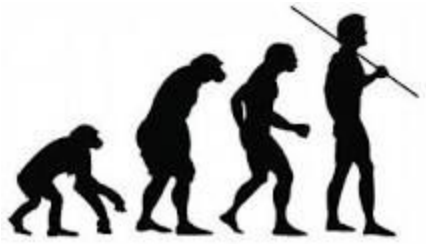
IPv6, Where is Darwin?



The business of providing Internet Service is a business that has gone through many evolutions in the last couple of decades since it's commercialization in the early to mid 1990s. I remember the early days of the Internet. It was an appliance, a centrally located computer in your home that required you to use a dial-up modem over a phone line to connect. In those early days, the World Wide Web was King and many "under construction" animated graphic images were common on many websites! Lots of websites, but content was not nearly as deep and rich as it is today.

Even in those early days, the Internet required Service Providers to standardize on the networking protocols and technologies to allow for global connectivity. The protocol used was introduced in 1983 and is known as IPv4. If we fast forward from the days of the Internet being a single dial-up computer in the home or business, today the Internet is comprised of high speed connectivity, advanced applications, machine to machine communications and it is relied upon to keep the lights on, medical facilities operating and a place to get your degree from the comfort of your own home. The list goes on…..

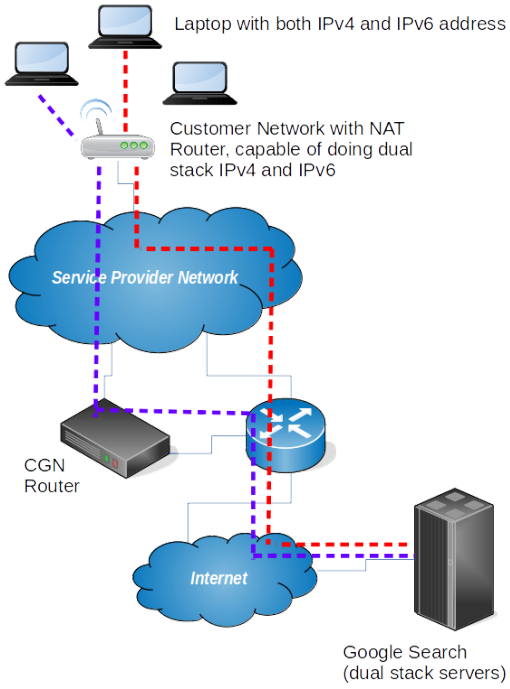
This all sounds great, so what is the problem? The exhaustion of the IPv4 address space has happened. The Internet has no more addresses for new customers, expanding customers and the growing complex maze of systems that rely on these IPv4 addresses. As an industry, we recognized that the IPv4 protocol was not going to be enough. In 1998 the Internet Engineering Task Force (IETF) introduced IPv6 as a draft standard. It was designed with massive growth in mind and designed to replace IPv4. Most hardware vendors that manufacture the equipment to move data across the Internet have supported IPv6 for over a decade now. You might be thinking. Wow, this is great! This doesn't sound like a problem to me! This is great news! Not so fast, there is a catch (there is always a catch!). IPv6 is not backward compatible with IPv4. A device with an IPv4 address cannot "natively" talk to a device with an IPv6 address. How is the global Internet going to move to IPv6? If IPv6 is not backward compatible with IPv4, how is this going to solve the IPv4 exhaustion problem? For the most part Internet Service providers shelved the idea of moving to IPv6. For a long time, most Service Providers had enough IPv4 space to allow each customer to use one IPv4 address. Customer Premise Equipment (CPE), such as wired and wireless home routers were developed that could allow multiple devices to use the single IPv4 address provided. The technology is called Network Address Translation or NAT. This technology allows the customer router to use the one public address for all Internet requests coming from inside the home or business. Because the SOHO router is making all

requests, it has to keep track of what request was made for each device inside the network so that it knew where to send the return traffic.

As an industry we continued to create and innovate and engineer ways to avoid having to deploy IPv6. It has been impressive. It brings tears to my eyes as it reminds me of my own attempts to avoid chores around the house. The demand for Internet connectivity continued to grow as the IPv4 exhaustion problem grew. Following the release of IPv6 as a proposed standard, transition technologies were developed to help service providers migrate their networks to IPv6. The most straightforward method to migrate to IPv6 is what is known as "dual stack". This means that your network, computers and tablets, etc. runs both IPv4 and IPv6 at the same time. From the network core all the way to the customer, the network would have both IPv4 and IPv6 addresses. Microsoft Windows computers, MAC Computers, iPhones, IPads, Android devices, Linux, BSD, etc. all have supported dual stack for many years. Once enabled, it is transparent to the user which protocol is actually being used to connect to various resources on the Internet. Service Providers continued to avoid IPv6 deployment. As it was looked upon as providing a single benefit (the exhaustion of IPv4). As we continue to move forward in time, The Regional Internet Registry that is responsible for IPv4 allocations to Service Providers in the North America has reached exhaustion.. So what now? Again, being Engineers good at problem solving, we developed Carrier Grade NAT (CGN). From a technical perspective CGN is not much different than the NAT home users run on their home routers. The Service Provider stops providing the customer with a "public IPv4 address". Instead it provided a "CGN IPv4" address which is then NAT'ed at the Service Provider level. Today many customer devices sit behind double NAT. If not doing CGN, providers are purchasing IPv4 address space on the open market at an extremely high cost.

So what has Darwin been doing all this time? Does the theory of Natural Selection not apply to technology? Clearly IPv6 is a superior protocol compared to IPv4. Darwin is alive and well and I believe is waking up and will force Service Providers to migrate to IPv6. Many Service Providers still ask, "we can deploy IPv6, but we still need IPv4, so what is the benefit?".

For Service Providers that have deployed CGN routers in their networks, dual stacking it's first customer will have a benefit on the Service Provider network. The dual stack standard states, that a host with both an IPv4 and IPv6 address should attempt to connect to a resource (e.g. a website) via IPv6 first. And if that resource is IPv4, then fall back to IPv4. So what does this look like in the service provider network.



In the above diagram the red line depicts the IPv6 connection between a wireless,dual stack PC and a Google server. The customer router does native routing (no NAT for IPv6). The CGN Gateway is also bypassed. Therefore there is not a single NAT translation in the path. The immediate effect is decreasing the load on the CGN router. The blue line path depicts an IPv4 connection to Google, where the customer router must do NAT and then the customer request also must be handled by the Service Provider CGN NAT router.

Even if you have plenty of IPv4 address space, there is a cost for Content Providers to provide both IPv4 and IPv6 access to content. It imposes additional load on network routers and servers as well as additional human resources to support both protocols. So again, I ask the question, where is Darwin and will Natural Selection occur? IPv6 after all is an evolution of IPv4 and has many common traits and similarities. As Content Providers see the demand for content via IPv6 increase, they will start to discontinue support for IPv4. Or perhaps certain applications within a cloud environment will be frozen/capped at a certain version if you are accessing via IPv4. And slowly what once was a valuable resource will slowly be devalued (IPv4). But just as my Uncle Stanley is the last knuckle dragger in my family, Natural Selection will take place and the evolution to IPv6 will occur. Will your network be ready?

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