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CRITICAL INTERNET RESOURCES
SESSION 25

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>> MODERATOR:Good morning, everybody. Welcome back.

Today is Day 2 of the APILP, the Asia-Pacific Internet Leadership Program. We talked about the overview of Internet confidence, the overview and more general topic. Today we'll dive into how the Internet works and we'll be talking about, of course, the 101 fundamentals of names and addresses, addressing the system.

I'll welcome our speaker, Paul Wilson, director-general, APNIC, APAC. A round of applause for Paul, please.

>> [Applause].

>> MODERATOR: Before he starts -- sorry, Paul -- today we don't have the luxury of getting into the discussion that we had unfortunately like yesterday. Paul will leave 5, 10 minutes at the end for you to ask questions. Of course, feel free to ask him anything after the presentation.

I'll pass the mike to Paul.

>> PAUL WILSON: Thank you, everybody, for being here.

The aim that I have today is to try and shed light on some of the essential points of how the Internet works. To cover everything completely would take a lot longer than just 45 minutes. This is sort of some selected points and issues I think are important in today's Internet governance discussions.

I think you probably understand that the Internet is pretty technical, a phenomena, a lot of what it does and why it does what it does, it is governed by technical factors, some of which can change, some of which are fundamental. It is kind of important to understand some of those things in order to get into discussions without not only on how the Internet works but how it could be or shouldn't be or shouldn't be different.

I'll talk about a few technical issues, a few sort of management and historical issues as well. Because I tend to talk quite a bit, if I get -- once I get started, there is a risk of consuming the time. I ask you, encourage you, please, if you have any questions, just raise your hand and, you know, contribute at the time because we may not have time in the end. I'll try and pause every now and then and let that happen as well.

How many people here -- how many of you think -- it sounds like you have a good technical understanding of the way the Internet works in general.

Nobody? Well, okay. I have a job to do then. I hope you feel differently after this.

I'll be talking about what the Internet is. I think we all know what the Internet is, but from the point of view of this presentation it is useful to talk, again, about the essential points. Part of that is the idea of standards and flares communications, something that you hear about but may not yet understand. It is an essential point that helps in understanding the Internet overall.

The issue that's most close to my heart as the head of APNIC is Internet addresses, so APNIC, it is the IP address registry for the Asia-Pacific region and that's what we have done and I'll tell you how it works. I'll be talking about the naming system of the Internet, the DNS which is sometimes confused with IP addressing, a bit about governance, challenges and issues if we get that far.

The Internet can be described in a lot of ways. Some of them are really quite important and fundamental. The Internet is often thought of as a single network, but it is actually a network of networks. The name "Internet" came from the days when there was many networks and the Internet was away to link them together. It is still a network of networks and many networks around the world operate autonomously essentially and

connect with the over the Internet. The idea of this is important. It is also a collection of applications and those applications run on top of what I will be describing here as the Internet. The reason it is so important is because of a platform of innovation and the reason it can be that is kind of fundamental, it is -- it actually has got to do with the way that the Internet works that we have this platform for innovation that people talk about. It has become a borderless -- hopefully a borderless cyber space and a critical Infrastructure and this is all because of the way that the Internet itself works. It is -- if the Internet was designed differently it wouldn't have been as successful as it has been today.

It started off relatively a long time ago, in the '70s and '80s. And it started off as a research project, as a nonprofit research, education, academic network, very open, very cooperative, and it put -- the developments that came about within the Internet were generally in the public domain known as open source these days. The idea is that it was easy to join the Internet and it didn't cost you anything to come into it.

It was so successful through the '80s in particular that it really became a useful, proven sort of Infrastructure. It actually started to be deployed, started to be used in a liberalizing, telecommunication environment with the regulations about telecommunications were being reduced and the Internet was enabled by that and the Internet also kind of encouraged more deregulation. It became a very commercial, competitive environment. You may know that the Internet that people know these days which is dominated by the worldwide web really started in about 1992, '93 with the development of the web. It is that time and through the '90s that it really took off primarily because of that interface being developed.

Now, really, it is a utility, a critical Infrastructure that people really rely on and Internet governance is actually a recent thought actually. It is because the Internet became so important, so critical to governments actually that they started to ask, well, this thing has happened, this thing has been given to us, it is sort of -- it is without government control and governments have started to think about how this instrument can be governed either to control it or to improve it in their minds. Really Internet governance which you have heard a lot about here, it is really a recent thing that's come about well after the Internet itself started to be clearly successful.

If you go back before the Internet, now this is before some of you I think were born, but there were a whole range of different networks that came from computer manufacturers. There were famous manufacturers way back there the 70s, 80s, even

earlier like digital, HP, IBM, they manufactured computers and designed the networks that would join the computers together. If you were a digital customer you could buy the digital computers and they would link together. Same with HP, same with IBM but they didn't enter connect very well, if -- interconnect very well, if at all. You had to pay a lot to get into the networks, to use them, and they only -- as I say, connected to themselves.

Now the idea of the diagrams is that in each of the networks you had hardware, operating systems, you had network systems and applications that were all linked together but not linked across. The Internet came about as a way to connect these networks together. It actually -- as I say, it grew rapidly over the following years and decades.

As I said, as I mentioned before, one of the critical factors for the Internet, it was this question of openness. It wasn't developed for profit, it was developed as an academic, research tool. Software, it was free, the barrier to entry, it was very low, you needed to have a computer, of course, you needed to have the means to connect but you weren't charged anything for the purpose of connecting. It wasn't a profit-making enterprise. That was actually very important, as it is today when you think of open-source software.

It seems funny to say a lot of people -- I was surprised by this, the Internet itself, it is a pretty dumb network. That's dumb in a positive sense. It is a light-weight, efficient system at the Internet level allowing all of this stuff to happen on top of it. The fact that -- as I say, the intelligence of the Internet, it is at the edges of the Internet, in the applications and in the devices, it is not in the pipes, routers, wires, all of that stuff. The Internet itself at that layer is really intended to be and designed as a dumb network.

What the Internet has become, it is a global, uniform, as they say, an end-to-end network, which means that any device connected to the Internet can connect it any other device, that's important. You don't have to necessarily go through another point to send a packet from one place to another.

Network neutrality, that's something that's actually come with the Internet as well. By design and by default, the Internet actually is a neutral network, it is a dumb -- as I say, a dumb transport layer that allows packets to be sent from one place to the other without any necessary distinction between different types of traffic or different types of destinations.

The Internet is very flexible. It allows you to distinguish if you want to and the debate about network neutrality, it allows providers to have different approaches to

different destinations and sources and to different traffic types, but if not for the Internet itself, we wouldn't actually have the term network neutrality. Before the Internet, as I said, everything was bundled up into different groups of providers and technologies and so forth and there was no chance of a neutral, global, end-to-end network. The Internet delivered that to us.

There is a session later on today about the Internet, the fundamentals, the Internet principles and we'll see -- I'll talk in that and arguing in fact that some of the fundamentals of the Internet are really technical fundamentals that we could lose if we're not careful, but which are what is allowed the Internet to do.

So there is an idea in telecommunications of layers and the standards that define the layers of communications in a network. Just to illustrate what that means, we have the telephone network, a pretty familiar thing, particularly to those of us who grew up with it. The telephone network can be seen as a sort of layered network. You have a bunch of -- you have a network of wires connecting points, cities, towns, streets around the world. Those wires join exchanges together which allow you to route calls. Those exchanges join to a local loop which provides a connection in your house and on top of those that local loop you have devices which can talk to each other.

The point about these layers, they're well defined. You can substitute, you can change things or add things at different layers. You know, the devices can be changed. Old phones became new phones and you only had to change the device, you didn't have to change anything else. The, changes themselves, you know, in the old days, you actually had people routing calls. You see that in old movies, but they could be exchanged with automatic exchanges, adding fax machines, things like this. The point of layers, you can change, add any one layer without disturbing the rest.

Now computer networking can be more complicated, and there was an old reference model for layered telecommunications developed by the international standard organization, it is a seven-layered model with the physical link transport session, presentation, application, it is a model that if you study networking academically you'll probably hear about this. The Internet is a little more simple and in practice the way that layered telecommunications has worked is in the Internet world, it is that you have at the bottom layer a whole collection of Infrastructure which can be dial-up lines back in the old days, ISD, lines, mobile, so on. You have the applications at the top. Back in the old days the Internet was kind of an application on top of a telecommunications network, and the

middle of the network you had what was referred to as a triple play, a multiple capability network delivering the voice, video and dial-up.

This is the way things worked as the Internet first evolved. The Internet was kind of something that users did on the existing telecommunications network. This is known as an hour glass, the hour glass of telecommunications. You can see why because of the shape. That middle part of the hour glass, that's actually become a lot narrower in these days because N fact, if you have applications which are now Internet applications, you have the Infrastructure which includes the LTE and all sorts of high capacity, Infrastructure connectivity mechanisms and in the middle all you have is the Internet and the Internet has actually become now the predominant network across the entire telecommunications Infrastructure of the world. If it is not true today, then very soon anything at all that you do in terms of telecommunications will be sent through IP packets across the Internet. That's how the layered telecommunications model has evolved.

Now the layers are important because they are defined by standards. Standards operate at different wires of that protocol, it is called the protocol stack. What a standard is, it is simply an agreement that says that we are going to encode, send, receive information in a particular defined format. I mentioned before the openness of the Internet, standards can be open standards which are freely available for anyone to use or they can be proprietary standards where you have to pay something to the inventor to use them. Again, the Internet is being dominated and is successful because of the open standards that have been developed.

The open standards process is a very important part of the way that the Internet works. It is a standard, an open standard is one that's being developed through open for the accessible processes, anyone can participate. The standards themselves, they're available without barriers such as licenses and fees.

You might say, well, a standard can also operate at an interpersonal level as well, you know, two people -- these two guys want to communicate. How will or will they do it? They will use the Internet like everybody does these days. When they do that, then what they're relying on is a huge and complex collection of standards that link together all of the devices, the networks, the Infrastructure, the wires, the applications that run on the Internet. All of those things are defined by standards and mostly by open standards.

This is a bit of a joke because when you move up the protocol stack into the realm, for instance of the Internet governance forum, you go up from the physical to the link all

the way up to the presentation, application, then you start worrying about the financial and then you worry about the political issues in the telecommunication world. That's from a T shirt that came about during the early ICANN days. It is a bit of an exaggeration but true in some sense.

Internet addresses: An IP address is the fundamental address on the Internet. Every device on the Internet has to have an address. It has to be uniquely identifiable with a numeric address. Every network, it has to have a block of addresses, range of addresses that are assigned to all the devices.

We have been operating on something called IPv4, it has an address size defined by the protocol, it is part of the specification and it defines quite a limited address, only 4 billion. 30 years ago, that seemed to be plenty of addresses, nobody could really imagine we ever would have a network requiring the 4 billion separate addresses or connecting 4 billion devices. In fact, that is very limited. Because of the limitation, it is always managed in a careful manner so that those who need addresses can receive addresses, and I'll be talking about that in a little while. And also talking about the move to the next generation, which is from IPv4 to IPv5. Speaking of addresses, it is important to distinguish a few things. A domain name -- 6 -- an address, they're different. IP addresses, they're not the same thing as IP in a legal sense which is intellectual property.

There is a -- there is plenty of scope of confusion here and I hope that the questions, that they're pretty clear.

How are addresses used? We have the Internet here as the typical cloudy blob at the top. We have got a network at the bottom here which is a bunch of devices connected by wires, by cables, and the box with the R, it is a router. Your router could be known as a gateway, that's the thing that actually connects to you the Internet.

As I said before, those devices, that network, they need addresses. That network may have for instance an address block that's defined by the numbers there. That simply is a range of numbers that are then assigned to those that are allocated or assigned to the devices.

Having the addresses is not exactly all that's needed. What you need to do is to announce to the Internet that you've got those addresses. Now, this is sort of the process that an ISP or a business that has a network needs to be familiar with.

What you do, you -- in order to connect to the Internet, you take the block of addresses you have, you announce it to the Internet into what's called the routing system of the Internet. That block of addresses, that range of addresses then appears in

what's a routing table. The Internet becomes aware of how to get to the address block that you've announced. Once that's done, then traffic can flow to and from your network in the expected way. That's Internet routing. It is currently managed by protocol called BGP, the Border Gateway Protocol which you need to know about if you're an architect or engineer. Luckily, none of us here in this room, I think are in that category, we don't have to go into the details of BGP fortunately.

When you look at how the Internet works at a wider scale, again mediated by BGP to make sure that the routing happens, then you have the idea of a global routing table which is where all of the different networks attract. As I said before an individual network ends up with an address in the routing table, every individual network needs to be represented in that routing table to be reachable on the signal of the global Internet.

The routing table exists in every different network of the Internet. It can look different in different places because it is a relative thing. It says from where you are, how to get to different places. In general we talk about a single global routing table because it tends to be similar in different locations.

If we look at how the routing table has grown -- this is a nice chart actually that shows since --

(Please stand by for technical difficulties to be corrected).

>> We use it for accessing the Internet, using the names instead of IP addresses. As you know, IP addresses as numbers, they can be very hard to remember. The whole idea of the DNS is to provide the human, readable names. The DNS is a like a phone book. You ask the Internet for the number that's associated with the name that you're interested in. Once that number is delivered to you by the DNS, the communication goes according to those numbers and you can forget about the name. The DNS is pretty important these days. I think you all know about the new GTLBs, about the.com boom, the value put into names. That's because increase in the phone book, they're very valuable, no one wants to remember a number. People with brands, companies, they want the name to be recognized. There is a hierarchy that runs from the top-down so if you look at a name like this in the hierarchy of names, it is part of the system, there is a mechanism for the resolving names by going to the domain naming system and quarrying the servers that exist for each of the names, each of the levels in the domain name that you're seeking. This thing called the root server, it is a path that determines at the top-level where you need to go for a country name, a.com name, a .asia name, whatever. That's important particularly in the ICANN scheme of things.

I could go on at something about the name servers, the DNS, why they're of particular importance. I will leave that for another day.

Which is a shame, we have ICANN people here and the DNS is particularly of interest to ICANN, they being the operator of the overall domain naming system.

That brings me to the end of a crash course of a few I think critical topics about the Internet. I think the Internet governance areas, something that was covered pretty well yesterday, anyways, I think that I'll leave it there. I'll also offer a chance for any last questions.

In any language, of course.

Thank you very much.

>> [Applause].

>> AUDIENCE: I have a question about the ISP.

When we're having discussions yesterday we come across the topic, when it comes down to taking down contents online, the ISP, there's a lot of interest so why does it -- why is it so difficult that -- when GTLBs have the policies to take down unsuitable contents potentially illegal contents, why is it difficult for ISPs to do so?

>> PAUL WILSON: That's a good question on why it is difficult to take down content. It is because there are different ways to take down the content.

The very best way would be to go to the place where that content exists and to take the content off of the server or to take that server offline. Most content takedown, it is something that's an international question. You know, if you want to take down content available here, you can't go to the U.S. and take it down. The next way that's often tried is to try to get in the domain naming system to take down that domain and that serves the content and you take that offline at the risk that that domain may be used for other content as well. If the content is on Facebook, you can't really take Facebook.com off line. That same challenge exists on a small scale for any content takedown. The other way to do it, in the routing system, as I showed the routing system routes traffic at the IP level, you can take content out by filtering that traffic on -- filtering that traffic on that IP address which has the effect of possibly taking out other content that's not the target, although IP address filtering is probably the most common approach that someone may try to take, it has serious performance penalty on the ISP because you're asking every ISP in the countries to filter their traffic and for that IP address to be taken out.

We can go back and look at content filtering across most of the topics we discussed and see how it can be and can't be used.

That's exactly why this kind of insight into how the Internet actually works is important for people trying to discuss these things, trying to work out what they want to do and how they may be able to do it and the cost of doing it.

Thank you. That was a very good question. You get the prize for sure.

>> AUDIENCE: When you were asking about taking down the content, related to the many different issues, one of them I think is the video issues because when ISP takes away one of the contents because the content is not necessarily belonging to the ISP and you have to have a legal to support you taking down the content from one of your customers. Also a reason is because of the intellectual property and because of some other issues. That's one of the reasons in some of the countries they have -- they have the intellectual property, they have a law that's talking about the safe harbor. The safe harbor is a mechanism to know how to take down the content of ISP. If you don't do that, there is also a possibility that the content provider can sue the ISP. What's the reason you take me out? You know, and ISP would be in a legal of those issues. So taking down content is not simple

>> PAUL WILSON: You can go up from the IP layer, the DS layer, to the political, legal layer, you do that to sort out the issues.

I have overran the time so far. Thank you for your attention. I hope it was useful and we'll make way for the next session.

Thank you.

>> [Applause].

>> Thank you for joining us. Tomorrow, same time, same place.

Thank you.

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