Applications that will Drive IPv6

Market Drivers
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INTRODUCTION

The earliest published standard for the Internet Protocol is RFC0760 [DoD standard Internet Protocol] in 1980, and later obsoleted by RFC0791 [Internet Protocol]. This later grew into what would be known as the Internet Protocol version 4 [IPv4]. At a time when participating hosts in the network were numbered in hundreds (if that) there seemed to be no limit to the connectivity and sharing afforded by the protocol. After all, it allowed for a full thirty-two [32] bit address! That was sixteen million Class A addresses [16,777,215, actually], sixty-four thousand [65,535] Class B addresses, and two-hundred and some [253 to be exact, excluding the broadcasts] Class C addresses. Who could possibly conceive of that many individual hosts connected to a single network, much less that many networks talking to each other?

Well, a couple of decades later, and following the creation of something called the "World Wide Web" it has become blindingly apparent that four octets worth of addresses were not, indeed, enough. While the term "host" was readily defined and understood in the earlier days of the 'Net, in today's environment such is not the case. Browser technology is embedded in devices ranging from automobiles to gaming consoles to cellular telephones. The common denominators among all of them are the mobility of the devices, and their sheer numbers. These factors alone are exhausting the pool of available thirty-two bit addresses, and present a crisis to current Internet architectures.

The solution: the rapid adoption of IPv6, the next generation IP that [among other capabilities] provides for a one-hundred and twenty-eight [128] bit address. Originally defined in RFC1883, [Internet Protocol, Version 6 (IPv6) Specification] in 1995, the protocol revision was specifically designed to resolve the issue of address constraints under IPv4.

There has been much published about the basics of IPv6, its advantages over IPv4, as well as the mechanisms for transitioning from IPv4 to IPv6. Although there are national IPv6 services (e.g.: most nations in Asia or on the Pacific Rim require a native IPv6 implementation), there are not many actual commercial implementations. In this paper, we propose that it will be new services that need the benefits of IPv6 (larger address space, security, end-to-end service) that will drive IPv6 commercial implementations. We also examine the current state of IPv6 in terms of experimental and real-life implementations.

DISRUPTIVE TECHNOLOGIES AND IPV6

According to the article "Upgrading the Internet" (The Economist, March 22, 2001), "Another possibility, raised by Pete Loshin, a computer consultant and the author of 'IPv6 Clearly Explained', is that IPv6 might spread in the form of a disruptive technology'. In other words, IPv6 might take off in totally new applications that the current incumbents in the networking business have not foreseen, rather than simply via upgrades of existing equipment."

While we agree that some disruptive technology might really push IPv6, it is proving more likely that applications talked about for years, but not quite ready in the past, may dictate using IPv6 and then spread the adoption of this protocol. We will discuss three of these applications that we believe will help push IPv6: service convergence, Next Generation Networking, and home networking; and we will also discuss possible implications for IPv6 coming from mobile IP and online gaming.

Service convergence

"Convergence" of one kind or another (well, really the same kind, if truth be told) has been a topic of conversation and speculation since the mid-90s. What it boils down to is this: the unification of separate networks into a single one, for the delivery of *all* services provided to subscribers connected to that network, regardless of the type of connectivity and end device. By the mid-00s, that has come to mean that legacy dedicated [ATM, Frame Relay or unstructured] networks designed to carry specific services are being collapsed onto what are predominately, packet-switched networks. These packet transports are being provided over a number of different media (e.g.: digital subscriber loops, fiber [to the premise or to the home] or wireless networks) but carry the same end-user services. Content has become divorced from underlying infrastructure, resulting in an explosive growth in not only numbers of end devices, but in device types, as well: kitchen appliances deliver multimedia data while forwarding purchase orders to local merchants; home gateways provide content to remote, same-domain devices across the public infrastructure; mobile devices such as telephones or computing devices (i.e.: PDAs or tablets) request and display information regardless of type or content (e.g.: HTTP data like maps or MP6 streams carrying on-demand Video).

This convergence of traditional wire-line and newer optical networks, and of traditional services such as voice with newer services such as video is giving rise to what is being referred to as a Next Generation Network. The NGN consists of a single physical plant on which are layered commodity services (e.g.: voice for a PSTN provider) and newer subscriber services (e.g.: streaming video).

Next Generation Networking

Carriers are deploying IP Next Generation Networks to deliver triple play services, including video-based services like IPTV. Carrier success in delivering the 'triple-play' of voice, video, and data is not only dependent upon the proper choice of service and content partners but also on the right network infrastructure. This network infrastructure must be capable of evolving as business and consumer needs change, as new services and applications are introduced into the marketplace, and as bandwidth needs grow. Video may play a small role in IP traffic growth immediately, but will figure prominently in the long term.

The initial video applications will be broadcast and on-demand video. Other growing demand applications will be video-based, as well. However the table stakes service is broadcast video and subsequently it has the highest level of expectation from the viewer -- therefore it will be necessary to protect the integrity of this service while seamlessly integrating it with existing voice and data services and introducing additional services.

This rise in broadcast video, video-on-demand and other video-enabled services will place increased demands on provider infrastructures. Traditional wire-line IP architectures are not robust or resilient enough to deliver video and support the viewing experience that is the expectation of the current consumer market. Providers are actively investigating the requirements to deliver video over this all-IP infrastructure. To adequately address the challenges imposed, it will be necessary to provide for high quality services protected from disruption and to do this while scaling to bandwidth in terms of terabits per second.

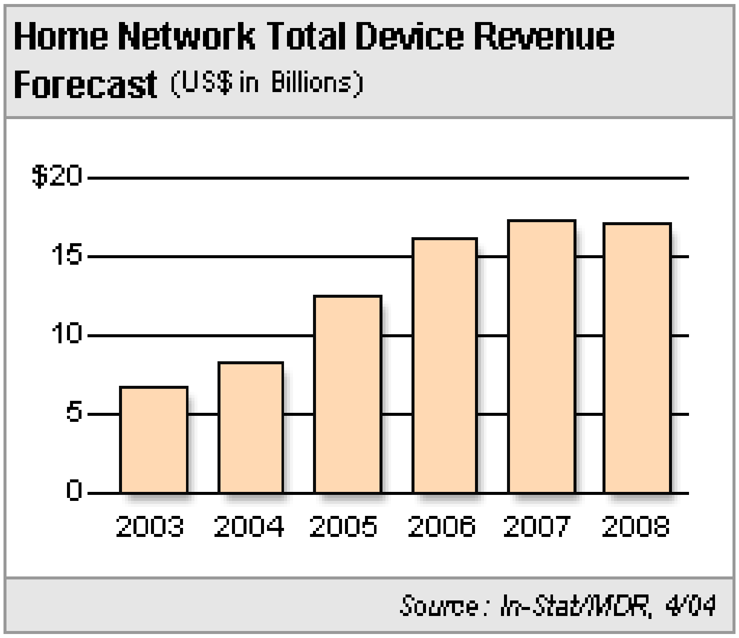
Only IP Next Generation Networks will incorporate all the elements, such as Quality of Service, massively scalable multicast transport and continuous systems operation which will provide the foundation necessary to offer the high-end, high demand video-based services providers will require going forward.

Using NGNs, multimedia data will be available on any device, at any time, anywhere in the world.

Home Networking

Market Opportunity

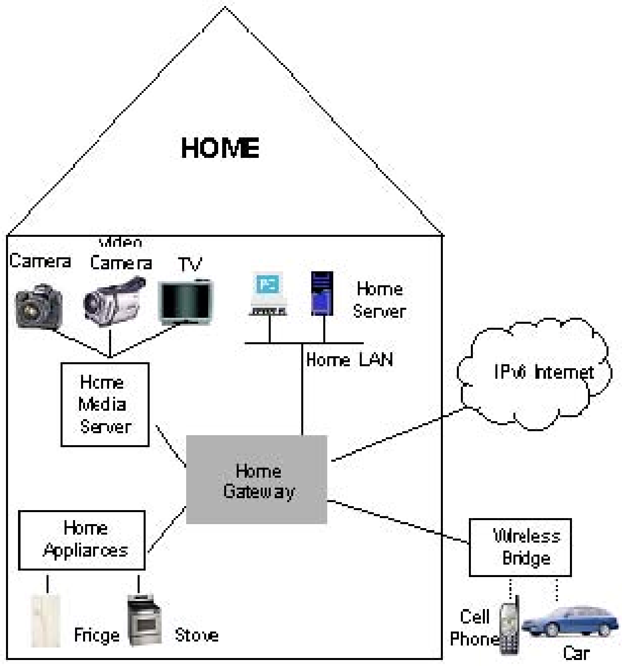
Embedded devices are all the rage in the electronics industry. More and more devices contain microchips and processors, such as cars, cell phones, video equipment, TV's, home appliances, and games.



Home networking entered the mainstream in 2003 and early 2004, as large numbers of broadband users installed home networks to share Internet connections and electronics vendors delivered new products to send high-value entertainment content over the network. In 2005, over 100 million broadband CPE units (broadband routers, residential gateways, and broadband modems) shipped, an increase of 31% over 2004. The growth of home-based broadband and DSL equipment is driving the market for home networking. According to In-Stat/MDR (http://www.instat.com), the continued need for broadband sharing and a growing interest in entertainment networking will drive the total value of equipment with a home networking connection of some type from $8.3 billion in 2004 to $17.1 billion by 2008. Currently, the home networking market is seeing entries from: Nortel, Samsung, Access/IP Infusion and Siemens, to name a few. All are getting in on the emerging market for Next Generation Networking, specifically the receipt and distribution of multimedia data like streaming audio, or IPTV. Further, the devices are targeted at the acquisition, storage and then delivery of personal multimedia data to both local and remote end-points belonging to the 'trusted' network.

The end effect is to introduce and connect even greater numbers of end-points to the network, straining the existing IPv4 address space.

Market Implementation



New technologies such as IEEE 1394, 802.1a/b/g and Bluetooth for both mobile and home use are being deployed in large numbers. As these processors make their way into more and more devices, it is ever more likely that these devices will be network ready. Televisions are being produced with embedded cable connectivity, as well as advanced networking ability as part of the Digital Living Network Alliance [DLNA]. Mobile telephones use this technology to take the place of remote controls in selecting programming for viewing. Content is distributed throughout residence using centralized gateways that store and forward audio and video data. That same data is then available via an Internet connection to household members as they travel on business.

The average consumer has no desire to configure multiple devices, in multiple locations, using multiple tools. Simplicity has been proven to be key to success in the consumer market. Therefore, devices are coming hardwired for IP connectivity, because consumers are not willing to perform these complex management tasks.

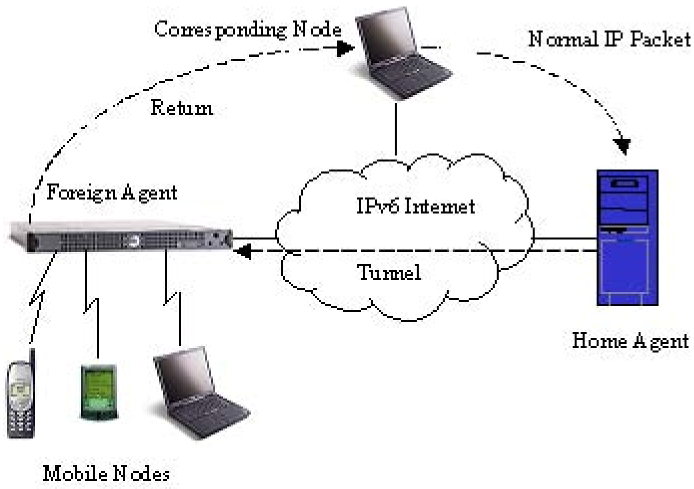
The solution is to embed IPv6 technology into new devices. IPv6 offers such a large address space that it is likely devices and appliances of the future will contain IPv6 network processors and be stamped with IP addresses that act as serial numbers. Imagine the refrigerator that has sent you an email telling you it ordered replacements for the menu items you selected and put in the microwave before leaving home. Imagine the microwave then sending a reminder that you have programmed dinner for seven this evening, and asking if you have managed to avoid that last-minute meeting, so it can begin the heating program. And then imagine sending a reply back to that microwave from your automobile telling it to accelerate things by a half-hour, because you've managed to leave the office early.

Home networking will drive the use of IPv6, both in residential gateways and appliances.

Mobile IP

Mobile computing is one of the most talked about technologies. With the explosion of mobile devices that need always-on connectivity, it is imperative that protocols be developed that allow for IP connectivity regardless of the physical location of a device. The problem is that IP was not meant for roaming devices. The answer to this problem was the development by the IETF of the mobile IP standard in RFC2002 [IP Mobility Support]. This standard defined the concept of a Home Agent (HA) and Foreign Agent (FA), together with a Mobile Node (MN), and Care-of-Address (COA).

The basic concept as shown in the diagram below, is that each MN has a HA. When a MN goes away from the HA, it registers with an FA. The FA then contacts the mobile nodes HA. When a Corresponding Node (CN) wishes to contact an MN, it sends the data packets to the HA. The HA then tunnels the packets to the FA, which delivers the packets to the MN.



Since RFC2002, there have been additional specifications in the IETF updating and expanding the role of mobile devices in IP networks (e.g.: RFC2290 [Mobile-IPv4 Configuration Option for PPP IPCP], RFC2794 [Mobile IP Network Access Identifier Extension for IPv4], or RFC3220 & RFC3344 [IP Mobility Support for IPv4]). These additions provide for the enhanced security and protection of session-related data to and from these devices.

While the IETF has been concerned with Layers 2 and above in the wireless arena, the IEEE has been fleshing out the set of standards for wireless communications not only protection, but performance, as well (e.g.: 802.1X, 802.11a/b/g, 802.15, 802.16). Wireless networking has grown from a LAN extension application to regional and long-haul services in areas where it is impractical or undesirable to implement wired infrastructure. Geographies and subscribers unimagined by the intrepid ARPA pioneers are getting connected to a global IP infrastructure, straining the IPv4 address space even further.

Because these protocols are so new and will incorporate a potentially huge number of devices with embedded IP addresses, it is very likely that Mobile IP will be heavily deployed using the IPv6 protocol. The neighbor discovery protocols inherent in IPv6 greatly simplify the process of finding a foreign agent. Mobile IP is a protocol that will grow with the advent of new mobile devices and equipment. This should greatly expand the use of IPv6.

Online Gaming

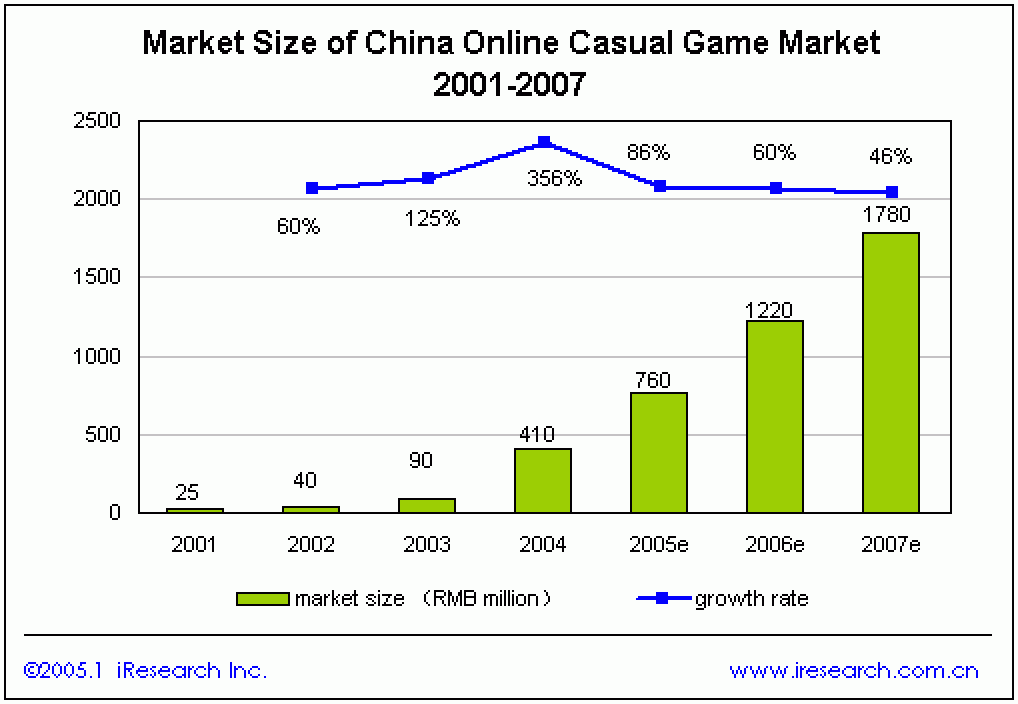
Shin Miyakawa, Research Lead, Internet Technologies at the NTT Multimedia Communications Laboratory expressed his personal opinion that “[o]nline games can be one of the killer applications which will boost IPv6 suddenly in (the) very near future.”

“Online Gaming” has taken some evolutionary paths that were not envisioned in the early 2000s when speculation first started as to the impact of this pursuit on networking, and the IPv4 address space in particular. Originally, it was foreseen as a very localized application between limited numbers of application-specific handsets that would nevertheless required unique addresses taken from the public address pool.

This still remains a viable application in the gaming world, but it has been eclipsed by the introduction of internet-accessible Massively Multiplayer Online Games [MMOGs], with subsets such as Massively Multiplayer Online Role-Playing Games [MMORPG] and Massively Multiplayer Online Real-Time Strategy [MMORTS] games. The names say it all.

The adoption of online gaming has taken some very specific regional paths that were not understood in the early days. Adoption has been very strong in the Asian and Pacific markets, with Europe trailing and adoption in the Americas relatively non-existent

According to iResearch's **China Casual Game Research Report 2004**, “[the] market size of China['s] online casual game industry was RMB 25 million in 2003, and it reaches to RMB 410 million in 2004 with growth rate of 356%... iResearch forecasts that market size of China online casual game industry will keep fast growth in the following years: its is estimated that market size of China online casual game will reach RMB 1.78 billion in 2007.”



According to IDC Research [July, 2006], "Viet Nam's online gaming market is expected to reach a compound annual growth rate of 14.9 percent during the next four years...with a compound annual growth rate of 21.1 percent from 2006 to 2010, the Asia Pacific online gaming market will more than double its existing subscription revenue market size by 2010 to an estimated 3.6 billion USD. China represents one of the world's largest and fastest-growing markets for online games, with IDC estimating a market valued at 1.3 billion USD by 2009."

Markets of these sizes will attract large investments in terms of financial and development resources. This sort of projected market growth will guarantee that efforts increase to tap into the potential revenue pools that are associated with online gaming. Unbound by application limits, MMOGs are accessible by anyone with Internet access, wherever they are located. As devices designed (originally) for telephony gain in functionality and sophistication, not to mention ease-of-use, the potential set of participants becomes almost limitless. Based on the Internet Protocol, MMOG-driven uptake of these devices for the express purpose of game-playing may put the end to IPv4 as the underlying technology of the global network.

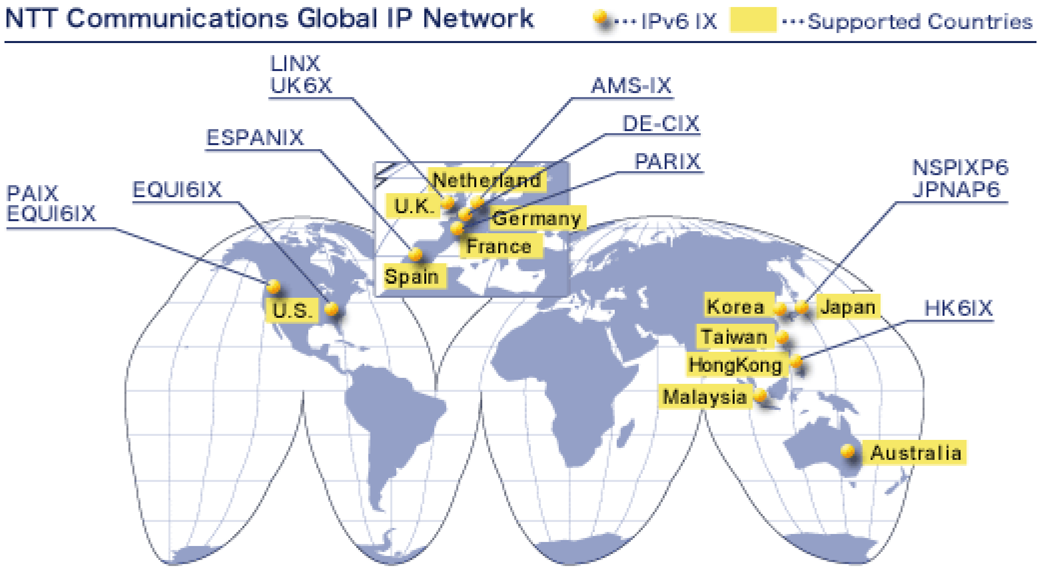
The current IPv4 Internet does not provide the infrastructure required for online gaming, mainly because of address depletion. Online gaming products and services must scale to many geographically distributed players and must be able to provide security for authentication, privacy, and payment. In addition, online gaming products and services must support both fixed and mobile networking. Because of these technical and business requirements, online gaming really cannot succeed without using IPv6 networking.

It is not insignificant that the socialization of online gaming is following the same regional trends as the implementation of IPv6 as the core networking transport technology.

THE STATE OF IPV6 TODAY

There are a number of standards efforts underway today to deal with issues such as: IPv6 architecture, applications, mobility, discovery, routing, security, transition, name service, management, and addressing. Some are complete, many are actively being discussed and worked upon.

IPv6 has shown definite regional trends. The Asian and Pacific Rim nations are leading the implementation efforts for native IPv6 in local and national networks. NTT has one of the largest commercial IPv6 networks deployed. This is a worldwide IPv6 backbone that is completely IPv6 end-to-end.



Also implementing IPv6 are local and national carriers in China and Japan. This can be attributed to the later investments in global networking, and thus the lack of established legacy transport architectures such as are present in the Americas and Europe.

CONCLUSIONS

Although commercial IPv6 offerings are still regional in nature today, we see a growing variety of voices that are asking for IPv6 solutions. There were 320 million Internet users in 2000, it is estimated that there will be over 550 million by 2005. But there were 405 million mobile phones sold in 2000, with over 1 billion being sold by 2005. There will be 1 billion cars sold by 2010, with approximately 15% having GPS or Yellow Page services. It is this increase in end-points that will necessitate the adoption of IPv6 in public networks. The ability to support increased devices will depend upon the larger address space that results from the 128-bit address of IPv6.

With billions of appliances potentially network ready, we have little choice but to proceed with IPv6. Fortunately IPv6 offers a number of new features and simplifications, which should enhance its cost effectiveness and provide additional services to the Internet community.

The main challenge to this protocols acceptance is the sheer size of the effort necessary for the transition, even with the vast array of transition tools, which are available. But it is likely that the main driver for the deployment of commercial IPv6 are the new services which are now being defined. These include home networking, mobile IP, gaming, and others as yet unimagined.

IPv6 has a bright future. The question is when, not if. The when begins now.