Indian Institute of Technology Kanpur

National Programme on Technology Enhanced Learning (NPTEL)

Course Title
Digital Switching

Lecture – 24

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In the earlier video we actually we have looked at the Cantor network and then came off with the computational cross point complexity for a strict in non blocking switch how much when you actually we can achieve and thereafter then we moved over to white sense non blocking switch configuration we have taken a switch we are actually made the complete state diagram we in fact also do exercise on how to actually find out the non equivalent states and what do you mean by equivalent the states we actually understood that and using those non equivalent states we had build n.

A state diagram and then we also understood that if we actually avoid transition through certain possible state transitions then I will never ever be moving into the blocked state and switch will always remaining strictly non blocking so but this requires and operational we actually in fact understood that and that also 4/4 simple switch and what we did was instead of actually having three stages of two switches each we had four stages in this case so this all when we are talking about we were actually trying to look into a cross connection technically so looking into.

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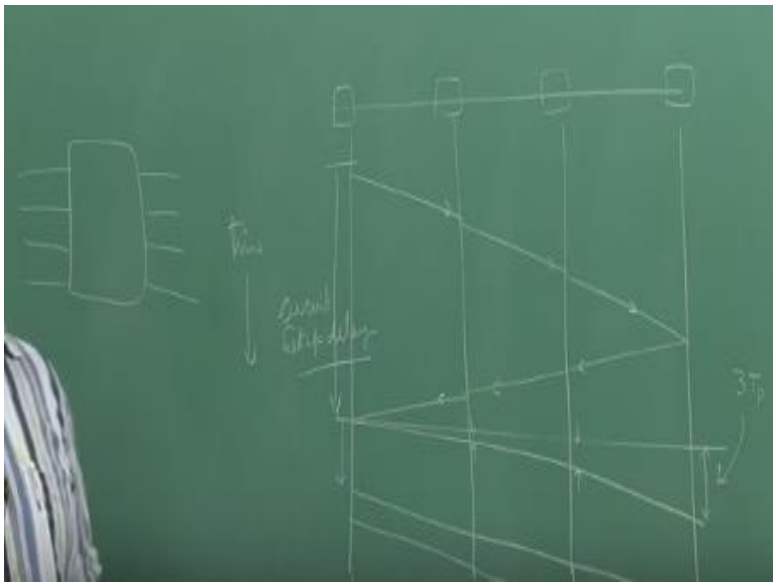

The inputs and outputs and we are trying to create the paths that is what we were doing and whenever the we are trying to see if a free input path input pot is their output port is whether I can setup the path or not but as actually we are progressed we have slowly have been move to something very popularly known as voice over IP so we use internet packets or IP packets for transporting the real time traffic okay so now I am actually moving over to something what we called packet switching so.

So far what we had done was all the basics which actually can be used for circuit switching has been used for circuit string for a long time now we will be looking into something called packet switching systems so but what is this circuit switching in packets switching so let me explain why are the packet string so look creative now in fact the concept of packet switching was known long, long time back in fact internet was working using packets string long time back but there was no why is being moving over that system it is only now that y is and live video streams actually have been moving over a internet network.

So why that is actually happening so the reason for this before to understand this we into understand what are the delay components in a circuit switching system and what are the delay components in a packet switching system so if you look at circuit so I am taking a very simple example that we have four switches and then formation has to go from first to the forth so there are three option in this case and this vertical lines will indicate the time so as I moving down my time is increasing okay, so normally when I am talking about the circuit switching scenario you will we will first fall make a request to setup the path all the way from source should estimation so request will be going from switch one to the switch two.

And they will configure the path then this will also look for resources it will also configure the path this will also configure the path one the path is done all through then the conformation has to come back so normally a conformation will be coming back and once the conformation here then I can actually start transmitting so whatever I am actually gathering as a information for example if it is a micro phone on this machine and it is capturing in audio so everyone 25 micro sec in one octane will be generated and that octane can simply be pushed through.

So the path is already setup it is like a pipe which has been created just be you pushing in the byte the byte will go all the way they are other side and it will come out routine action actually has been done here itself only once path setup is being conformed and now you start doing transaction you start doing transaction byte by byte as you are generating more and bytes you are transmitting information is reaching here and as you are receiving the information you applying it back so only till a which happens from source destination in this cases this now this technically is whatever is a propagation delay in the first off then there is a propagation in the second up get saturate then propagation in the third off so this delay is propagation delay three times of that which is going to happen in this scenario.

And information is available whenever you want to disengage the circuit that time either from this side you will tell and the disengagement will happen are from the side this engagement message actually can come up through the switches either of these this or this can happen and connection can dismantled so there is circuit setup delay which is involved in between before you transect now what happens in a packets switching system now of course before I move to

packet switching what is the problem here, so you can actually list down the problem so first problem is, your circuit set up delay is pretty high.

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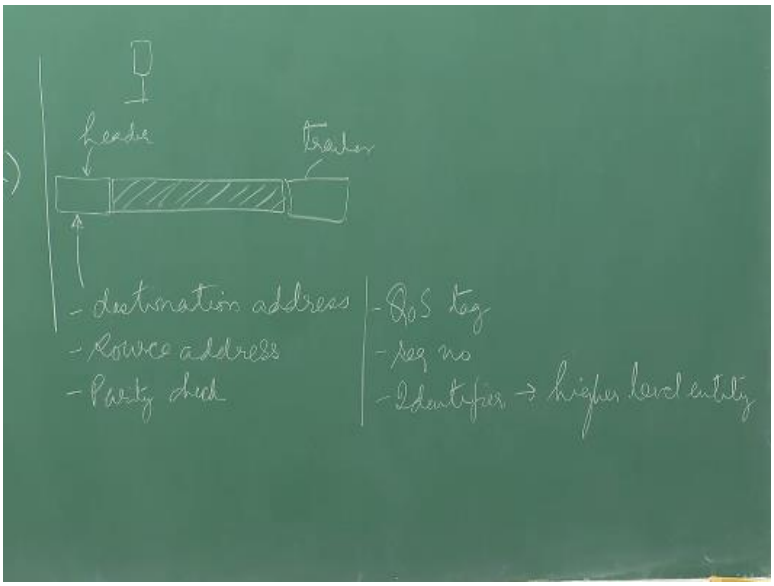

Okay so once you set up a circuit then only you can transfer the information, second thing which happens when you actually have set up a circuit after this even if I am not speaking my bandwidth is going to preserved for me that whole path is reserved for me so bandwidth will not be used if I am not communicating and typically in voice communication when two people are communicating one of them will be listening other one will be speaking and this roles will keep on changing actually, okay.

So 50% of the bandwidth actually goes waste immediately there itself and then people will have possess in-between when they are speaking so they will also be losing bandwidth at that point off time so very small actually will be utilized, so it is very inefficient system in that sense, okay. And there is another problem because if the link actually fails then what will happen, the whole path is now gone it has to be reset again before you can transmit the data it has to be re-created again, okay.

So resilience actually is missing this resilience what build in internet when packet network actually where implemented but they were not for real time traffic but the resilience is because I am not setting up any path what I am doing is I am trying to create a small information packet and this basically here let me complete this stuff, inefficient use so BW stands for bandwidth and of course recovery does take a lot of time.

So when number of hops are very large the probability of failure in any one of the link actually becomes pretty high and then recovery will take lot of time so we need to move to something called packet switching which is different mode of communication the idea here is at the source as I am speaking it with collect the information after the information is collected it will actually put all the information.

Chunk of bites so there has to be proper encoding then I will attach an header I can also optionally attach a trailer and this is what I have formed up packet actually, okay. So packet this is the first bit which will be transmitted and so on and this will be a last bit which will be transmitted, okay. So in this case the header I had not set up the packet path before head, so how the packet will know that we have to go?

Here the path is already been set up so when I am sending chunk of bites I am not touching any information they just pass through it is like being a pipeline being created from source to destination, in this case there is no circuit set up being done, so this header will actually contain additional information, so there I was only sending the information path with probably may be my voice samples.

But here I am also sending something extra every after every collection of chunk of these bites so of this is what is known as packet and this header normally will contain a destination address this will contain source address, there may be a parity check, parity check normally is done in the trailer but it can be there also in the header, or check sum. We can actually have many other fields IP headers actually do provide them.

Quality of service tag so different packets can be treated differently in the network whenever there are problems or whenever the priority has to be given so we have quality of service filed which can be there we do provide sequence number so the packets can be played back in sequence, okay. So you cannot have out of sequence stuff and of course with may have an identifier.

Which says that when the packet is received so which particular program or software the packets or the chunk of bites have been passed on to, so they can be multiple, so internet protocol typically has this particular filed which says which protocol it has to be handed over to, okay. So identifier for higher level entity, so once you have a packet which has to be done and this is typically which will be the format if I draw the same thing let me do it whether different color how it will look like so this circuit set up is gone.

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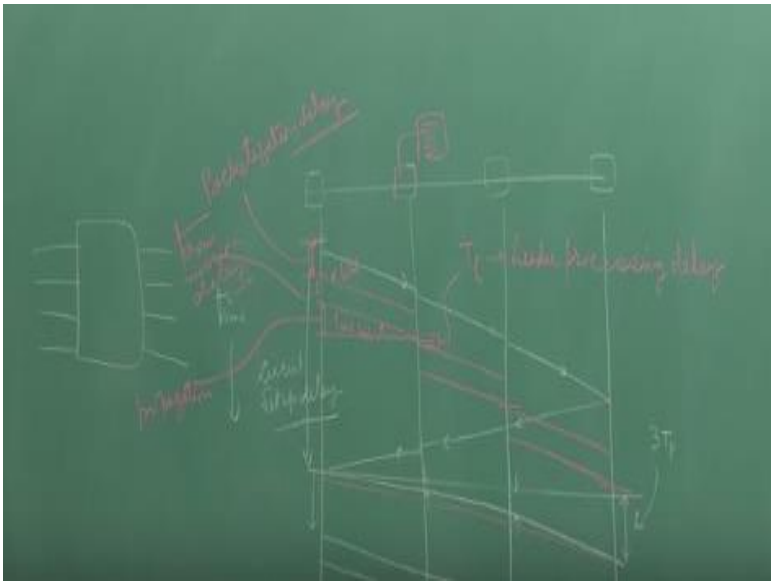

Now I will actually first of all it start collecting my voice samples. Once have sufficient amount of data collected okay then my pack can actually be frame so now I will actually create and header create a trailer and I can start transporting the packet so this is the first bit which is gone and this is the last bit which has gone and packet has been completely received at this note at this

point of this time now this delay that when the packet has being formed is known as packet can delay it. Okay.

And this time is known as transmission delay okay and then we will have as usual the time which is required this a proposition delay so this of course you cannot do much this is the material this is the system property as you move you have take time roughly it will speed of light in divided by 1.5 in case of optical fiber so you will be roughly going by 3/1.5 which is above 2×10^8 meter per second that will be the speed.

So in fact this time proposition time will be very, very small in most of the systems so but the problem here is next I cannot actually transmit by this as it is remember with the bye it was coming by ever been translate it was like a pipe here you cannot do it you have to receive the complete packet first analyze if the parity bit parity is okay not okay there is a packet has been corrupted or not if it is corrupted you have to drop it actually.

If it is not and everything has been checked then we will look in to the desk adder find out the destination address and it will maintain it is all local routing table it will search in to the routing table find out to which outgoing line it has to go has only show in one but this might be connected to some other notes also so it is to figure out where it has to go.

Earlier also when the circuit was being set of you are doing this but it was done only during circuit set up face okay so we need to transmit from here all the way again the whole packet so the packet will be completely received here again so I will have the small amount of delay here which I will call TH it is a adder processing delay.

So we will actually have the complete packet will be received here then it will be transmitted finally packet is transmitted here so whatever is the voice chunks by it switch have come in they have to put in a buffer mean while another packet will be come will be coming and that packet will put in the buffer and the play back will be done okay so the everyone 25 micro second 1 of data is to be played back.

If you do not have buy it single buffer you have be a just silent at that point of time or you skip that much of the voice but if you are getting to many chunks you have to keep on buffering them you cannot do much okay so the packet will be reaching here, now what will be the delay when you will be using circuit switching and package switching let us look at this, for circuit switching the delay will be so if there are in this case there three hops.

So t delay in this case if it there n hops will be nothing but if TP is a propagation delay only in one hope so this actually delay here will be 3 x TP which I have written here every time this it will be n x 2p that is a only delay which will be there in circuit switching system while if you look in to the packet switching which I will draw with the different color so in this case you will have packetization delay TP which okay let me because this TP.

We will confuse I am going to propagation TPR propagation delay okay so I am just changing the symbol this is packetization delay I have written there so one packet plus the transmission delay since there n times the packet will be transmitted plus the adder processing delay and times plus n times plus n times T_{pr}. The amount of delay which we will actually have extra, in case of a circuit switching system, in a packet switching system, this is the extra delay, which will be increasing, so if you want to actually have a real time voice transport or real time video transport, this actually should be as less as possible.

In the earlier days, in internet was actually, packet switch based, but the bit rates were used in the system, where much smaller, we were not having the optical fiber at that point of time. So the consequence transmission was pretty large, our processes, our routers were not very fast, so header processing which means you're going to search through this table side and then make an action and set up your switch.

This particular things were large, so for very large numbers, you will be not able to transport, your voice or any real time traffic, so for real time traffic, circuit switching was the case, in fact that is the reason for longtime, we actually had a separate telephonic network which was circuit switched and a separate internet network packet switched. But of course the benefit has increased, so my transmission time in number of bits, in a packet or b and my bi rate is r.

The amount of time required id B/R, if my R is very large, which now we actually operated Giga bit per second, we operate 10 Gbps and 40 Gbps higher, so this time becomes the extremely small. So this magnitude of water is actually has gone down and because of this, this time has become very small, we actually have started at some point of time, started using very short packets, we call them as synchronous transform mode, atm packets.

They were used to be 53 bytes frames actually, in that case internet protocol or IP protocol does not use short length packages, actually does allow variable length ones and the length can be very, very large. So if you use short length packages, packetizing delay will be small, remember if I have to even collect 10 bytes, I have to wait 10 into 125 micro seconds, before I get 10 y samples to make a pay load

My switching technology actually has been improving, I have better processes and better memories, so I can do much faster header processing, in fact this still remains as challenge, so that's the reason, why now we have been actually trying to move, something what we call optical bus switching, where many multiple packets are been put together and then there is only one header.

So you have to process only one header for large number of packets, instead of processing large number of headers, so of course this has gone down and now we can have voice over IP because of this, so now it's because of high bandwidth processing capacity, that we are able to actually have this technique. In fact even with packet switching, in for a real time traffic there was a problem.

I was not able to process large number of packets, so people came up with multiple protocol switching, so there multiple packets, being identified, this technically, something called virtual circuit switching, so in fact when I look when the packet comes to me, I will actually not look into the computer, out in table, I will set up a virtual path, I will actually create this tag will be coming, this packet has to move, and then this tag has to be modified to this tag.

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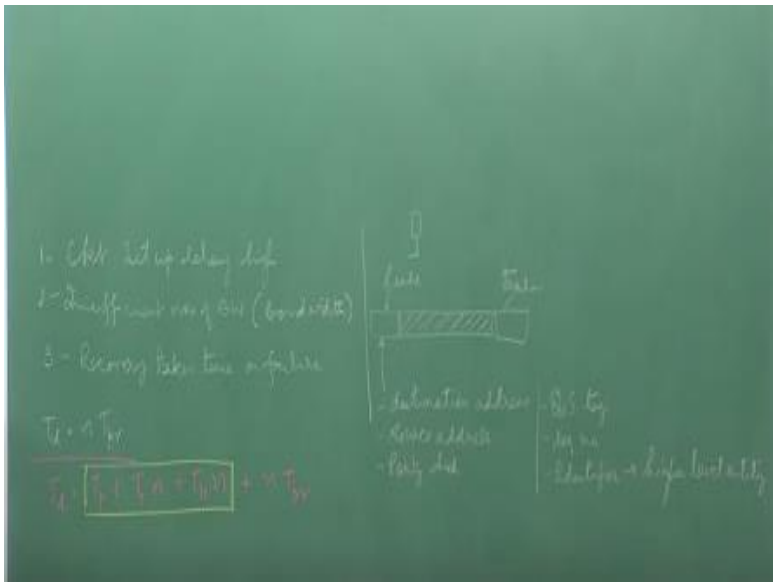

So I will only maintain what are the flows which are going, but there always going in small chunks, which we call them frames or packets. So multi protocol label switching, essentially improves, my performance of the switches, so this is the reason why packet switching is much more lucrative, let see how we can actually build this. So one of the most common things all of you will figure it out, all of you will say.

Let's take a PC four multiple cards inside that, and let the packets come from one card and the software which will do the analysis and it can be pushed out to another card. Now this has a limitation, in fact we use to call this as outer area earlier.

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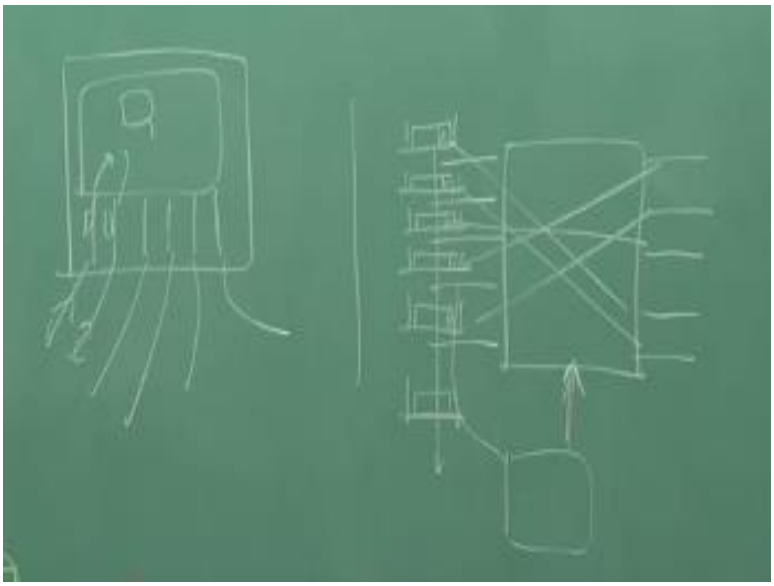

So you have PC which has a processor or a board, with lot of interface cards, and these interface cards are been connected to the outside world, so packets can come in and go out. So these can be terminate interface cards or something else, but this Intel processor maintain the outing table, there is a Linux kernel or whatever it is, and every packet which comes in has to be analyzed and then pushed out and these are input buffers, which have been an output buffer has been maintained across this, normally this kind of routers will perform very poorly, so if you take a PC you can put multiple cards and put drivers and try to build up a outlets okay for lab, for a small load, but not for very high performance this actually not going to work we have to change the design.

So how we can actually build a design? So that's the question now, so now remember I had talked about cross bar can I use a cross bar for doing this job. But you will again ask the question that IP packets are variable length packets how this can be done? So let's relax this condition that all packets I will be switching of fixed length.

How IP packets will switched will come to that ,okay there has to be way for even handling that ,so if that is possible I can actually take a cross bar and I have inputs and I have a slots this slots

are synchronized at all the inputs ,and i have the out puts and then what I can happen is the packets will be coming in this slot these are fixed length packets ,and these packets i can actually tap.

And for when these packets will be coming based on that I can decide what will be cross bar state .which packets should be which outgoing port and, I will decide I was set up a circuit through this cross bar so that these packets will go to specific designated ports wherever they want to go, okay, and where these packets are out for the next plot which will be coming. I will again set up this configuration, so every slot I am going to change my cross bar.

So it is not like y circuit for the whole voice duration the circuit has been set up, so every slot I am actually changing it, so I will be able to do now packet switching and this will be much faster then what you will do with the router, which is based on the PC with multiple interface currents, okay.

So idea is that you now look in to that ideas of all these packets these has to be analyzed by somebody a map has to be decided how the cross bar going to operate it has to actually exact the control that row and column control, first that is done then by the time the packet will be coming up, packet will be passing out to the output and then the next set of packets will be coming in.

Again the same procedure you will to keep on doing it, now one important observation which you can see is that all the headers which are coming I should be analyzing all the headers should decide the connection in map, I need to finish all the hydro analysis within one slot because then the next slot again same number of headers will be coming, so numbers of headers coming per slot will be equal to number of incoming ports.

So this processor ultimately will now lead to limitation of this switch performance, because now I have to process n number of headers per slot, so you cannot actually increase this size literally, but of course we can actually have we have ways by which we can use multiple small cross bars and then create a interconnection network for packet switching.

So it's like the way we did in circuit switching we had a initially a small cross bar then we move to three stage inter connection network same we can do with the packet switching to take to elevate from the problem of or the bottle neck of this part of the processor, actually take care of that.

So now typically what will happen is there will be something called network there is has to be interface board on the cross bar so that when the packet comes in the header has to be tapped, header has to be then communicated should be made available to the processor ,packet has to be held there so that there is sufficient time in which the processing is done ,cross connection is set up and then only packet should be pushed into the switch .So we will be actually having the interface board here .

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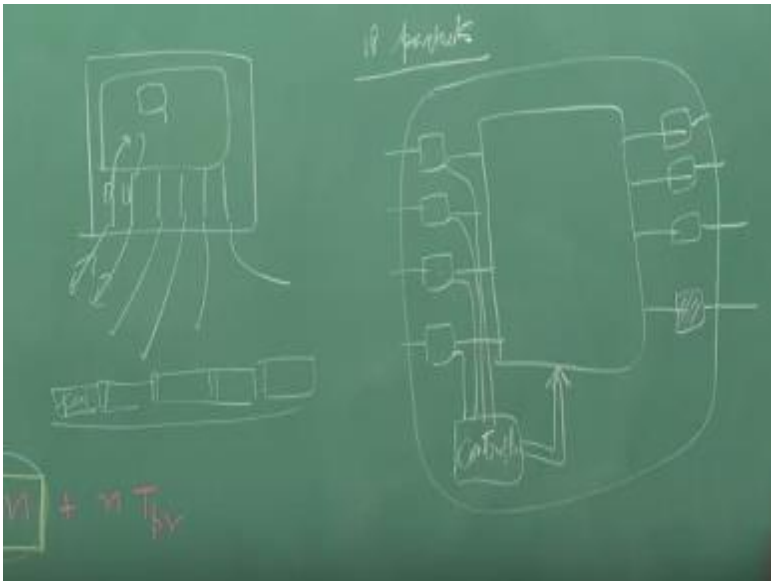

Now these interface boards also has another important function, so that i can handle the variable length packets i will come to that so I am just drawing the four by four these are interface boards this is a cross bar, and I will actually have one control line through which I will get all header information, controller will get and then it will exact row column and control, on this cross bar set up the things.

So in this case the headers will retrieved from here and they will be analyzed here and packets will be stored for one slot so that by the time these headers are been analyzed and switch has been set up and then the packets will be pushed out next packet will be coming in their address will be analyzed, it will again take one full slot. And next group of packets will be again stored for one slot.

So at least one slot delay will always be there in this so one slot plus propagation delay in this case will be present in this cross bar, and this will be the controller which will be the ultimate limiting factor now for the switch performance, now thus i have asked the question if I am going to use IP packets how I will handle them? Okay so what i will do is I will also put up an interface board here so whenever a large packet will be coming a variable length packet this packets will be sliced into a lot of smaller fragments we called them frames, so a bigger packet will come I will slice them into frames actually, so may be a frame where some of them will be bytes will be just padded so that all of them are fixed line frames.

So this is what it is going to do it is going to put a each one of these frames it will add some bytes which will say sequence number which is the last guy so they all belong to the same packet all kind of identifier, and the these fixed length frame that's what will be switched out, so all these frames for belonging to same variable length packet will be passed in to same interface board.

So it will this outgoing interface board will identify that all the frames which has been received belong to same packet it will just assemble back the whole IP packet hence and it further, so when you are actually seeing this box you will never realize that inside this cross bar actually switching fixed length frames ,it's not switching by variable length packets ,so variable length packets have been converted to fixed length frames by the end of interface boards, into the input side from back from those fixed length framed to the various length packets at the output side ,Okay, so this is how the variable length packets actually can be handled.

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