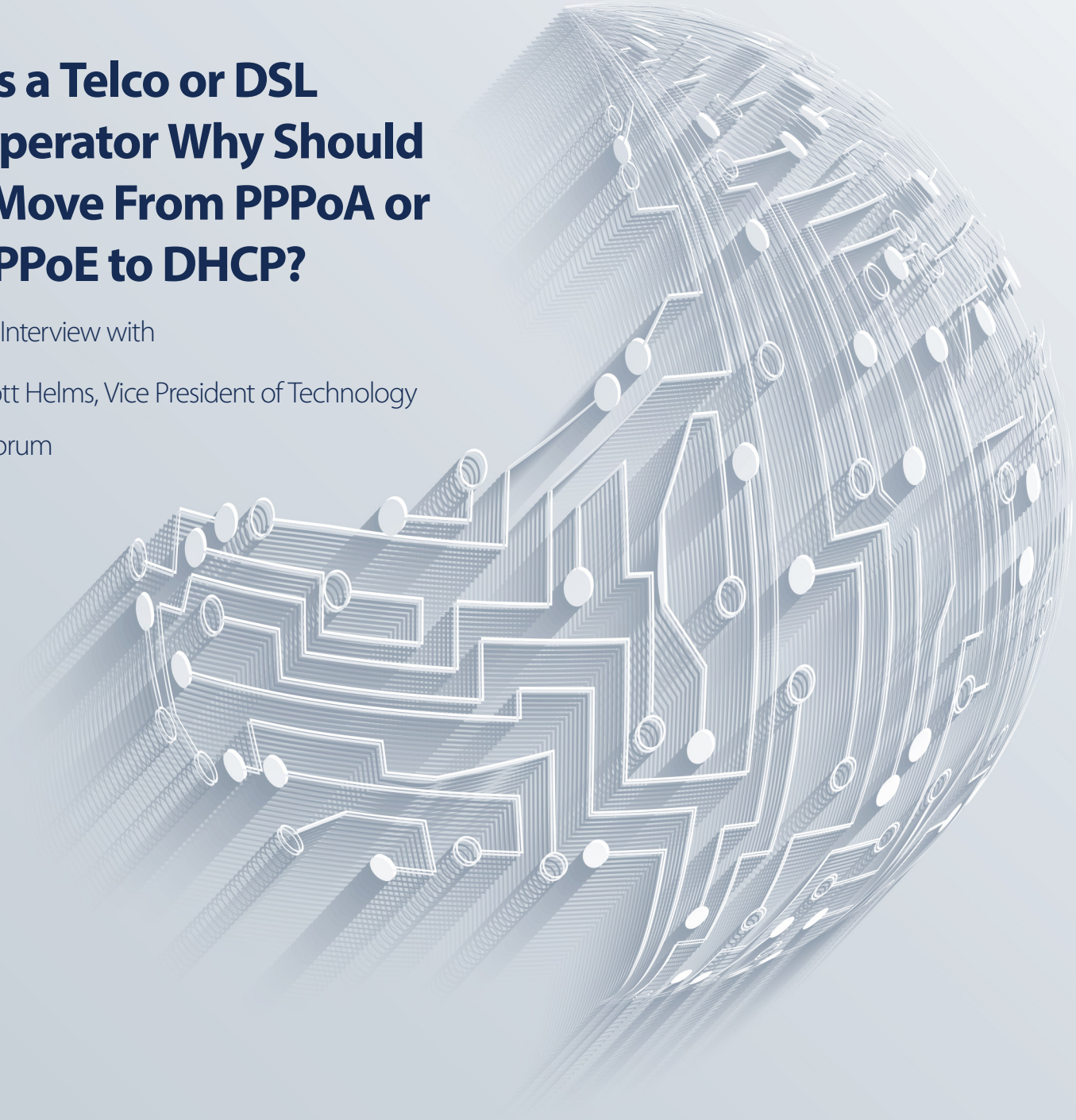
ZCorum's Ask a Broadband Expert Series:

As a Telco or DSL Operator Why Should I Move From PPPoA or PPPoE to DHCP?

An Interview with

Scott Helms, Vice President of Technology

ZCorum



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Who in the Telco world does this apply to and why?

Helms: The primary audience could be almost anyone in the telco/DSL world concerned with transitioning to DHCP (Dynamic Host Configuration Protocol).

How did we get to the DHCP Technology and why?

Helms: Let me give you a little bit of history and it'll make more sense. In the early days of DSL most operators chose to do PPPoA (Point to Point Protocol over Asynchronous Transfer Mode). It was the only good choice. Operators could still do DHCP or static assignments of IP addresses but both of those options left you vulnerable to having inaccurate IP information if you needed to answer law enforcement or a copyright abuse case or any other reason you'd need to know who had a certain IP address at a certain time. The other advantage that PPPoA had was that it worked with another system that operators were already comfortable with, which is RADIUS (Remote Authentication Dial In User Service).

How did RADIUS work?

Helms: If you remember dial-up service, you would enter your username and password and hear the dial up tones. What was happening, during those few milliseconds, was the dial in access server would take the username and password, turn around and talk to the RADIUS server to authenticate against. You could imagine the process as "Hey, someone dialed in, this is the username and password. Is that good? And are there any other records that come along with it?" And the RADIUS server would respond. If the credentials were correct, the response was 'yes and these are the parameters for this user.'

So, as telcos introduced DSL, not only was PPPoA a better solution for understanding who had what IP address, it tied in with their existing authentication systems and usually with their billing systems as well. Operators could easily turn on and off RADIUS accounts so it was really good integration. It also let them leverage the other part of RADIUS, the accounting part, which let them track when and how long a customer was connected and how much data they transferred. RADIUS accounting sends a start, a stop and sometimes intermediary records. Basically it's a way of saying "okay, Joe is connected, and he's using this many bytes of traffic", and at the end of Joe's session it would send a stop record. So, you knew very well when Joe dialed in and when he disconnected, so there is literally no chance anyone other than Joe was using that IP address at those times. You had a very defined set of records. That's why the telcos went the way that they did. It already tied in with the RADIUS and it was the best technical solution that they had.

So if it worked so well, why did they change?

Helms: ATM (Asynchronous Transfer Mode), which is the "A" part of PPPoA, was being phased out of operator networks because of the cost difference between an ATM interface versus an Ethernet interface. In many cases the difference was multiple tens of thousands of dollars. There was never a real technical reason for the phase out, but the protocol itself also made it very difficult to implement. The guys who designed it came from the telco world where everything was circuit switched, and they built a protocol that matched those same qualities of service. But the thinking evolved to where it was better to have something that wasn't as guaranteed in terms of QoS (Quality of Service) but had a much

better price point. So over time DSL networks began moving away from having an ATM core and transport network with PPPoA to having an Ethernet core and transport network in PPPoE (Point to Point Protocol over Ethernet).

So largely everyone moved over to PPPoE because it was pretty painless, and most often didn't require any replacement equipment. All you had to do was tell your BRAS (Broadband Remote Access Server) to prefer PPPoE and most of your clients would go that way.

This sounds like a great solution. So why is DHCP preferable?

Helms: PPPoE really had all the same advantages that PPPoA had. It worked with RADIUS, it still worked with most of the existing equipment, it let them transition parts of their core network to Ethernet and save money, so those were good things. But over time more and more people said PPPoE is pretty nice but it has its drawbacks.

PPPoE Drawbacks?

Overhead

Helms: With PPPoE there is an additional amount of overhead because of encapsulation. Imagine the pipe in terms of those Russian nesting dolls. When I say encapsulation that's really what I'm talking about. Because we're talking about DSL networks, our first container is the DSL framing. Lower level protocols will encapsulate higher level protocols so that we can carry that traffic and the different layers of the stack don't have to know about each other. So this pipe is DSL and when somebody talks about speeds on a DSL modem this is the part that they're actually talking about, this outside band.

So now we have this DSL connection, and we know, even today, that all of our ADSL Connections are at least ATM (which didn't completely go away), between the modem and the DSLAM (Digital Subscriber Line Access Multiplexer). And there's this little bit of overhead that ATM is going to consume for its additional framing and information. Now this is layer one and some of layer two.

Now let's say we're going to PPPoE, what really happens is I am now going to put Ethernet frames inside of ATM, which means a third layer. Still that's not the end. Inside of that, PPP frames add yet another layer. So, it's already PPP over Ethernet over ATM, and this pipe is being whittled away with each layer.

And now we add another layer. When the DSL world first started we didn't know everything was going to go to IP. The thinking was that more services would be done at the ATM layer. More video and the video transport would be separate from the data. But as we now know, all we really think about today is our internet data. And in some cases when operators are doing IPTV or telco TV they will have a separate ATM Permanent Virtual Circuit (PVC), one for the video and one for the internet data. So now inside of PPP we do IP which is not a straightforward layer, because it breaks apart some of your traffic as UDP and some as TCP. With the number one driver of traffic on the Internet today being video, the UDP share of the pie has increased over time. Video streams from Netflix, iTunes, etc. are all UDP. And don't forget SIP traffic, also UDP, further whittling the pipe.

But if it's working…?

Payload

Helms: That brings up another drawback. Ethernet was never designed to carry PPP. In fact, some detractors of the protocol will call it a hack. But, something you need to understand about almost every kind of networking, there is an idea of how big of a pay load we can send in a single burst of transmission. In Ethernet and in fact in a lot of protocols this is called the Maximum Transmission Unit (MTU), and normally an Ethernet MTU by default is 1500 bytes. To run correctly in a PPPoE environment you have to change the MTU on all the clients to 1492. A majority of the time this is not a big problem because most all of the DSL modems you can buy today already know this. But in certain circumstances it can be a source of problems that are very difficult to troubleshoot. So the answer would be to get rid of PPP and you get rid of the 1492 requirement.

Is that possible?

Helms: That's one of the big advantages of DHCP. You can completely eliminate PPP and that's a significant action. It's just a small slice, so it won't make that much difference to an individual subscriber. But when an operator can take that small slice and increase the aggregate throughput for all of his subscribers by 8 bytes per transmission unit for everybody, then that becomes a pretty significant number when multiplied by the total number of DSL subscribers he has.

This is where some of the differences come in to play, right?

Helms: Correct. The DHCP based system is very similar to the others except you get rid of this PPP layer. Naturally you might think if you get rid of the PPP layer there should be a DHCP layer, right? You think, 'Oh wait a minute, why isn't there a DHCP layer?' And this is one of the critical differences between PPPoA/oE and DHCP. The point to point protocols are part of the connection path while DHCP is not. DHCP is an informational service. All it does is respond to requests and provide the answers. In many ways it's not really correct to compare DHCP and PPPoE, it's actually more correct to compare DHCP with RADIUS in terms of additional layers. Like RADIUS, DHCP does not cause any extra overhead on the connection itself so you get to that IP layer faster.

I've touched on one of the differences; DHCP doesn't live in this connection path, so no overhead. Now the other big difference and this is actually what scared the operators away from DHCP initially, DHCP is not an authentication protocol.

DHCP is a method of providing information about the IP network to clients. And that's it. We've done some things, as an industry, so that DHCP can be part of an authentication system but in and of itself it is not an authentication system the way that Radius is. Radius's primary use is saying 'yes this user should connect' or 'no this user shouldn't connect'. DHCP doesn't do that.

How does DHCP work in the DSL world?

DHCP Enforcement

Helms: To begin with, two really, really important features had to be commonly adopted by the DSLAM and shelf manufacturers before DHCP could be acceptable in the TELCO world. First is what I call DHCP enforcement. The DSLAM listens to traffic as it goes through, and it pays attention to the IP address that the modem is given via DHCP. Then if you try from this modem to use a different IP address, it blocks you. It's a very simple idea. Basically the DHCP server says "your IP address is 198.10.250.34 that's the only IP address you can use; if you don't like that one—sorry." And you don't go anywhere.

So, this gave the operators a level of comfort that what the DHCP server was saying was true. The operator knows for certain this DSLAM is connected to a specific telephone line, and this modem's at the other end of this telephone line, and therefore knows where the IP address is. It doesn't matter if someone takes their modem and compromises it or they change the Mac address. They can do anything they want. They think it's changed but it's not. This DHCP enforcement, the ability to always identify a modem and IP address, was the first important feature.

Option 82

Helms: The second is DHCP Option 82, and in case you were wondering, yes there is a whole litany of options and sub-options in the DHCP protocol. Option 82 in particular has a sub-option that is really important to telco providers and is called the circuit ID. This is the feature that DSL providers care a lot about. In a DSL environment the circuit ID will contain two key pieces of information.

Remember, this a box. It may be on a pedestal, in the neighborhood or maybe attached to a telephone pole, but it's physically a box. So the first key piece that the circuit ID will have is what's called a shelf ID (sometimes node ID also). And the shelf ID is just something that the operator assigned to it. Now, it's not usually a name, actually it shouldn't be a name, but a number, but it will be a unique number in the ring that shelf lives in.

Let's just say this is shelf ID 37. We just called it 37, but it is also unique, so it is a locally significant label. We know, for example, that shelf ID 37 really is the Green Oaks node. It will have a unique slot number/name. Just like a CMTSs, DSLAMS have slots. Let's just say we're on slot 12. And then lastly, it is going to have a port. And a port is the actual port on the card that I'm connected to. Let's say port 8. So now we have the unique shelf ID number, the unique slot number, and port number.

Now, and this is really important, we have a shelf that is doing DHCP enforcement so you must accept the IP address that the DHCP server gave you and the DSLAM is passing back some option 82 circuit ID info, so I can tell this IP address went with this shelf slot and port number during this time frame, definitively. No one else could possibly be using that IP address. Now, that's how it works from the standpoint of definitively identifying who had that IP address.

Now, DHCP is again, not a authentication protocol. DHCP leases are very different from a PPP start and stop record in RADIUS. But at the end of the day, all you really have to be able to do is say, okay at this

certain time and date, someone used this IP address and then go look in the DHCP server and see who had it leased during that time frame, because no one else could possibly be using it.

What are the challenges of switching?

Helms: DHCP does give you the ability to tie an IP address at a specific point in time to a specific customer, even though it is not strictly an authentication protocol. But it doesn't do the other part of what PPPoE or PPPoA does, which is generate RADIUS accounting records that give us the bandwidth information. So that's one of the main challenges in switching to a DHCP based system.

Why would an operator want to switch?

Helms: This is actually the number one reason to transition.

I'm just going to talk about the typical DSL network here, with a Broadband Remote Access Server (BRAS). Let's think about a very simplified DSL network. For the moment we're just ignoring the DSL infrastructure because at the end of the day, in a PPPoE environment, you've got modems, you've got your DSL network and then out of that you've got a feed that goes to your BRAS. And this is one of those places that you really start looking at the cost of the interface, so if I have this one line that's carrying all of my traffic, it's got to be fast enough to be able to support all of that. So this is usually gigabit and or 10 gigabit Ethernet. So this is the BRAS. And most of the time this will be a Cisco, Redback, (who is now owned by Ericsson), or Juniper box. Those are probably your three most common. So what do those three companies have in common? Cost. And it's a LOT for their big "carrier grade" boxes.

The number one reason why people change from PPPoE networks to DHCP based networks is the cost of upgrading or replacing their BRAS. Most often it is the most expensive piece of equipment in the IP chain. So, when operators start looking to upgrade or changing out this box they're going to be dreading that expense. And unfortunately in a service provider network, it's not just the initial cost of buying the box; you also end up paying Juniper, Redback or Cisco a maintenance agreement and/or keeping spares.

So operators started looking at the changes in the DSLAM infrastructure that allowed them to do DHCP safely and they said "Wow, if I can do this, and instead of RADIUS this becomes DHCP, do I really need the bandwidth information that much or can I find it some other way? And with that they're making the decision to switch.

Now running as flat of a network as possible is good network engineering, as it's better to eliminate boxes that are in line if possible. There are fewer moving pieces, less expense and one piece of complexity has been removed. I've removed network overhead and connection to the user themselves. So, lots of good reasons for switching. But the most compelling is definitely the economic reason.

Why don't all operators switch?

Helms: Eventually they all will as they began to realize the advantages. But usually what begins the process is operators get to a point where they need or have to make an upgrade to the BRAS and that's when they make the jump. They see the price tag and think "Whoa it's going cost me $250,000 to replace that box. Do I have an alternative? Can't I just switch over instead and simplify my network?" The answer is almost always a switch. But before an upgrade is needed there isn't as much incentive.

And when they do switch, they realize other benefits. For example, DHCP, from a troubleshooting standpoint, tends to be simpler. So the troubleshooting process is a little less complicated.

Another thing that's really nice is most telco service providers are not just doing DSL or DSL2. In fact, on most DSL elements today, an individual port will support both VDSL2 and ADSL2+ on the same port, so depending on what kind of modem you have and how far away you are, you may actually train up on VDSL2. The major difference between cable and DSL networks or telco networks in general, is an average sized telco operator instead of having one to four access concentrators in a head end like the CMTS on the cable side, telcos are going to have two to three hundred. Maybe as many as four or five hundred depending on how spread out they are. So you have a lot more active elements that are out in the field because this distance hugely impacts the performance. Very commonly, the telco operator will also have a fiber network and these could be GPON, BPON, active Ethernet, it really doesn't matter. But the really nice part is now because these networks were almost never deployed initially with PPPoE, because the early PON standards didn't support it and deploying a box just to do PPPoE in an active Ethernet network didn't make sense to a lot of people. This meant you probably had to build a DHCP infrastructure to support them. So in a lot of cases they already have a DHCP system in play. This lets them use the same infrastructure for both kinds of networks. And if they have wireless, for example if they are doing WI-MAX or a licensed wireless play, DHCP is also most likely the protocol that will be used.

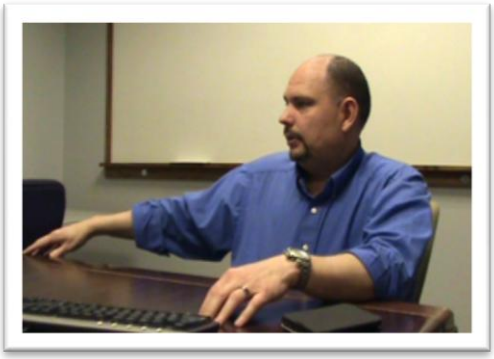
Chances are they're already equipped to switch?

Helms: Right and it's always a good idea if an operator can get all technologies using the same piece for the IP information as this makes things a lot simpler to manage. If they are using IPTV, even in the scenario where they were doing PPPoE, this was also true. If people are doing IPTV, they're also doing DHCP. Because I know of no system that tried to do PPP on the video side, so what would happen in that scenario is the modem would actually have two Virtual Circuit Identifiers (VPI:VCIs). One for video and one for data, and it would have multiple Ethernet interfaces. You have to for this case, so one that would go to the video side and it was doing DHCP, and then one that was going for the internet side for the home, and this one could be doing PPP. So again, in that scenario, that is just a lot more people who have a DHCP system already and it's simpler if you can marry those two things together and can get rid of the PPP side of your architecture. And even if somebody's not doing fiber today, at some point, they are going to be doing fiber. Most telcos are already, even if it's just for one specific case.

So to sum up…

Helms: To sum up, operators may already be equipped to switch, they'll see a huge cost savings when it becomes necessary to upgrade the server, and they'll realize network simplification which will make their whole operation run smoother.

Biography



Scott Helms began his career with ISP Alliance which later became ZCorum, back in 1998, ancient times in light of today's technological advancements.

A South Carolina native, Scott attended the University of South Carolina to pursue a degree in Political Science. While at USC his interest in communications began with the Army's Signal Corp. After winning a scholarship to Gordon Military College in Georgia, that interest escalated while working part time at ISP Alliance, a fledgling company that became the first ISP provider in the state of Georgia.

It soon became apparent that he had found his niche as he worked his way through the various positions in the Tech Support Department, moved up to Assistant Manager of Web Development and began working on DSL deployment projects. Soon after he was promoted to Director of Technology and put in charge of the Development, Production and Broadband Groups, at that time located in Gordon, Georgia.

After moving to Atlanta and ZCorum's corporate headquarters in 2004, Scott was promoted to Vice President of Technology. As VP, he leads the engineering and development teams, located in Alpharetta, Georgia, in managing ZCorum's Affiliate networks and developing software applications.

Scott spends his spare time, hiking and reading and writing code. He met his future wife while attending college and they are expecting their first child in December.

He's an active member in the Society of Cable Telecommunications Engineers (SCTE) and the American Registry of Internet Numbers. (ARIN).

About ZCorum

ZCorum provides broadband Internet and communication solutions to telcos, cable companies, utilities, and municipalities, assisting in all facets of broadband implementation, integration, engineering and consulting, network monitoring and diagnostics. ZCorum also offers wholesale, private-labeled Internet services, including data and VoIP provisioning, email, Web hosting, and 24x7 support for end-users, enabling service providers to compete effectively in their local rural and suburban markets. ZCorum is headquartered in Alpharetta, GA. For more information, please visit www.ZCorum.com or contact Alex Rivera at 800-909-9441 ext. 5562 or arivera@zcorum.com.