Information Security 3
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Module 47
Network core - Definition

In this module we will actually try to understand in a little bit more detail of how the network core actually works and what kind of concepts of their which we will need to understand to really appreciate the complexity that goes into the network core.

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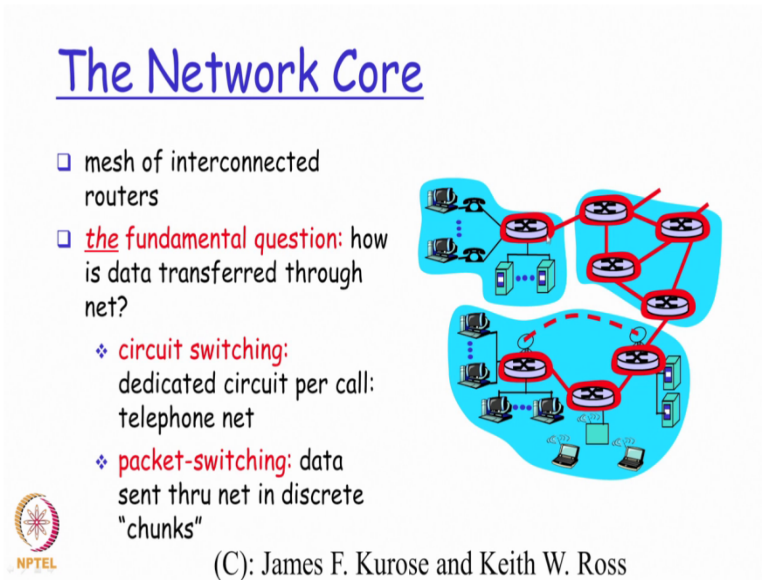

So the network core is basically a sort of a interconnected routers a mesh of interconnected routers and the as we were saying the network core is going to be consisting of routers which as basically the core responsibility of forwarding the packets from a source to a destination and that's basically the core functional behavior of why we typically set up a a network right. So how is this data going to be getting transferred through the entire network, so you have something called as a circuit switching and you have something called as a packet switching. Now the circuit switching is something very similar to a normal phone call that we would make so historically if you look for example in your normal landline call, so you lift up the handset you dial the number to whom you want to talk to and what really happens is over the different telephone exchangers there is a sort of a dedicated circuit that is actually set up once the dedicated circuit is set up, you would sort of hear the ringtone and then you actually start talking when the other person is lifting up the phone.

Now what do we mean when we say that there is a dead dedicated circuit that is actually getting set up, now what this means is that in each of the exchangers or each of the switches that it that it requires to go through from your landline phone to the other party's landline phone certain resources like for example from understanding point of view let's take it something as a memory resource and likewise other resources are all sort of reserved right now for this particular call that has been set up right, now when I make that call and I just try to keep the phone down not on the base set but just outside the base set irrespective of whether I am talking, only when I am talking I am going to be really having some data to be transmitted across to the other side so irrespective of whether I am talking or not talking those resources that has actually been allocated for in each of those switches and in the exchangers they are like sort of dedicated for this particular call that was originated right, so that is basically what is refer to as a circuit switching.

So when I basically say that I I have a network that is circuit switch I basically say that before I start transferring the data, I am going to identify the exact path that I am going to take to reach the destination so in each of the devices on the path I am going to have certain resources sort of logged for this particular call to be used and those resources will be blogged in each of those switches till I go and disconnect the call right. So that is essentially what circuit switching is all about, on the other hand what packet switching is all about is that there is no explicit reservation that is done in the path from the source to the destination so whatever the the the route to the packet has to taken from a source to the destination mission there is no explicit reservation that is done but it always takes the path that is available at that instant of time, right. So here because of the fact that there is no explicit reservation that is done before the packets are actually starting to get transferred you have a better way of utilization of your physical resources rather than a sort of a blogged and a reserved kind of allocation of resources that is typically done in my circuit switching mode of transferring to across the network core.

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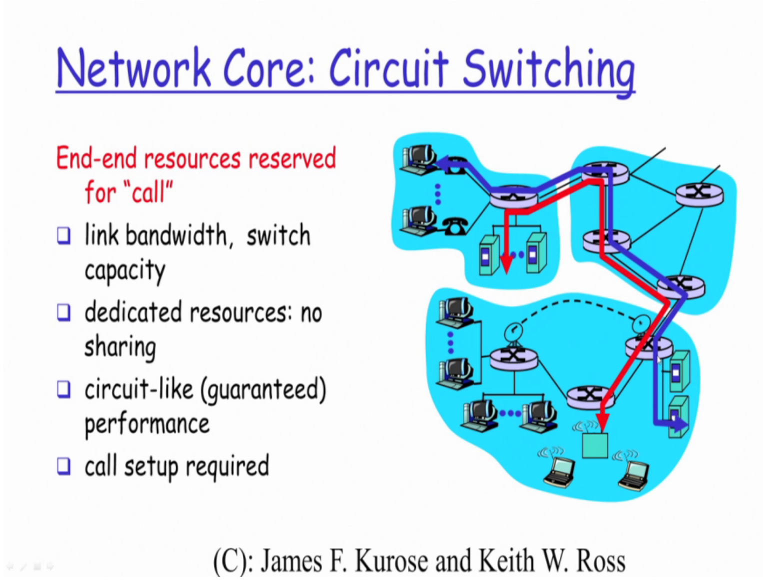

So in the end to end resources are reserved for the call in a circuit switching so if I basically have a requirement to communicate form this particular end system to let us say this particular end system for example my packet has to actually go get transferred across this system, across the various devices here on all the intermediate devices that my packets are going to go through I will have a set up that is done, I will have a resource that is set of resources that is actually reserved originally before data transfer is done and these resources will be reserved till that time the call is getting disconnected, right?

So there is a parameter of the link bandwidth that we define in our previous module that will need to be identified and appropriately selected because of which my the switching capacity of my packets from one device to the next device on the path will basically be getting decided right, so and there are dedicated resources as I was telling there is no sharing of those resources so if I have actually blogged for example a certain amount of memory on this particular device in this particular device that portion of the memory cannot be used for any other call that is getting set up till such time this call is active and in line right and it and and and and alive so now there is a performance that could be guaranteed here for a simple reason that I have resources that is actually set up on each of the devices in the path because of which I can give a sort of a guaranteed performance saying that for your data to be getting transferred from the source to the destination it is actually going to be taking no longer than x units of time, right?

Because of the fact that the resources have to be identified and sort of reserved and each of those devices in the path I cannot directly start transferring the data without doing initial call setup right, so the call setup is something which will be require to be done up front before I do the transfer of the data because only as part of the call setup first the the path will be identified for the for the destination to be reach and secondly on all the identified devices in the path appropriate resources will also be reserved for it to be used in a dedicated manner only for transferring the data of this particular end system to to reach the destination end system so thereby this basically forces us to basically make use of the the call setup to be done initially before the data transfer phase could be actually started.

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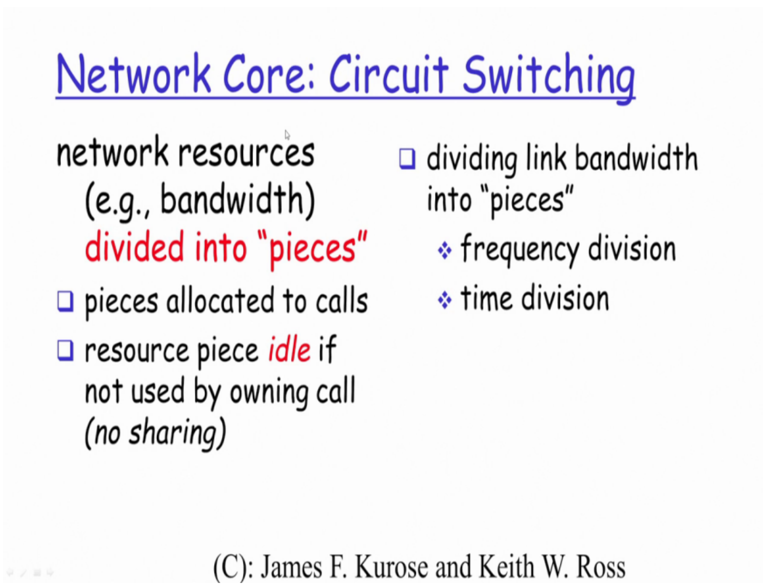

So a circuit switching would be typically do is the bandwidth is is divided into what is called as a pieces and each piece is actually located to a call, now the problem here is that the resource piece will be ideal if it is not used by the the call that really required that resource originally, so that is what we were just discussing earlier that if I am basically going to be not using that particular circuit for a certain period of time because I don't have any data transfer to be done in that period of time what really happens is that that particular resource goes waste without getting utilized right.

So again coming to an analogy of a normal phone call you why you would typically find that there will be portions of time in a normal phone call where both sides will not be really requiring to talk, may be they are just thinking about the possibility or thinking about what to speak and all that stuff, those portions of time there will be really no data that is actually getting transferred from either side but unfortunately even for those periods of time the resources in each of the switches on the path is actually being blogged for this particular call those resources will continue to be remaining idle without it being very optimally utilized for any other call that would have required that resource during that period of time.

So that is the flip side to the circle switching approach while we do have definitely an advantage of a guaranteed performance here, we also have a a disadvantage that we will have to realize that the resources will not be optimally put to use especially in scenarios where I am going to be having situation where the data is not going to be coming down in a very systematic manner getting transferred from one system to the other system and then they responded from the second system back to the first system right, so in that way we will have to understand that there are certain disadvantages with going in for a circuit switching approach because of which primarily today you don’t really find too much of a circuit switching approach when you really talk of computer networking today. Now coming down to the dividing bandwidth into the different pieces you have two different approaches, one you could either do a frequency division or you could do a time division.

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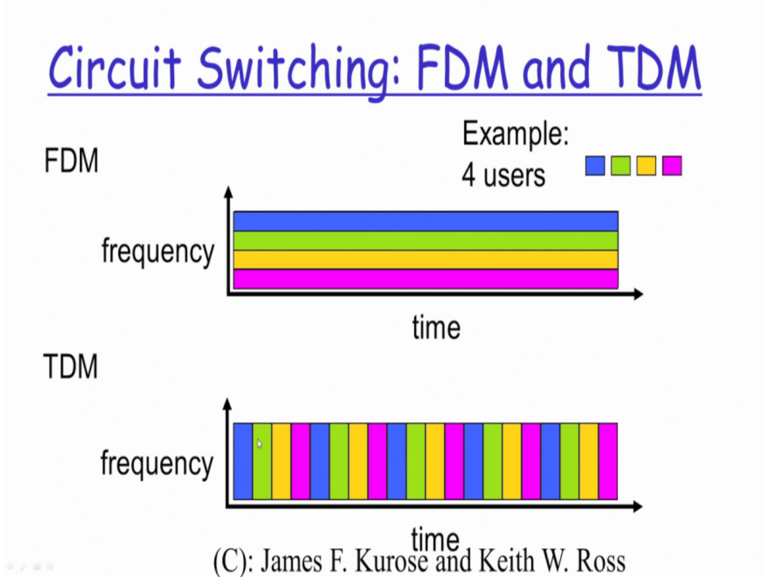

So how does this actually work, now when I say frequency division multiplexing what essentially happens is that I have a certain amount of frequency and let say that I have four different users that I need to share this set of frequency that I have among these four users right, so what we end up doing actually is that we will split the frequency across four different bands right and each of those bands will typically be allotted to one user right, so the first band that I have split here so starting from this particular frequency range to this particular frequency range will be assigned to this user and so on and so forth right. So this is why it is called as a frequency division multiplexing, so among the available frequency band that I have basically try to split it up among how many users that we want to split it upto assign a sub frequency band to each of those users right.

So thereby it basically becomes the multiplexing that I do by dividing my available frequency band width among the users that is required to be sharing that particular frequency band, on the other hand instead of dividing the available frequency across the different users you could also take a route of trying to divide them based on the the time portion of it also, so in this case what we will do is again if we really have let say four different users for whom we will have to allocate our existing resource we split the available frequency on individual time slots and then assign each of those time slots to different users, so this particular time slot will be going to user one, this particular time slot will be going to user two the third slot will be going to user three and so on and so forth right.

So we do have a a circuit switching that is possible either based on frequency or based on time but the there are limitations that we talked about with a circuit switching or whether whether we actually do it based on frequency or on time in both of them that limitation is present wherein if for example the user three for whom this particular band has actually being allocated is not having any data to transmit at that point in time right, in this time frame where this particular time slot has been allocated then what happens is this particular time slot even though the user two is having some data to send he or she will not be able to use it because that particular slot has actually been allocated to user three so this is basically what we were referring to as a sort of a non optimal usage of my available resource which basically reduces the kind of overall bandwidth capability that I could attain on this kind of circuit switching approach.

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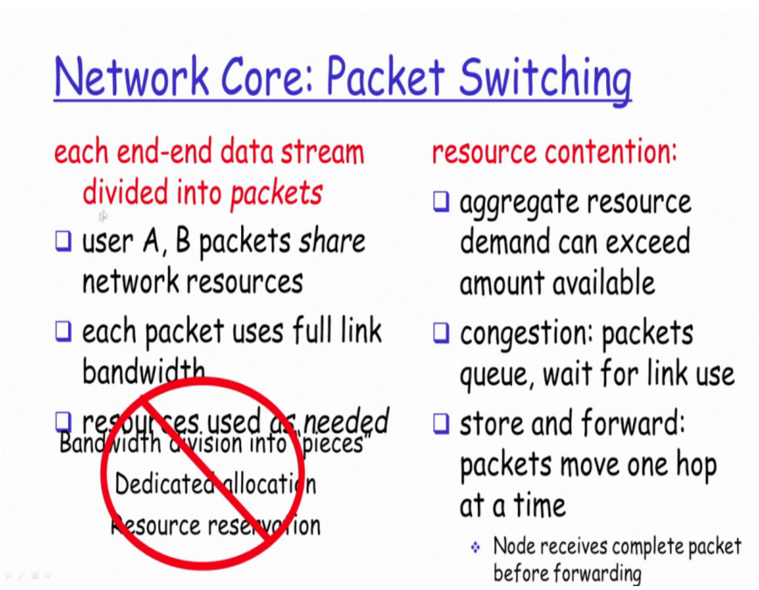

So in the packet switching I basically have my entire end to end data stream divided into packets so if I have two different users, they will basically want to have their packets send over on the network the the the users will typically share the network resources on a available bases at that instant of time, now what we mean by asses available bases at that instant of time is that whenever the packet is actually coming into the network that packet will be send to the destination as if that is the only packet that is right now available on that particular device right, in the in the network core, so it will basically try to make use of whatever resources are available on that particular network device at that point in time and then send the packet out across using the full link bandwidth right.

Now here resources are actually used as needed and there is no prior division of bandwidth that is done saying that this particular piece is going to be used by user a and this particular piece is going to be used by user b like what we had in our circuit switching right, so which is basically what we saw was the potential limitation of the not being able to actually make use of my entire bandwidth in the most optimal manner right, so in the in terms of the resource contention and the packet switching I could really have the aggregate resource demand typically exceed the maximum amount that is actually available which will actually sort of lead into congestion that we talked of now earlier so what we mean by congestion here is that the packets will have to queue and wait for the link to be available because as we as we have been discussing right now.

I don’t have any fix it from the source allocation here and it is going to be taken up for action on a asses arrival bases at that point in time what is the capacity, what is the link bandwidth that I have free and it is going to be serviced by default in the order in which it was received, right? And then it is also going to do store and forward because if my link is currently used for transmitting one packet i need to actually store the newer packet that is actually coming in from another user into my device till such time the first packet is transmitted successfully across onto the network right. So I have I I follow the mechanism here called as a store and forward by which I store the packet till such time the link is fully available for the packet to be transmitted across to the across to the network after the current packet is fully transmitted, right?

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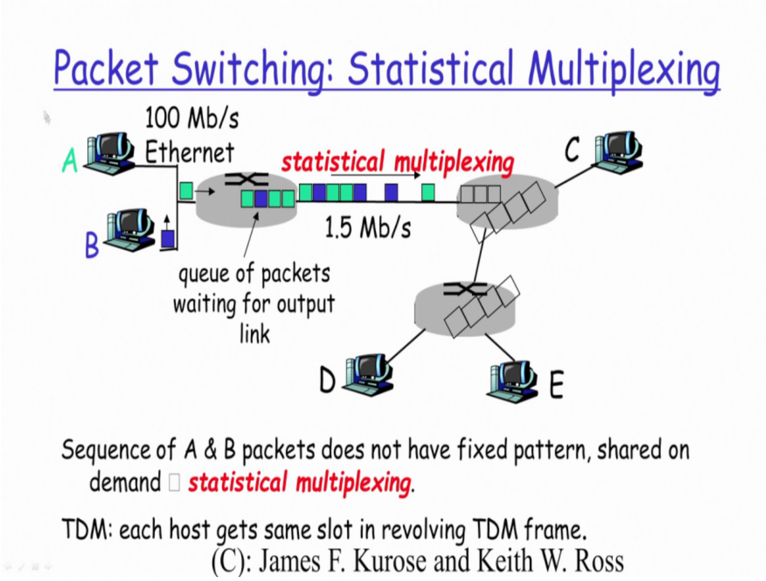

So we will Just see with an example here now in this case a and b are two users on the network so there is a packet that is actually coming from a and there is a packet that is actually coming in from b right, let us say that this is router device so you see the icon here so we discussed that this icon is something which will be used typically for an icon or for a router device in my network, so on this router device I have a queue of packets right, so why is there a queue of packets because in packet switching every packet is going to be treated independently and as send when the packet comes it is going to be treated as if that is the only packet that is available right now to be sent out and then that packet will be sent out on the communication link.

Now when the packet is coming in newly from a or from b in this manner I already have a set of packets that is there in the router device which has been queued right, now why is this being queued because there are more packets that is actually getting transmitted on the communication link over the network right, so because the communication link is right now busy in these packets getting transmitted across I have a queue which I am maintaining inside my router device and this queue is going to contain the packets that are received from a and b waiting for the output link to be free so that they can actually also be sent out right, so now this is basically what we refer to as the buffer in my network device that is my router device, what is this buffer going to be used for, this buffer is going to be used for queuing of the packets that is actually coming in and why are the packets needing to be queued, the packets need to be queued because the output link on which this packets have to be sent out in packet switching mode that output link is right now busy in sending out the previous packets that actually comes from the end system right.

Now where do we have the congestion, the congestion will start happening here, when do we have the congestion now you will see the four packets are there in the router device at some point in time if my output link is let's assume little bit slow and it is not able to take the packets as quickly as how quickly it is getting introduced into my router device by these two users then what will happen, my buffer that I have the queue that I have inside my router device will start getting full, now you see four packets here assume that I have four more packets here also that has coming, now I have eight packets that is there and I I I I have buffer space available inside my router device only for eight packets now if the ninth packet is going to come inside my device either from a or from b in this sample network, what is going to happen I don't have enough buffer space in my router device and automatically those packets will have to be dropped doubt or the router saying that I don't have enough memory buffer space available and that is basically what we refer to as congestion right.

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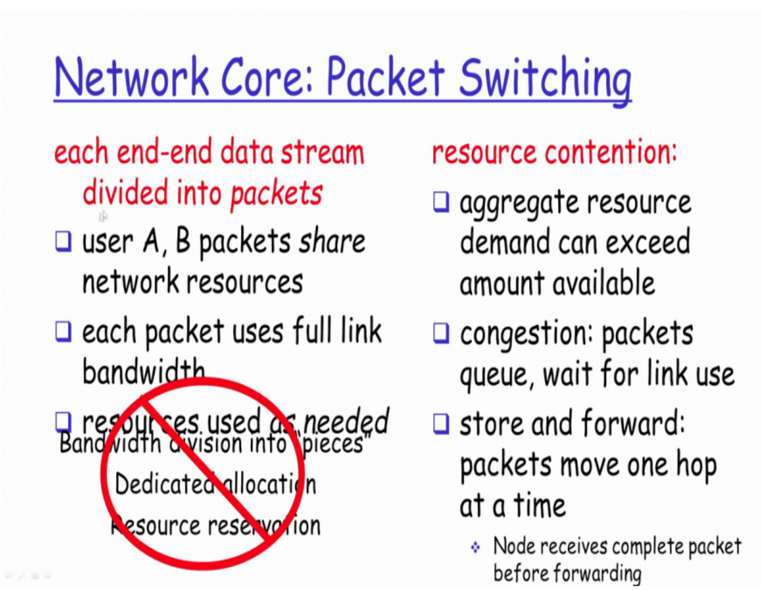

So if you see in the previous slide we talked about congestion here, a congestion will typically be happening whenever I am basically having the packets queued in and packets are getting queued because they are waiting for the link to be made available for that packet and because I am trying to avoid the congestion and I am also saying that I am trying to have an internal memory buffer I am using the concept of a store and a forward here.

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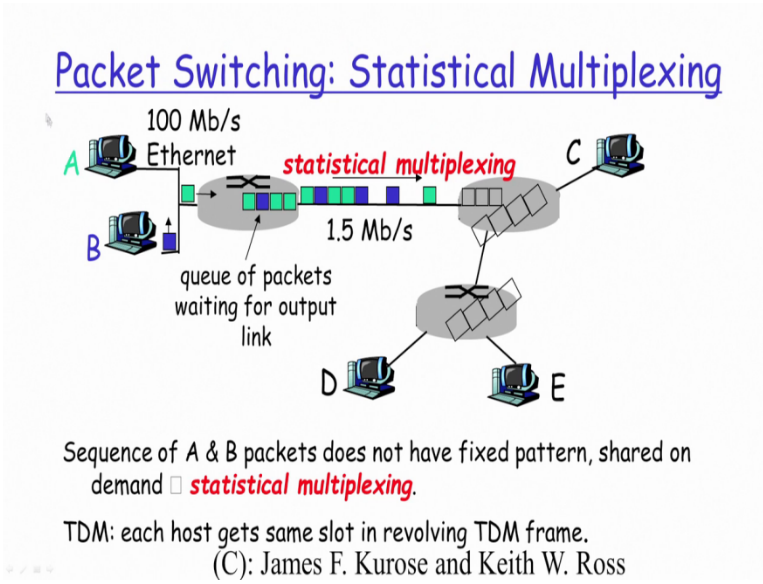

The store and forward basically what you see here of these four packets getting stored and forwarded out one after the other as in when this output link is getting freedom. So this whole concept of multiplexing a link a single link for the different users the and the packets that are getting originated by this different users sharing of the single physical link is basically waiting what is refer to as a statistical multiplexing and you typically will not have any fixed resource allocation or a fixed pattern and ideally it will be dependent on what are the network applications that are running on a and b at that point in time how busy are they actually running and how much of packets they are trying to inject into the network for them to communicate over to some device on the network remotely. So based on all these parameters the at that instant of time the link will be decided the the usage of the link will be decided to see if it is sort of saturated or if it is sort of free to take in more traffic, so because of the fact that it is going to be multiplex the router devices typically have a queue maintained, where is the queue maintained.

The queue is typically maintained inside the memory buffers on the router devices and when the amount of buffers in my router device is sort of getting fully utilized because I have too much of packets coming in into that network by these a two users a and b but at the same time the link, outgoing link here is not that much fast enough then that results in what is called as a congestion that we talked about because of which my entire buffer that I have to maintain the queue inside my router device will get full because of which the newer packet that is actually coming in here about the possibility of those packets getting dropped and that is basically when we refer to it as a principle the network has got congested.

Thank you.