being used and they there is a link margin in the downlink 5 db link margin is provided.

Now, let us go back to the calculation c by n naught is e b by n naught plus r that is transmission bit rate in db are multiplied by r n n ratio its c by n naught is in ratio and now c by n naught is equal to EIRP from the satellite g by t of the station receive station minus the losses downlink loss and miscellaneous losses anything and then the constant and if there is a link margin, link margin also has to be added then the transmission bit rate EIRP c by n naught is replaced by e b by n naught and r e b by it is taken in the right hand side.

So, that transmission bit rate is equal to EIRP plus g by t minus losses minus k and minus e b by n naught these are all in db and put this numbers. So, the transmission bit rate comes out to be 70.6 db hertz. You remember the k number that was minus 228.6 So, here minus minus becomes plus all of the numbers are already available in the problem. So, r comes out to be 70.6 db hertz and convert into ratio you will get 11.48 mega bits per second. So, we have been asked to find out transmission capacity based on transmission rate based on EIRP and g by t and we have calculated based on c by n naught.

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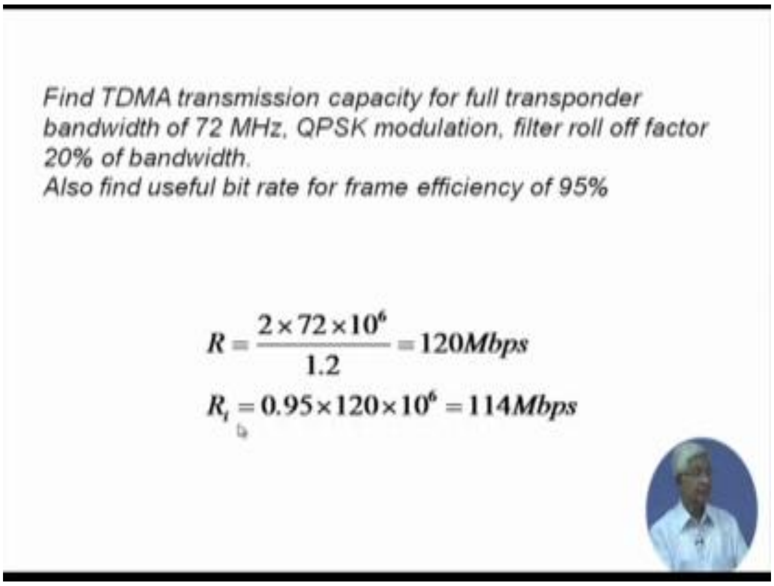

Let us take one more example which is to find the TDMA transmission rate, a transmission capacity for a full transponder bandwidth these bandwidth example for a full transponder bandwidth of 72 mega hertz QPSK modulation filter roll off factor 20 percent of the bandwidth and useful find the useful bit rate for frame efficiency of 95 percent, just look at this number 72 mega hertz normally, we are always talk about 36 mega hertz transponder these much larger transponder. Some cases normally most of the satellites they use 36 mega hertz, but in some cases where larger bandwidth or larger bit rate communications is going on then intense at some of the satellite support such a such wide band width transponder 72 mega hertz.

Now, here the calculation is straight forward that is spectral efficiency is 2 because its QPSK modulation that is 2 bits per hertz and then 72 mega hertz and filter roll of is one point that is point two and one plus r is 1.2, you get transmission rate of 120 mega bits per second and frame efficiency is given 95 percent. So, you can find out what is the information bit rate or useful bit rate that is 114 mega bits per second a there is one more that is a find the number of voice channels.

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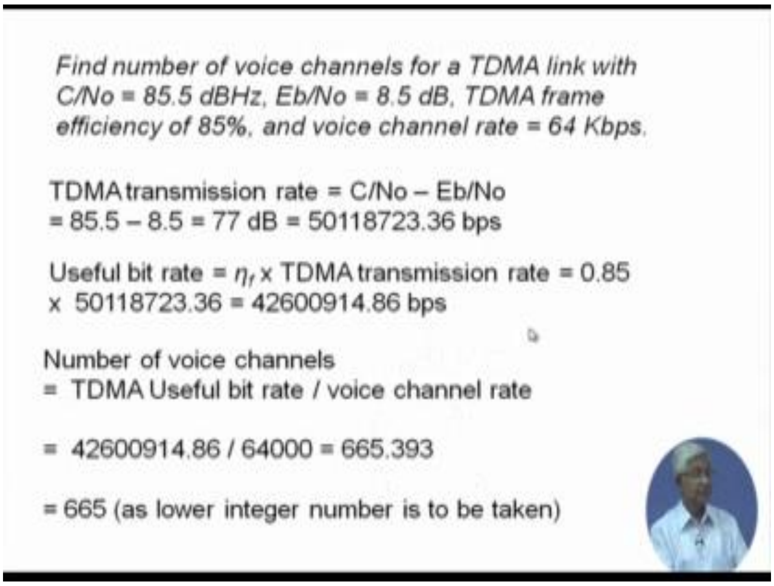

In this case trying to calculate the capacity in terms of voice channel and we are calculate only the useful bit rates for a TDMA link with c by n naught 85.5 db hertz e b by n naught of 85.5 db and TDMA frame efficiency is 85 percent quite poor, normally its more than 90 percent and voice channel rate is 64 kilo bits per second. So, that TDMA transmission rate, transmission bit rate c by n naught minus e b by n naught and that becomes 77 db which is a. So, many bits per second it is a more than 50 mega bits per second and the useful bit rate since the efficiency is given frame efficiency into TDMA transmission rate.

So, you multiply these numbers and you get the useful bit rates of 42 mega bits per second, here its bit more than 50 mega bits per second is more than 42 mega bits per second because of the frame efficiency is quite low 85 percent and this number is quite a large difference. Now, we find out the number of voice channel, voice channel rate is 64 kilometer since we have got the useful bit rate these divided by the voice channel rate that is useful bit rate by voice channel rate you get the number of voice channel divide see you get 665.393 as the number and again we have to take the lower number as integer that is 665, you cannot take the next higher integer now we have discuss this logic earlier. So, this is how some of the small quick examples are given that is simple calculation, but you have to know how to approach to this.

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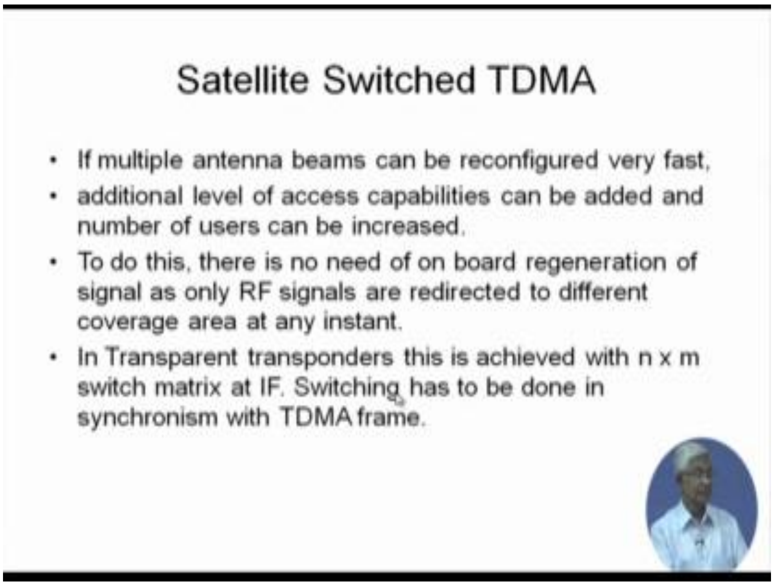

There is one more advance level TDMA being used for very, very high a lay high traffic network and a quite advanced level of switch are required is called satellite switch TDMA, its use inters satellite of inter satellites if the multiple antenna beams it is multiple antenna beams and each antenna beam is covering different regions and if those switching of the antenna beam can be done very fast of the megabits and hundreds of megabits is quite fast switching when additional level of access capabilities can be added and the number of users can be enhanced or increased because more number of users can be supported because your switching between beams to do this there is no need of on board regeneration. Here, your signal is a only RF signal are redirected from beam to another beam to one coverage area to another coverage area at any instant of time.

Since they are being switched in terms of time a. So, the RF signal or at the bro beam back at if level and switch that is that is enough. So, switch at the RF or IF level is enough it do not have to come down to a regenerating the bits and then redirecting that is demodulation and a modulation a is not required in transparent. So, therefore, on boot transponders are not using this case a transparent transponder beam pack transponders it can be achieved with a n by m matrix at RF or at IF, the switching has to be done in synchronism of TDMA frame because each switch will hold for a sometime which is synchronism to TDMA frame.

So, the switch has to be properly synchronism this is the tough thing one switch has to be very fast, fast switching has possible using a micro switches, but then it has to be synchronized with TDMA frame that is the a interesting issue anyway we have going to second details, we just talking about the systems.

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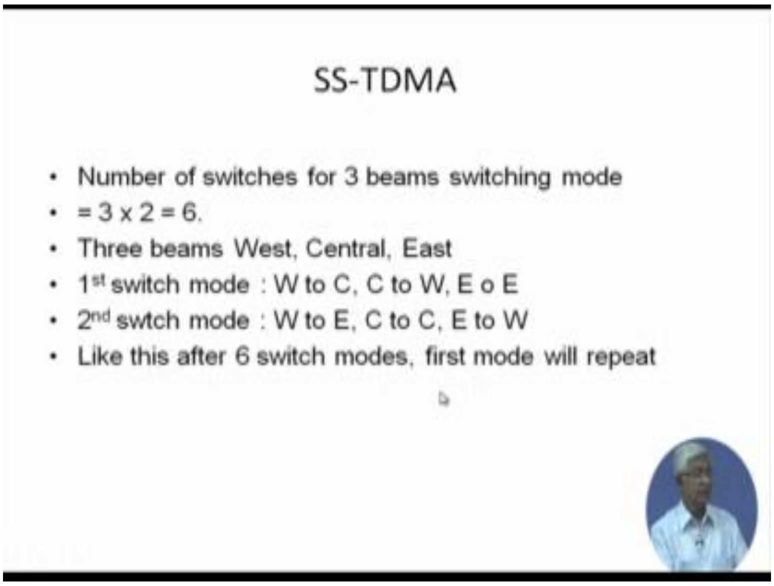

So, let us see the SS-TDMA there is a quick example. I am trying to give that is number of switches let us say there are three beams to be switched. So, how many number of switches that is 3 into 2 that is a 6 number of switches are required that is west, central and east say let us say India, India is covered with three beams west, central and east. I assumed a northern and southern are covered a partially by west central and east beams three beams scenario for easy example.

So, in the first switch mode a configuration where switch will be connecting to west beam to central beam a central beam to west beam see its taking a full duplex and east beam to east beam and the full duplex this in a second mode west beam to east beam central to central east to east. So, like that different combination you can draw the picture you can see different combinations are there I will come back to the first switch mode.

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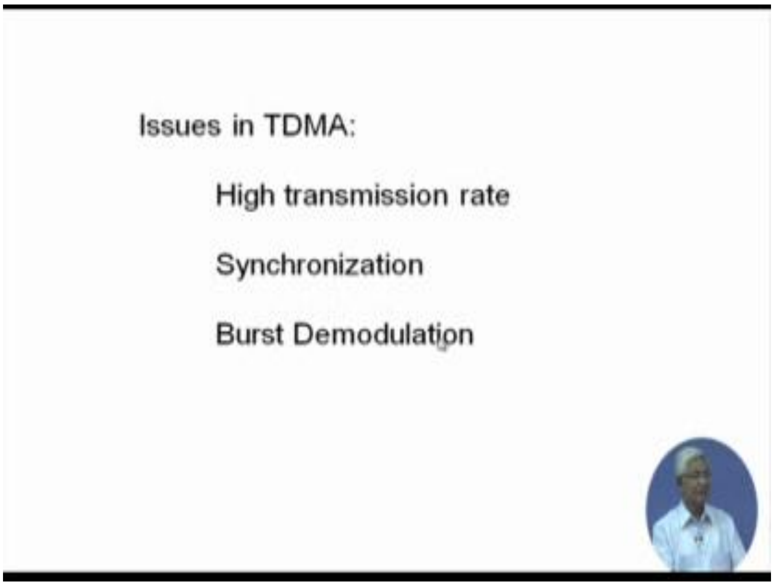

So, like that 6 switching modes will be required and then it will come to the first mode and it will repeat on that. So, all this quick discussion on TDMA, certain issues came up that is it needs high transmission rate, though there is big advantage of TDMA. At the beginning, we stated and it is clear that at time one career is coming up and occupying the a full resource taking the full resourcing in terms of bandwidth and power and even if the transponder is non-linear you can operate at the situation point. So, you can extract maximum power from the transponder.

So, EIRP situation will be operating therefore, you can covered to the largest possible extent or g by t of the user can be reduced because your transmission EIRP is high either coverage can be larger or g by t can be reduced that is biggest advantage of TDMA. But the price you pay for that is that whatever continuous data is coming you have to compares them and transmit, so that within one bit time you should able to complete the all transmission and come back to the first user, that you can take up the next bit. So, therefore, it has to be compressed and that means, high transmission rate meaning of high transmission rate is the r is high.

Therefore, your c will become high requirement of c by n naught will be higher. So, obviously, will be higher or g by t as to be higher the second issue this high for transmission. So, second issue is the synchronization the all stations there may be geographically and the clock of them which is running between them is to be properly synchronized in terms of burst clock at the satellite, they should reach in their burst allotted burst time properly. So, they you need some sought reference station who supplies the frame timing and obviously, from the frame timing repetition of the frame and knowing the size of the burst you can extract the burst timing.

So, burst time clock has to be extracted by a common station which will be transmitting this. So, common stations clock will be synchronized by all, the receiver will be synchronize all the receiver clocks, so that way the receiver clocks, burst clock I should say burst clock gets synchronized its different than your bits clock are frequency that is different this a burst clock will be synchronized and we say that this is of course, you have to pay for reference station and since one different station if we feels hope whole network fails.

So, therefore, you need two reference stations, first goes up and not only that you have to send the reference burst which will be part of the TDMA frame. So, that is overhead of TDMA frame. So, efficiency is your loosing in terms of time and the reference frame time, so that is the synchronization loss and the other more difficult which is not part of these course is the demodulation has to be bursty demodulator that means, there are a guard time when there is no transmission, a receiver is receiving some blank time that is no transmission and certainly a burst appears which has all the frequency clocks beats etcetera.

So, your demodulator has to quick lock in to it that lock in time is very important and for that sequence which is given that is carry at a query time is given to required career bit timing, recovery time is given to require recover the bit clock. So, the burst demodulator is also another new additional note into the total system. So, these are the couple of issues in TDMA. So, we stop discussion on the TDMA here and will continue our multiple access discussion in the next period.

Thank you.