**DEPARTMENT OF COMMERCE**

**National Telecommunications and Information Administration**

**The Incentives Benefits, Costs and Challenges to IPv6 Implementation**

**Docket No. 160810714-6714-01**

**RIN 0660-XC029**

# COMMENTS OF AT&T SERVICES, INC.

AT&T Services, Inc., on behalf of itself and its affiliates (together, "AT&T), respectfully submits the following comments in response to the National Telecommunications and Information Administration's (NTIA) Notice and Request for Comment concerning the Incentives Benefits, Costs and Challenges to IPv6 Implementation under the Request for Public Comment Docket Number 160810714-6714-01. In this docket, NTIA seeks public input on a series of questions to help guide future action and policy decisions for promoting the adoption of internet Protocol Version 6 (IPv6). More specifically NTIA raises a series of questions regarding the benefits, obstacles, incentives, motivation, return on investment, cost of implementation and promotional efforts around the migration to IPv6. AT&T, as one of the nation's largest providers of Internet based-services, has extensive experience in the deployment and implementation of IPv6, and based on that experience offers the following comments in support of the NTIA's important efforts to promote the continued migration to IPv6.

## BACKGROUND

The Request for Comment recognizes an important consequence of the explosive growth of the Internet. As ever more devices connect to the Internet -- computers, smart phones,

netbooks, tablets, connected vehicles, smart cities and the Internet of Things (IoT), each of which requires its own unique IP address -- the legacy system supplying those addresses is rapidly nearing the point of exhaustion. In short, we are running out of IP addresses. The IPv4 standard, which has been in place since 1981; simply lacks sufficient address space to keep up with the surging demand. In contrast, the successor technology to IPv4, IPv6, is available now, and should be capable of supporting a virtually limitless number of new devices that will connect to the Internet. As such, and as NTIA recognizes in the Notice, transitioning to IPv6 is a critical step for supporting the continued, sustainable growth of the Internet.

For its part, AT&T envisions a future in which literally billions of IP-enabled devices are connected to the network, and IPv6 is a critical enabler of this vision. Accordingly, AT&T began planning for the transition to IPv6 in 2006. But AT&T's long history of leadership in the development of IPv6 pre-dates even our initial transition plans. This includes our 1996 connection to the 6Bone IPv6 test bed network and our 2003 support for the MoonV6 network. In addition, AT&T started supporting initial IPv6 Internet customers as early as 2004.

In 2009 AT&T opened a corporate program office to kick-start and manage the ongoing migration to IPv6. Given the complexity of this transition, AT&T had to anticipate that IPv4-based networks would co-exist with IPv6 networks for a substantial number of years, meaning devices and networks connected to the Internet through IPv4 addresses would have to continue to be able to send and receive packet communications as they do now. Successfully managing this transition required AT&T, and other companies, to employ multiple techniques to extend the life of existing technologies and minimize the impact to customers. Some highlights of this program included the following:

- Optimizing our IPv4 address inventory to extend their life until exhaust.

- Offering dual-stack IPv4/IPv6 services (started in June 2009) and other capabilities such as tunneling (6rd) to enable interworking between IPv6/IPv4 networks during this transitional phase.
- Enabling our IP backbone to support IPv6 over peering links
- Providing IPv6 content from AT&T websites
- Ensuring that our network and IT infrastructure is IPv6 ready by providing interworking between pure IPv4 networks, dual stack IPv4/IPv6 networks and native IPv6 networks.

Our objective throughout this process was, and continues to be, to ensure that our customers experience no impact or loss of functionality as a result of the transition. According to WorldIPv6Launch.org, as of September 30, 2016, approximately 60% of the wireline traffic and nearly 15% of the wireless traffic originating from AT&T Autonomous System Numbers (ASNs) is using IPv6 today.[1]

Ultimately, IPv6 gives the industry greater room to grow, innovate and support new devices. Thus we applaud NTIA's efforts to drive greater IPv6 adoption. All members of the Internet ecosystem, from broadband internet access service providers, content providers, enterprise network providers, applications developers, consumer networks/end users, equipment vendors and others, will need to prepare for IPv6. Although we have seen significant progress in this area, there is still clearly more work to be done. In the following section we address some of the topic areas raised by NTIA.

## BENEFITS

As noted above the primary benefit of IPv6 is that it addresses the address exhaust concerns around IPv4. But that is not the only benefit of moving to that protocol. For example, IPv6 is critical for the deployment of Voice over LTE (VoLTE) services because VoLTE is

[1] *See* http://www.worldipv6launch.org/measurements.

dependent upon a direct connection to the end user and will not function behind Network Address Translation (NAT) or other technologies that would otherwise be used to extend the life cycle of IPv4 addresses. Also because IPv6 enables that direct connection, IPv6 can offer lower latency, which improves call quality. More advanced users also may find it easier to run servers; e.g., host games, support their own email server etc., again because of the absence of NAT.

## OBSTACLES

In AT&T's experience, one of the biggest challenges related to IPv6 implementation is that running dual stack service requires more computer memory and central processing unit (CPU) capability than single stack. This problem is most evident in consumer devices. Old hardware in consumer devices simply cannot run IPv6 because they must still support IPv4 during the transitional phase. As such they lack the processing power to manage both IPv6 and IPv4 simultaneously. This is a hardware limitation; thus firmware upgrades don't resolve the problem. This problem also is exacerbated by the fact that new devices continue to be built that only support IPv4 and will not be capable of supporting IPv6 in the future due to hardware limitations.

Another challenge that AT&T and others in the industry continue to see involves deficiencies in some operating software, particularly software that is used to run consumer grade devices. For example, at a recent IETF meeting in Buenos Aires several ISPs reported that obtaining routers with working IPv6 code was proving to be one of their biggest challenges with IPv6 deployment.[2] This is in spite of the router testing that is available from the University of

[2] *See* "IPv6 deployment in LAC: successful and not so successful stories" *at* https://www.ietf.org/proceedings/95/slides/slides-95-v6ops-1.pdf.

New Hampshire Inter-Operability Laboratory (UNH-IOL), and well-documented and consistent requirements from Broadband Forum, CableLabs, and the Internet Engineering Task Force (IETF). Lastly, there still remains some network equipment that cannot support IPv6. This is why companies such as AT&T have had to implement 6rd technology or tunneling to enable IPv6 over an IPv4 network.

In order to overcome these obstacles and successfully manage IPv6 deployment, all players in the ecosystem will need to develop internal IPv6 expertise and to engage proactively in the broader Internet community to remain up to date on developments in the technology. As IPv6 moves further along the maturity curve many of these issues may ultimately resolve themselves, but they will be continue to present challenges at least for the immediate future. NTIA can play an important role in raising awareness and in convening stakeholders to drive adoption across the ecosystem.

## INCENTIVES

The single largest factor that contributed to AT&T's decision to migrate towards IPv6 remains overcoming the impending unavailability of IPv4 addresses. Also, the greatest incentive for dual stack of native IPv6 is the cost of implementing other technologies, such as Carrier Grade Network Address Translation (CGN), tunneling (6rd) or other work-arounds.

In terms of incentives that may help encourage adoption of IPv6 among the broader community, perhaps the biggest driver is that more and more devices and applications, in particular in the emerging IoT space, will depend upon a direct IP connection, rather than being able to operate behind NAT boxes or proxy servers. This means that companies, content providers and other entities that want to participate in this marketplace will ultimately have to

migrate towards IPv6. This likely will be a gradual migration, as for many companies, the performance benefits of IPv6 may be difficult to determine given that they are likely largely to be invisible to the user. For those companies the gains of implementing IPv6 now may not be seen as greatly outweighing the costs of delaying deployment, or ignoring it altogether. The NTIA thus could play an important role in accelerating the transition by raising the awareness of the benefits of IPv6 technology.

## MOTIVATION/RETURN ON INVESTMENT

The fundamental motivation behind an organization's decision to implement IPv6 ultimately boils down to necessity. ISPs or service providers such as AT&T know that, despite current workarounds, eventually IPv4 addresses will exhaust, and that supporting the ever-escalating demand for Internet access makes migration to IPv6 inevitable. But it is far from clear that other stakeholders in the ecosystem have yet fully recognized this reality, especially as, at least in the near term, migrating to IPv6 does not generate new revenues, and in fact may increase operational costs. This may be particularly the case with device makers, for whom the benefits of IPv6 technology may be extremely unclear.

## IMPLEMENTATION

Finally, NTIA inquires about the planning process and time to implement IPv6. In AT&T's view the implementation of IPv6 is evolutionary. We expect IPv6 and IPv4 networks to coexist for a significant period of time as the industry gradually migrate towards IPv6. As we described above, IPv6 readiness requires several steps and significant investment in new equipment or upgrading existing equipment with firmware updates, operating system updates,

other software and router updates, firewalls, and hardware upgrades. All of this takes time, and thus a gradual managed migration likely will be the norm.

## CONCLUSION

AT&T applauds NTIA for its support of the IPv6 transition, and for opening this inquiry into steps for further promoting that process. AT&T looks forward to continue working with NTIA in that important work.

Respectfully submitted,

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