Indian Institute of Technology Kanpur

National Programme on Technology Enhanced Learning (NPTEL)

Course Title
Digital Switching

Lecture – 07

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Okay, so now we will actually look into how to differentiate between probability of call loss and probability of switch being in blocked state these are two different things. And the ways of actually estimating these two in the switches.

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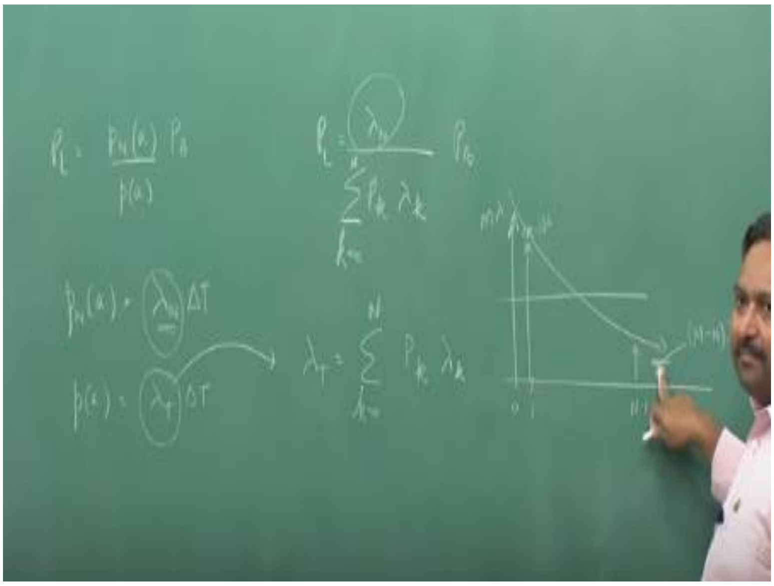

So if there is a switch and there is a call which arrives and when the call arrives it finds that switch is in the blocked state. Now call will not be able to go through, so the probability that your call will not go through is known as call loss because call has been lost. So if you make 1 million calls out of which 10,000 calls you found that switch was in block the state at that point of time call cannot go through.

So that is a call loss or we call it a call congestion okay. Secondly even if the call comes or call does not come does not matter you look whether switch in which states, if switch is in the blocked state even if call does not come it does not matter if there is no call coming in switch is in blocked state there is no loss, there is no call is being lost actually in that case. So the second possibility is we call it a, that switch is in the blocked state, so that we callas a time congestion.

So now question is how these two are going to be related, one thing which is sure that then switch is in the blocked state that is basically fraction of you are actually technically observing the time when for example, I estimated in my previous lecture probability of switch being in blocked state what does that mean, you observe the switch for a long time say a few years and you find out fraction of time for which switch was in that state which is the blocked state.

So ratio of that particular time divided by the total observed time will give you the time congestion that is why the time congestion word is being used, but the probability that your switch is in blocked state does not mean call is blocked, only when the call will arrive then only the blocking will happen for the calls. So call congestion usually will be lower value having a lower value then the time congestion.

So that I think intuitively is clear, but let us build up a relationship between these two. So if we define that probability that of call arrival is defined as PA probability that a call is arriving and I also define $P_N(a)$ this is the conditional probability that call arrives when switch was in Blocked state okay so I define call congestion as probability of call loss P_L I define the time congestion as P_B being in the blocked state.

So now I actually have four variables and these need to be related to each other, remember this is a conditional probability conditional probability when switch was in a blocked state and a call arrives, so this call is going to be lost and when it probability that a call arrives this is the probability that the call will be loosed okay condition on that call arrives actually so P x L into P(a) this gives the number of calls which will be getting lost over time okay remember when I am saying when a call arrives and it finds switches in blocking state that is a conditional probability.

That is a call congestion and this will be on an average number of calls lost over long time if my arrival rate is high more number of calls will be lost arrival rate is lower less will be lost over time okay, so this should be equal to because both are going to lead to the same thing this will lead to nothing but probability that is a conditional probability that call will arrive and switches in block the state and probability that you will be in block the state is P_B this technically is a Base rule.

Okay what I am saying is that they are event and B switches in block the state and calls arrive so this P(A,B) be that both things I happen is P (A|B) so probability that switches in block B state probability that call arrives condition none switches in blocked state okay so this represents right side it is also possible to write P(B| A) the call arrives and when the call is arriving on that condition that is which was in block the state at that point of time, is a technically basil which I have written here and this is what I am going to use to estimate the relationship between PL and PB. So I can now write and we will do it for m/m composites which only.

I can right now PL(S) and of course now very important observation which you can make, probability of call loss and probability of blocking will be almost same, if my call arrivals probabilities are independent of switch state if they are independent of switches state this and this has to be exactly same and they will cancel both of them will be called loss probability or call congestion and time condition will be same, okay.

But that actually does not happen this is going to be a true statement if my n is comparatively much smaller than m, m is very large. So the arrival probabilities does not get impacted by the change in switch state they will be almost same and both of them will be similar but when m and n are not n is not much smaller not much smaller than m then this is a PL = PB cannot be taken we have to actually estimate a relationship between that.

So what is PN or K let me see how we can find out, so when the switch is in state A then what is the arrival rate, I have to find out that and the small elemental time δT so I can put some δT here. So that is a probability of arrival when you are in state n in small time δT, probability of arrival this will be the average value of the arrival rate, with every state change there is going to be different arrival date.

Remember in the previous lecture when you were in state zero, arrival rate was Mλ when you are in state one it was M -1λ and so on, I make an estimate average estimate depending on that probability of the events and I will get this average value in totality, so that is what is going to be the call arrival rate on an average basis which is independent of state states actually have been ironed out by taking what we call a proud mystic average.

So in this case λT now can be estimated as because I am taking a probabilistic average i can write that you I am in probability of being in state k & state k what is the probability of what is the arrival rate so I am taking a probabilistic average am I take all states goes from k to n so that will be PA.

So I can now solve it so i have already remember I am taking ratio δT is will cancel these are immaterial so P_L will be λ n divided by ∑ of I have to write down this thing okay so this is what will be the relation now λT there I will rate and let the end they will be related λn will always be smaller than λT okay this of course you can make a drawing so when you were in state 0 mλ was the arrival rate as you keep on moving by state it becomes a - 1 number and you will keep on reducing at this point it will be M -n λ.

And this monotonically decreasing as your state's as you are actually going to from 0 to n^{th} state so the average value will be somewhere here and there the smallest value so this top one is the smallest value so this has to be smaller than the average and of course with this you configure out that this is going to be smaller than this so P_L is always going to be less than P_B this was also the intuitively the result which I explained in the beginning the call loss probability will be smaller than the switch being in the block state that probability from okay it will be smaller than that so let us solve it so λn essentially will be M -n so I am just going to put everything in this expression.

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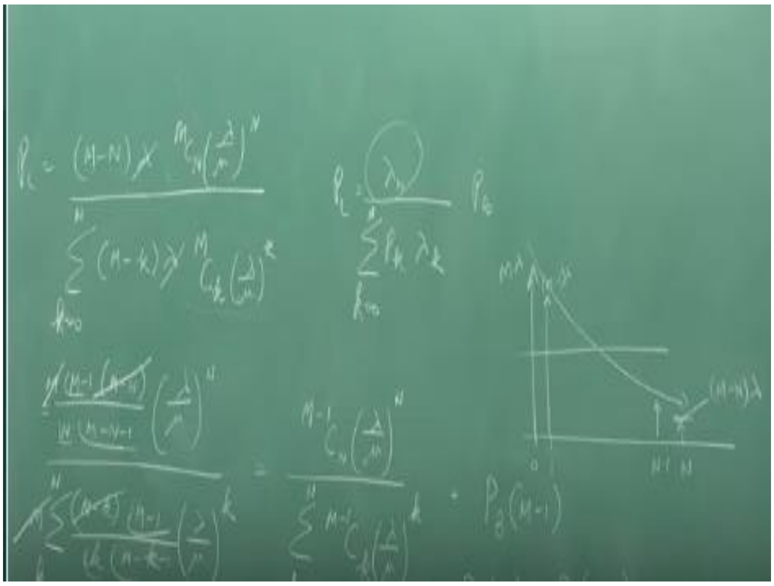

And we will solve it and this expression will be that is your λk probability that you are in that state I am going to use the Tang set probity distribution will be given by MC k λ/μ^k /again there has to be a summation okay so I can also now to place this PB in the blocking probability x in fact I have to put again now this is independent of k this and these two are same so I can cancel them actually once I cancel I will get I can actually raise it now from here okay.

So this λ will cancel with this one this M factorial by n factorial m - n m factorial by K factorial so I can cancel and I can make it - 1 so and I can make m here and take 1 m here out i can do the similar exercise here this am will cancel and i will have M -1 C n λ by $\mu^n \sum$ k goes from 0 to n, m - 1 CK and of course you can see this is the same expression as the probability of being in blocked state for M by n composites which except now instead of m I am going to have M -1 here.

So i can write this thing as nothing but probability of blocking but for m - 1 inputs instead of using M by n if I use M -1 by n composites which the probability of it being in block the state is equal to probability of call loss for M by n switch so which actually implies that p l of m should be equal to PB (M -1) that is how your call congestion and time congestions will be related to each other.

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