Introduction

Microsoft has a long history of supporting IPv6, starting with Windows Vista, Windows Server 2008, and Windows XP Service Pack 3. Our early support demonstrated technical leadership and a recognition that IPv6 represented the future of networking. We appreciate the opportunity to provide feedback to NTIA regarding the challenges of IPv6 adoption.

This paper assumes that IPv6 and IPv4 will coexist for quite some time. For this reason, we do not include any discussion about potential power, computational or software maintenance efficiencies which would arise from a purely IPv6 environment.

Benefits of IPv6

Aside from the obvious benefit of a much-larger address space, IPv6 benefits to Microsoft include improved peer-to-peer networking for communications and multiplayer gaming and improved delivery of personalized user experience using IP-based location services.

We expect to see minor performance benefits as address translators are removed and implementations are improved. Since some equipment implements IPv4 in hardware, but IPv6 in software, hardware parity over time should improve performance. To date, IPv6 performance in Microsoft has been the same as IPv4 for practical purposes.

Obstacles to IPv6 Implementation

As recently as 2014, Microsoft encountered noteworthy price and support deltas from our equipment suppliers for IPv4 and IPv6 solutions. Hardware with larger addressing tables to accommodate IPv6 in the Microsoft datacenter environment was significantly more expensive than the IPv4 solutions already in use. In addition, we encountered IPv6 breaking bugs during vendor firmware updates which strongly indicated that IPv6 test processes were not at parity within the vendor engineering departments.

When rolling out IPv6 to users of the Office 365 Exchange Online email service, Microsoft encountered multiple customer-impacting bugs in service providers, from mobile operators to edge network providers. One such bug remained open for several months as the mobile operator worked with their hardware supplier; in retrospect, the difficulties they shared with us could have been a good predictor of troubles we would have with our own supplier months later.

Incentives to IPv6 Implementation

Service providers are impacted by IPv4 address depletion – globally routable addresses are becoming a precious commodity.   Some Microsoft services are impacted more than others from either architectural or scenario perspectives.

However, some services are relatively unimpacted and are able to continue to as IPv4-based systems. For the latter services, the engineering cost to add native IPv6 cannot always be justified relative to the cost of operating the existing network with address translation, in spite of the inefficiencies.

Service providers are also impacted by the difficulty of providing personalized user experiences and targeted advertising based on location services when IPv6 support is delivered via address translation, since NAT64 obscures location data and can be very misleading. Location services are also limited when IPv6 data is not well populated in location service databases.

Few customers request IPv6 support, and those who do typically do not require native support; address translation is acceptable.

Government mandates are to date the only credible customer forcing functions for adding IPv6 support. However, not all government have mandated IPv6, and of those that have, enforcement of the mandate differs from agency to agency. Microsoft is not alone in that our engineering groups are justifiably cautious about such mandates, which may force changes to feature delivery priorities without delivering commensurate customer usage.

Motivation for Implementation of IPv6

As a provider of online services, Microsoft's motivations are described above. As a networked organization, Microsoft is looking for internal efficiencies in its "Intranet of Things", including servers, workstations, BYOD, and infrastructure embedded devices such as cameras, sensors, clocks and displays. Decisions are made at levels below the CTO and are based on the individual goals and budgets of the executives who seek such efficiencies.

Advocacy of IPv6 occurs at levels below the decision makers. It is understood that IPv6 will be a hard sell because it is more difficult to quantify the potential benefits than to quantify the likely costs to replace equipment, retrain staff, and implement the physical and configuration changes required to make the transition. This is particularly true when networks are heterogeneous mixtures of operating systems and include embedded devices and sensors which are assigned addresses and remotely managed differently than servers and workstations.

Return on Investment

For Microsoft as a service provider, the anticipated return is a mixture of reduced risk and increased market opportunity. The internal use of globally non-routable addresses creates risk because the addresses can leak into the Internet due to human error and misconfiguration. Moreover, the need to purchase IPv4 addresses on the open market introduces risk due to fluctuating commodity prices.

Market opportunities increase when customers mandate IPv6 support and when IPv6 allows faster infrastructure growth for services experiencing rapid customer usage.

Microsoft corporate IT efforts are based on a belief that IPv6 support is a cost of business, with returns on investment to be seen only over a very long time frame.

Implementation Details

The implementation of IPv6 requires code reviews by developers of services and internal line of business applications, contractual requirements for vendors and equipment suppliers, new addressing plans which accommodate a heterogenous environment and redesign of online protection services to protect

against spam and other malicious activities. The IT planning activity, which spans multiple organizations within the company, was equivalent to at least single resource dedicated for many months over at least a calendar year. Changes to each impacted online service have been even more costly.

Promotional Efforts

NTIA should encourage public sector entities to mandate that all hardware, software and online services providers have a published IPv6 roadmap with a clear service level agreement in place for mitigating IPv6 issues which arise. These mandates should be more than checkbox requirements in contracts or blog posts on government sites. They should be backed by resources who can participate with suppliers to ensure roadmaps and support processes are sufficiently developed.

Governments may be loath to make such mandates because their own efforts may be nascent, late or even nonexistent. This choice merely postpones the essential engagement with suppliers of hardware, software and online services by IT, procurement and standards agencies within the public sector.

Microsoft is not aware of any effective private sector promotional efforts to drive IPv6 adoption. ISPs and mobile operators are indeed touting their own IPv6 adoption, and have in some cases forced changes to their software and online service providers (e.g. redesigning peer-to-peer offerings with hardcoded IPv4 dependencies), but this creates little direct impact on companies outside of their supplier base to provide IPv6 support.

Contributors

Armando Stettner, Principal Program Manager, Microsoft Corporation
Dawn Bedard, Senior Program Manager, Microsoft Corporation
Marcus Keane, Senior Service Engineer, Microsoft Corporation
Mark Svancarek, Principal Program Manager, Microsoft Corporation
Zac Smith, Principal Service Engineering Manager, Microsoft Corporation