

# **Disruptive Technologies:** Applications that will drive IPv6



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## Introduction

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. Though the one question that is not addressed adequately is, what will really drive IPv6 implementations? Although there are experimental IPv6 services, 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.

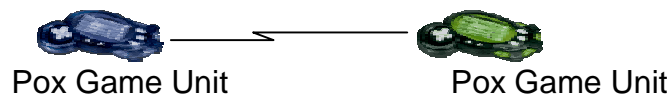
## Disruptive Technology and IPv6

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 more likely that applications talked about for years, but not quite ready in the past, may take advantage of IPv6 and spread using this new protocol. We will discuss three new applications that we believe will help push IPv6. These are online gaming, mobile IP, and home networking.

## Online Gaming

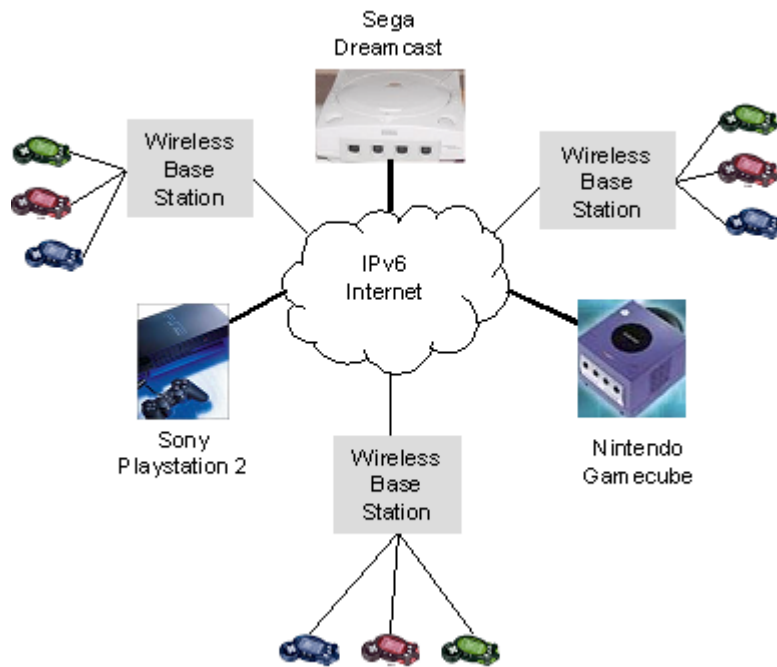
Recently, Hasbro announced a new handheld game called *Pox*. Essentially the game allows individuals to play against each other via wireless radio-frequency technology. A player starts by building a “warrior” character on his or her POX unit. When two units are in range of each other, the warriors will face off in a virtual battle. Round-robin type tournaments will ensue until a single victor emerges when multiple POX units are in range.



This is an example of a multiple player game that can be played across a network. The network in this case is a wireless network with limited range. What if we could network current game units, such as the *Sony Play Station 2*, and allow players to play across the country rather than just in their own rooms? The possibilities are endless of course.

In fact, if we look at the market, we see that the potential is massive. In Japan, from August 2000 to January 2001, 4 million copies of *Dragon Quest* were sold. Over 3 million copies of *Final Fantasy IX* were sold in Japan in 2000. The number of game units sold worldwide is gigantic and growing. In the US alone, the game market is currently over \$10B. Today’s game hardware is becoming more sophisticated and network ready. The Chairman and CEO of Sony Corporation, Mr. Idei, recently stated at the IPv6 Summit in Osaka, Japan, “I’m telling people in Sony not to create anything without network interface.” The *Sony Play Station 2* is almost network ready. It has a PC-Card slot, IEEE 1394, and a USB port. While the *Sega Dreamcast* has a serial port and embedded analog modem with RJ11 to PSTN interface.

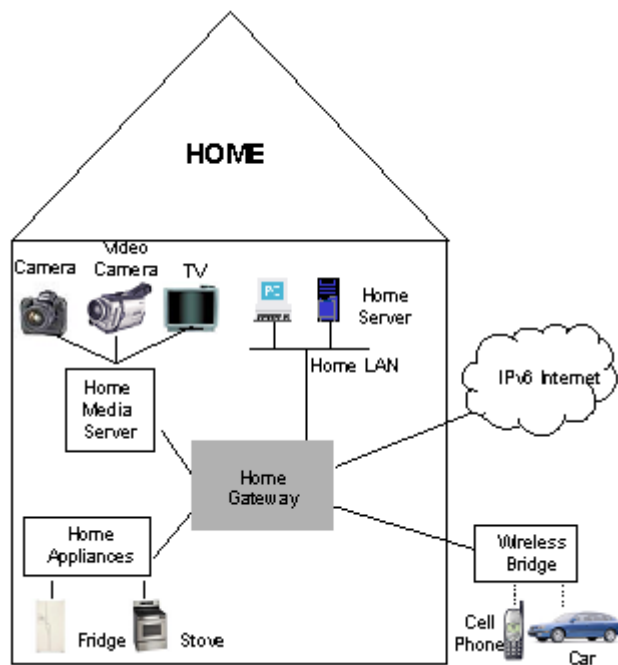
Shin Miyakawa, Research Lead, Internet Technologies at the NTT Multimedia Communications Laboratory has recently expressed his personal opinion, that "Online games can be one of the killer applications which will boost IPv6 suddenly in (the) very near future."



The current IPv4 Internet does not provide the infrastructure required for peer-to-peer online gaming, mainly because of address depletion. Online gaming needs to utilize the full peer-to-peer model of TCP/IP. 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. More importantly, we believe that online gaming is technically feasible and will rapidly occur over the next few years. This should drive the requirement for IPv6 native networking software and equipment.

## Home Networking

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. In fact the number of home gateway units shipped is estimated to grow from 618,000 units in 2000 to 16.8 million by 2005 according to Allied Business Intelligence. Global revenue of home gateways will rise from \$223M to \$3.7B during this same time span. The growth of home-based broadband and DSL equipment is also driving the market for home networking. In fact IBM, Cisco, Sun, Microsoft, and 3COM all have home networking projects currently underway.



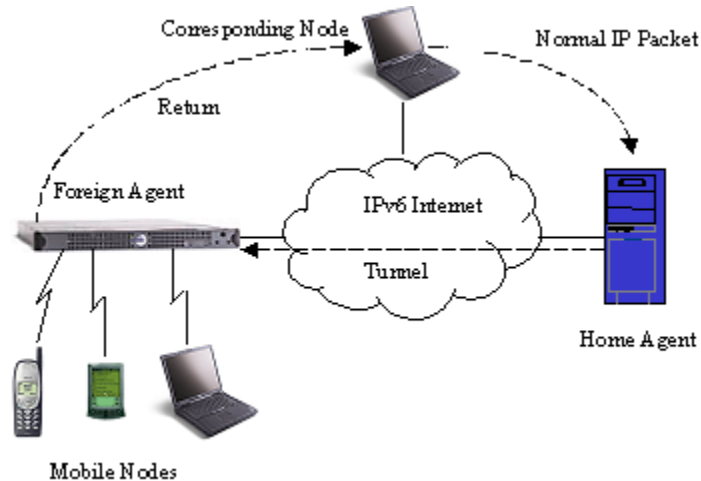
New technology such as IEEE 1394 and Bluetooth for both mobile and home use are being developed. As processors make their way into more and more devices, it is ever more likely that these devices will be network ready. But how do you manage networking for a refrigerator or camera? Clearly these devices must come hardwired for IP connectivity, because consumers are not savvy enough to perform complex management tasks on their own.

The solution is to embed IPv6 technology into new devices. We have already seen that this is happening with gaming equipment. 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. Think of the security possibilities. If all devices are stamped with an unchangeable IPv6 address, we could easily catch criminals that connect stolen property to the Internet.

Imagine a toilet that can send you an email telling you it is plugged up. 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-online 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 is the development by the IETF of the mobile IP standard. 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 it packets to the HA. The HA then tunnels the packets to the FA, which delivers the packets to the MN. The discovery and registration process are defined in RFC 2002.



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.

### 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. The IPv6 forum has well over 100 companies involved ([www.ipv6forum.com](http://www.ipv6forum.com)). Their mission is to promote IPv6, but not to force its deployment or its specifications.

A number of active IPv6 testbeds are also underway. The 6BONE is an IPv6 testbed that is designed to assist in the evolution and deployment of the IPv6 Internet. Basically it is a set of IPv6 "islands" with tunnels over the IPv4 Internet. More than 50 countries are involved ([www.6bone.net](http://www.6bone.net)).

NTT has one of the largest experimental, commercial IPv6 networks deployed. This is a worldwide IPv6 backbone that is completely IPv6 end-to-end.



NTT IPv6 Network

## Conclusions

Although few commercial IPv6 offerings are available today, we see a growing chorus 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. With billions of appliances and games 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.

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