Information Security 3
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Module 50
Network Protocol Layer

So in this module we will actually be trying to discuss about the different protocol layers in the network, so as to get an understanding of why the concept of layers is actually come in in order to explain the flow of a packet from a higher level application down almost through a physical wire and then over the physical wire go and reach the destination and at the destination side how the packet basically goes across the different layers till it reaches the application running on the destination mission.

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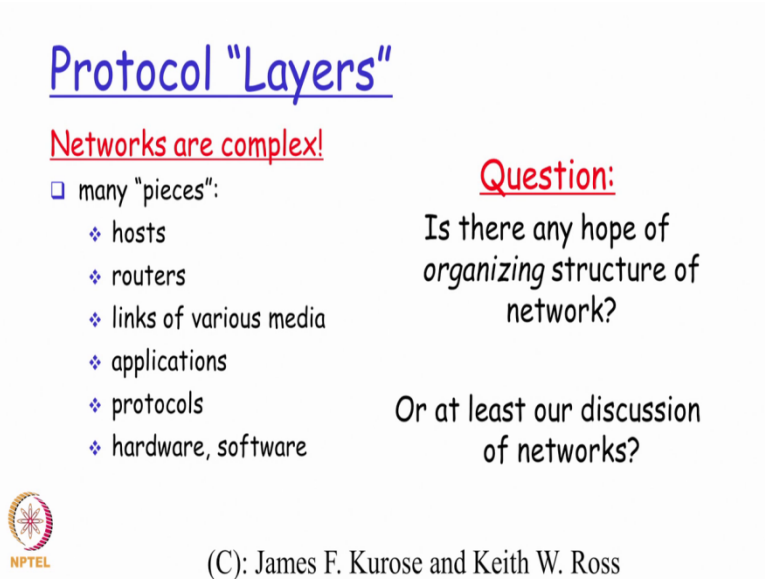

So the concept of layers is basically introduced because of the fact that as a network there is an heavy amount of computing that has to be also done for the individual packets to be successfully transmitted from the source mission and successfully received by the destination mission all the way up to the application right,

so there are like different pieces in my network as we have seen till now so I have host typically the source and the destination host, I have one or more routers which are there in the path from the source to the destination mission, I have different types of communication links between the

different network devices, I have applications running on end systems, I have individual protocols and then I have the different kinds of hardware and software running on the router devices as well as on my source missions right.

So with all these complexity of so many pieces and so many components in the in the entire network topology is there any way by which I can put a structure to it, for me to sort of be very clear about how my data is going to be sent from the source to the destination number 1,

Number 2 for also for for also the purpose of having certain very specific responsibilities given to the individual owners of it so that I can actually have a very clear cut trust model for the different layers so to say because when I have one layer committing on one particular responsibility I can trust on it and then expect it to complete it and be reliable from the perspective of implementing that particular responsibility by that layer right.

So the whole concept of a layer is basically to ensure that I could assign responsibilities to split up this huge complex humongous task into individual components in such a way that each layer has some very specific responsibility and the layer over that and the layer below that can basically be completely rest assured depend on that particular layer

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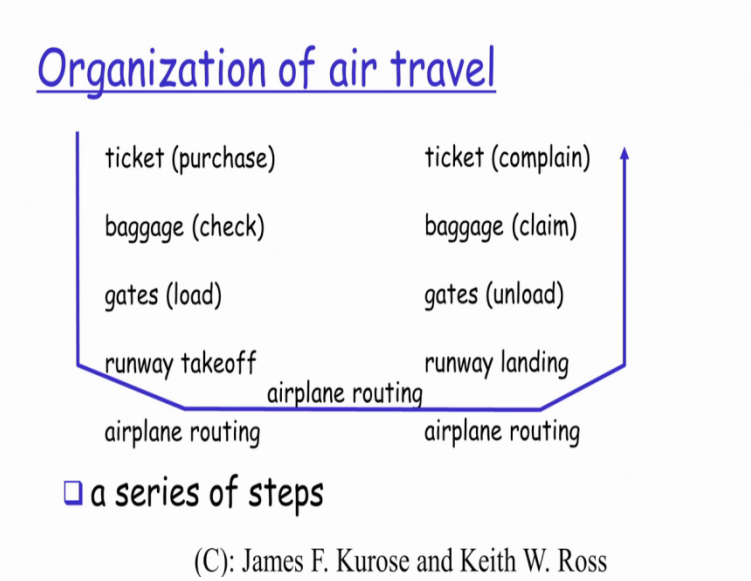

For having done its responsibility without any failure right, so in order to understand the layering the network layering part of it, one very common example that is always given is something like a air travel right.

So when you basically plan for an air travel the first thing that we actually try to do is purchase a ticket so that is the first activity that we do it there so once we purchase the ticket and the day comes for boarding we actually do the the checking of the baggage, then we go through the gates to board the the aeroplane, flight starts taking off on the runway goes towards the destination through the airplane routing different kind of different support from the ground level, then it finally lands in the destination right,

the gates are opened up again for passengers to disembark then the bag gages are cleaned and again if there is any complaint you go to the ticketing section and do right, so if you really see here whatever is there on the source side from the play from that from the plays where your boarding, you have a corresponding level at the at their final destination end right.

So you have a pair at every level and ultimately at the lowest level you have the the physical transmission of the plane from the source location to the destination location in a fixed path that is typically given right, so if you find there is a series of steps that is actually done on the source side.

There is a transmission that is happening on the at the physical level form the source to the destination and then there is a the same series of steps that happen on the source side in a reverse manner that gets done on the destination side right. So if you actually take the analogy of the air travel in this manner you could actually map it the same way.

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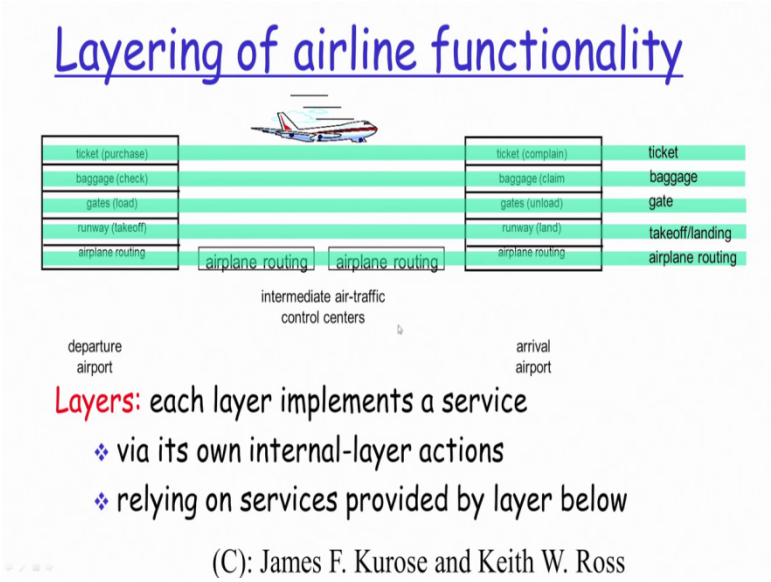

Into the network layer right, so if you see here this basically explains it more in the perspective of what really happens at every level so I just come down it each of these levels here then the airplane routing happens by the areas intermediate air traffic control centers, so these intermediate air traffic control centers in a network world gets mapped to our router devices that could potentially be there, right?

And then on the destination side I have the same set of steps that happen on the source side so from the departure airport to a arrival airport so I go through the same set of steps at the arrival airport in the reverse manner till I get out of the airport on the destination place and then go to my final destination right, so each layer implements a service so this is basically what I was referring to as a responsibility of that layer, right?

So every layer will implement a particular responsibility and the other layers above that and below it will expect that layer to actually have implemented it as per the directions given to it right, so it could do it via zone internal layer actions or by relying on services provided by the layer below so both these things are actually possible.

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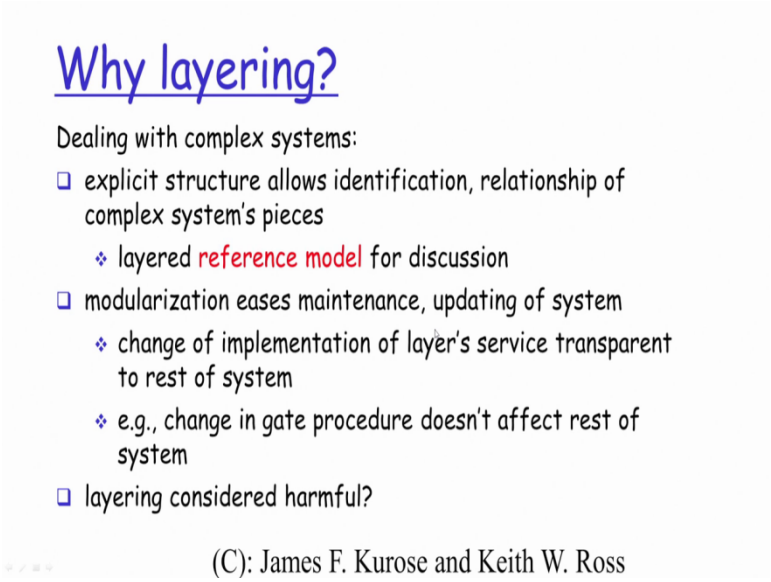

So the same kind of a layering is what is actually taken in to actually break down the huge complex part of the networking where we an expressive structure allowing the identification or relationship of complex system pieces with a reference model and another advantage is modularization will basically ease up the maintenance or updation on system so if I basically want to update one particular layer.

I could do it in such a manner in this kind of a layered model without affecting the other layers either above it or below it right, so that basically helps me in the subsequent maintenance of it or for the purpose of actually introducing the intra probability portion of it also right.

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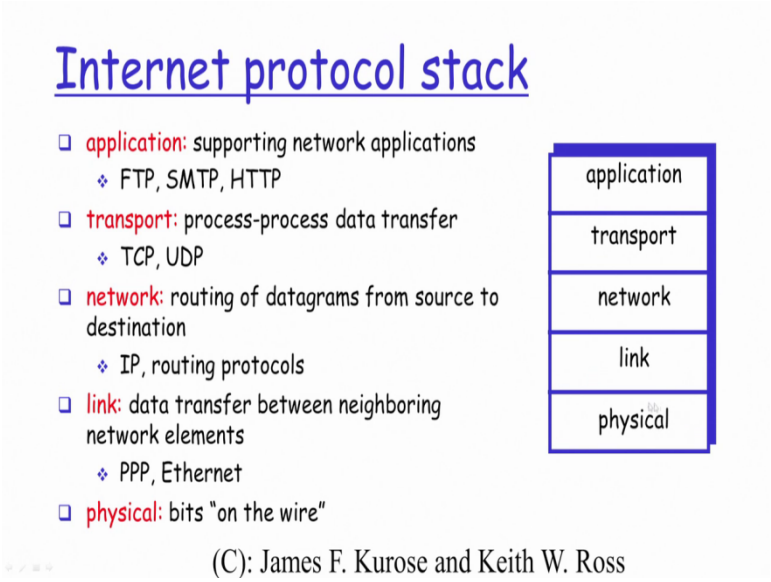

So in the internet protocols stack you typically have 5 layers, so starting down to the physical layer at the bottom you have a data link layer shortly called as a link layer, you have a network layer, you have a transport layer, you have application layer right, so this is basically the IP stack that is there but in the theoretical world which is refer to as an osi 7 layer model,

You have two more sessions which is sandwich between the transport and the application right, called the presentation layer and the session layer but in the practical implementation part of it what we refer to as a internet protocol stack, so you have these five layers where my presentation and session layer is typically collapse to into one single layer at the transport itself and then have application at the top of it, right.

So at my application layer I typically have all my network applications so if you really say that you want to browse the internet so you run a browser on your client side and you run a web server on the server side right, so this browser program and the client side and your server web server program on it server side are basically the application level that are actually running on these two end systems right,

So they will actually support different kinds of network application protocols so some protocols that you will very commonly have heard of till now is something like http,https,ftp,smtp right, so

pop and so on and so forth right. Next comes the transport level where as we talked about in the earlier module you have two different commonly used popular protocols called tcp and udp right,

So one providing you reliable communication at the process to process level across the two different systems and another the udp protocol providing you a unreliable fast communication data transfer between your process to process on your end systems right, then coming down into the network level this has got a very clear responsibility of routing the datagrams from the source systems to the destination system where the most commonly used protocol is basically the IP protocol right,

So the internet protocol that is the most commonly used popular protocol at the network layer whose primary responsibility is to basically ensure that it has intelligence to determine what is the correct path to reach a particular destination and subsequently whenever a packet is coming in with a particular destination IP address what is the path in which that particular packet has to be sent through to reach the particular to reach that specific destination right.

So then at the next layer I have a data link layer which has got the responsibility of just transferring between the neighboring data elements so here I will not really have the view point of my entire network what is my source mission and what is my destination mission but this data link layer has a very clear responsibility of just ensuring that it is able to get into the next hop whichever it has to take to reach the final destination, right?

So it is only bothered about reaching the neighboring element as compared to the the responsibility of the network layer to reach the final destination right, so thereby you see a clear differentiation between the responsibilities that has been actually assigned to the individual layers as far as this particular IP stack is concerned, right?

So some of the commonly used protocols that you will see in the data link layer is what is refer to as a ppp point to point protocol or Ethernet right, so these are some some very commonly used protocol terms that you will find across when people are referring to you at the data link layer right then comes the last layer of the bottom which is a physical layer where the bits that we talked about in the earlier module or actually sent across on the wire right.

So here on the wire has been actually specified as double codes because it could be even a wireless medium that is really a a logical wire for me so the the link here could be a wireless link which is basically my physical medium for transmission in certain cases like we discussed in our previous modules.

So when you look at the internet protocol stack you have 5 layers starting from your application to transport to network to data link and physical and you will very clearly see that each layer has a very clear cut responsibility of offering a particular servers to the layer above that or below that right, so this is basically what we are referring to as a layering model and in the internet protocol stack you have these 5 different layers with each of them doing some very specific work, right?

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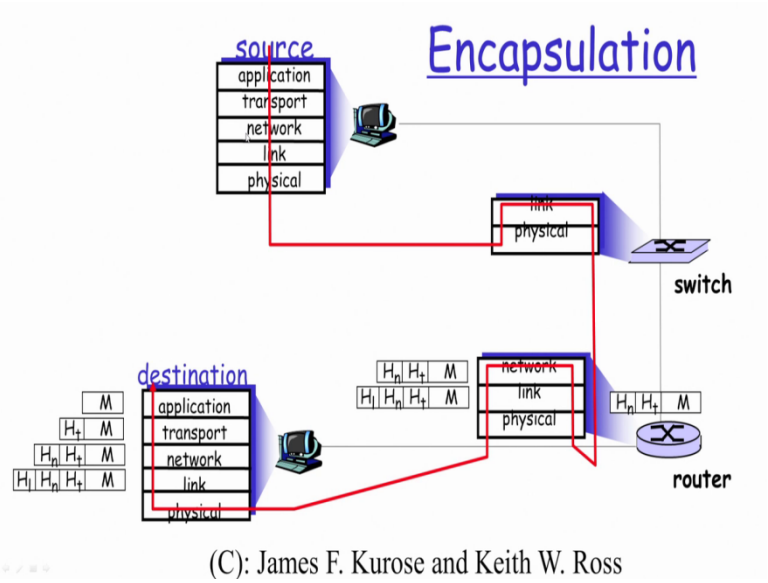

So how does my packet which I am basically generating on the source mission get sent all the way to the destination right? So when my packet is actually generated at the source side by my application so if we talk for example an http protocol message former from your browser application for example right.

So it is going to now write a message, generate a message and then write it down into the transport layer right, so when it writes down into the transport layer, what this transport layer is going to do is it is now going to create a segment, the segment is nothing but a transport layer header added with the message in it and then it is now going to push that into the network.

So when it pushed into the network the transport layer segment is going to come into come in as the datagram in my network layer wherein I will have a network layer header added into this transport layer segment and then this network layer datagram will now be getting pushed into the frame with the data link layer header added into that as part of the physical link and this frame will now travel over the physical link and then reach towards the destination, right?

So now when this physical frame gets travelled across this network it say that it has to reach a switch so on the switch it will go up to the data link layer and then it will again comeback down and then go and let say the next hop on the device is going to be a router device where I will have up to my network layer header and then from the router device it will get transmitted onto the the physical medium and then if this is going to reach the final destination as a next hop it will travels all the way up to reach towards a destination application, right?

So when it goes over each of those layers in the destination layer you will, in the destination mission you will find the corresponding headers right, will be actually getting removed out for getting processed by the next layer in that particular destination mission.

So when it reaches the data link layer here the data link layer header that got introduce a source mission here will be getting removed out and the remaining part what we refer to as a datagram earlier will be getting sent it to the network portion and from from once a network layer processing is done in my IP stack on the destination mission, the network layer header will be removed and the remaining part of it which we refer to as a segment will be sent into my transport layer and so on till my application receives the message that my original application on the source side had actually written down, right?

So the whole process of converting an application message into a data link layer frame by making it passed through the different layers on my source mission is basically what we call as encapsulation right, so the process of get the original message from a data link layer frame and the destination side is basically what is called as a a de-capsulation and at every layer I have a corresponding header added to it for a simple reason that as we discussed previously each layer has some very specific responsibilities to do right.

And for it to accomplish that responsibility all the necessary meta data required for that is actually kept as part of the corresponding header so for example we said as part of the network layer right. The router devices are responsible for ensuring that the packets that is coming in into the net into the device are valid packets without having any errors and also the router devices are responsible for determining what is the path that it has to take to reach the final destination right.

So implementing all these responsibilities it requires some metadata and all this metadata will be actually available as part of the network layer header information which is why this network layer header information is getting added in my network layer on the source side as part of the encapsulation right,

So similarly and on the destination side because the network layer header is already going to have a processed all the metadata that was there finish this responsibility that network layer header information is removed and only the remaining pay load of that datagram packet is given to the transport layer on the destination mission right.

So this is basically what we are referring to as a de-capsulation because the corresponding header information is getting removed and then the remaining part of the pay load alone is getting sent to the higher level layer right,

So this is what we actually refer to as encapsulation and de-capsulation so through this process my network packet which is actually getting originated from my application on the source mission traverses through my entire IP protocol stack on the source mission reaches through different devices on the network reaches the final destination through this path and then on the final destination traverses up my IP protocol stack and then reaches my final application that is actually running on the destination mission.

Thank you.