BEFORE THE
NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY
AND THE
NATIONAL TELECOMMUNICATIONS AND INFORMATION ADMINISTRATION
WASHINGTON, D.C. 20230

Request for Comments on Deployment of Internet Protocol, Version 6	)	Docket No. 040107006-4006-01

COMMENTS OF
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Motorola, Inc. ("Motorola") hereby submits its comments in response to the *Notice of Inquiry* of the National Institute of Standards and Technology ("NIST") and the National Telecommunications and Information Administration ("NTIA") regarding deployment of Internet Protocol, Version 6 ("IPv6").[1] Motorola is a manufacturer of wireless and broadband communications equipment, as well as networking and Internet-access products for consumers, network operators, governments and industrial customers. Motorola recognizes the potential of IPv6, and welcomes this opportunity to comment on the U.S. government's role in this technology's development and deployment.

IPv6 appears to promise certain improvements to Internet technology – increased address space and perhaps faster, more secure and more user-friendly networking. Yet, the U.S. marketplace has not yet embraced IPv6 technology. Demand for products running the advanced protocol remains low, and information technology companies seem concerned about upgrade

[1] Request for Comments on Deployment of Internet Protocol, Version 6, *Notice of Inquiry*, 69 Fed. Reg. 2890 (Jan. 21, 2004).

costs in transitioning to this new protocol. Given the nascent state of the technology, questions also remain about the time frame within which IPv6 will achieve its potential.

Motorola believes that the potential benefits of IPv6 are such that the U.S. government should encourage research and experience with this technology. At this time, any mandate for IPv6 implementation is premature. It is also inconsistent with the government's traditional reliance on marketplace forces for Internet development and evolution – an approach that has proven so successful to the growth and development of this space. Motorola submits that better understanding of the benefits of this technology and how it will interact with existing systems is necessary before businesses and the federal government can effectively analyze the costs and benefits of broad IPv6 deployment. Accordingly, Motorola urges the U.S. government to take steps to encourage such understanding – through support of IPv6 research into interoperability with existing IPv4 systems, federal government deployment and experience with this technology, incentives for private sector deployment, and policies facilitating the introduction of new services and equipment that could drive IPv6 demand.

I. IPV6 APPEARS TO PROMISE SEVERAL IMPROVEMENTS TO INTERNET FUNCTIONALITY AND USE

As indicated in the *Notice*, IPv6 has the potential to improve the Internet's current level of functionality and to introduce myriad new uses of the network. It seems clear that IPv6 will expand address capabilities. It is also hoped that this new protocol will enhance Internet security and facilitate a variety of new Internet-based offerings.

A. IPv6 will expand Internet address space

By lengthening Internet addresses from 32 bits to 128 bits, IPv6 would increase the number of possible Internet addresses by several orders of magnitude. As Internet use continues to increase, augmenting the Internet's addressing space will be crucial to satisfying the demand

for current products as well as to deploying new products and applications. In Motorola's experience, customers here in the United States are not currently clamoring for additional address space. Technology solutions and the fact that the United States holds over 60% of the IPv4 registered addresses are factors in the low U.S. market drive for IPv6 deployment. For example, "middleware" technology like Network Address Translation devices ("NATs"), which allow a single address to serve multiple users, appears to be satisfying existing and projected near-term demands for Internet addresses. Nevertheless, Motorola believes that address space ultimately must expand as Internet applications increase and the limitations of middleware are felt.

B. IPv6 may improve Internet security

IPv6 potentially could improve the security of Internet communications. Under the current Internet protocol, IPv4, security holes often are introduced into the systems of less security-savvy consumers and businesses in order to foster connectivity. IPv6 potentially could plug these security holes, while improving connectivity. Due to this new protocol's identity-authentication features and support for pure "peer-to-peer" connections, even entities less sophisticated in information technology could experience these benefits.

In addition, IPv6 may increase the use of the security tool IPsec by expanding available address space and thereby eliminating the need for NATs. Without NATs, IPsec presumably would work better at authenticating online users because each host would have a unique IP address rather than sharing IP addresses with multiple parties. However, it is unclear at this point whether the security gains from broader use of IPsec would be offset by security losses due to the elimination of NATs. NATs currently provide networks with a layer of insulation from the public Internet, without which companies and consumers could face enlarged security threats.

Notwithstanding any security improvements under IPv6, it must be recognized that this technology will not be a panacea for all Internet security concerns. For example, in its current form, IPsec running over IPv6 would not defend against denial of service attacks, which constitute some of the most damaging Internet security breaches. IPv6 running on a victimized system would recognize source machines hijacked in such attacks, but not the perpetrator itself.

C. IPv6 has the potential to support a variety of new Internet offerings

By increasing address space and introducing other characteristics that facilitate rapid transfer of information, IPv6 appears to facilitate a wide variety of new Internet offerings. Motorola is especially interested in IPv6's potential to advance mobile communications and home networks.

IPv6 technology may drive enhanced 3G wireless services, including the wireless Internet and data transfers to mobile devices. The technology might underpin future offerings for mobile customers such as instant messaging, multimedia messaging, location aware services, streaming video/audio with one or several media components, and seamless roaming between converged networks. Specific applications, such as push services, VoIP, and Push to Talk, will benefit from having a global unique IPv6 address as opposed to a private address behind a NAT.

IPv6 also opens exciting opportunities for wireless sensor networks and machine-to-machine communications. In addition, by simplifying header architecture and protocol operation, the technology may ease internal network management for corporations and institutions. Even homes and small businesses may be able to install inexpensive and user-friendly routers running on IPv6. This will facilitate growth in the home space by allowing a user to control any appliance in the home network (such as lights, dishwashers, refrigerators, cameras, home computers and other home appliances) from anywhere using a mobile or fixed device.

D. Other countries are betting on the realization of these potential benefits and investing heavily in IPv6

Fostering the U.S. market place activities in the IPv6 space through encouraging research and experience with this technology is consistent with actions that have taken place in other countries that have also recognized the potential benefits of IPv6. Even at this early stage in the new protocol's development, certain nations have identified IPv6 deployment as a policy goal and have taken steps to facilitate its realization. The European Union has made IPv6 deployment part of its Information Society action plan.[2] Asia-Pacific countries are investing heavily in IPv6 testing and deployment. For example, China reportedly has earmarked the equivalent of hundreds of millions of dollars for government-sponsored IPv6 projects.[3] Some nations may perceive IPv6 deployment as an opportunity to leapfrog over the United States, which is heavily invested in IPv4, the current Internet protocol. Clearly, countries with less extensive IPv4 infrastructure can avoid the cost issues that the United States would face with an IPv6 transition.

II. AT THIS TIME, THE U.S. MARKETPLACE IS NOT DRIVING IPV6 DEPLOYMENT

In the past, the U.S. marketplace has been a key driver of important new technologies, particularly in the Internet space. But so far, the U.S. marketplace has not been charging ahead to embrace full IPv6 network deployments. Motorola believes this caution is due in large part to the costs inherent in migrating from extensively-deployed IPv4 equipment to the new protocol.

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[2] *See, e.g.*, Communication from the Commission to the Council, the European Parliament, the Economic and Social Committee and the Committee of the Regions, *eEurope 2005, An information society for all*, COM(2002) 263 final (21/22 June 2002), *available at:* http://europa.eu.int/information_society/eeurope/2002/news_library/documents/eeurope2005/eeurope2005_en.pdf (*last visited* March 8, 2004).

[3] *See, e.g.*, Ricky Lu, China Starts Full-Scale Implementation of IPv6, Beijing Internet Research (May 26, 2003), *available at:* http://www.ipv6style.jp/en/special/20030526/index.shtml, *last visited* March 8, 2004).

In addition, the lack of a pressing need for address space in the United States and the nascent state of IPv6's other potential benefits have provided information technology companies with limited incentives to transition to IPv6 at this time.

A. The transition to IPv6 will generate real costs as well as opportunity costs

Because IPv4 technology is currently deployed extensively throughout the United States' communications networks and end user facilities, migration to the new protocol in this country will necessarily involve upgrading or replacement of existing equipment. As an initial matter, the transition to IPv6 implies hardware upgrades. For example, routers generally would need at least four times their existing Content Addressable Memory ("CAM") in order to perform as well looking up 128 bit IPv6 addresses as they currently do looking up 32 bit IPv4 addresses. CAM upgrades are expensive, and upgraded routers consume substantially greater amounts of power. Expanded buffers and routing tables also would require additional memory.

Migrating to IPv6 requires much more than upgrading routers. Outlays for re-engineering and software development present an additional hurdle to adopting this technology. For example, software must be rewritten to recognize IPv6 addresses as unique identifiers of a node before applications can take advantage of the purported benefits of hierarchical IPv6 addressing. To illustrate the point further, maintaining a "dual stack" that supports both IPv4 and IPv6, as a stepping-stone to pure IPv6, itself triggers considerable engineering costs.

There are also opportunity costs associated with investing heavily in IPv6 and the network effects that might characterize an IPv6 market. Companies like Motorola strategically direct their limited R&D dollars to technologies with a foreseeable market. Investing in IPv6 over other promising technologies imposes additional risk because the advantage of IPv6 products over existing alternatives would depend upon a ubiquitous roll-out of high-speed, high capacity IPv6 infrastructure, which no individual information technology company can control.

In order for IPv6 to reach its full potential value, there must be an IPv6 infrastructure to transport information services in IPv6 and applications developed to take advantage of the technology. A clear roadmap for IPv6 deployment requires a full understanding of how to achieve the protocol's potential while maintaining current operational capabilities.

B. The need and demand for IPv6 products is limited at this time

In Motorola's experience, there is presently little demand for products that support IPv6. Although many leading information technology companies have participated in the protocol's development, to our knowledge there are few applications built on IPv6, let alone "must-have" tools available exclusively on this new protocol. Notably, although foreign governments are actively promoting IPv6 as an opportunity for technology leadership, foreign companies and consumers have yet to convert IPv6 policy into even fledgling markets for IPv6 products.

This limited demand to date may be due in part to the fact that the need to invest in IPv6 is not yet pressing for most information technology companies and Internet users. As discussed above, due to the widespread deployment of middleware such as NATs, Internet users are not yet experiencing a shortage of Internet addresses. Thus, one of the primary benefits of IPv6 is not perceived by most to be necessary at this time. In addition, questions remain about the extent to which the other benefits of IPv6 will be realized. IPv6 advantages may attenuate when deployed alongside IPv4 within an existing network. Further, the technology may fail to yield net security gains. It is thus not surprising that U.S. information technology companies and their customers are hesitating before investing heavily in IPv6 products.

III. THE U.S. GOVERNMENT SHOULD NOT MANDATE A TRANSITION TO IPV6, BUT RATHER ENCOURAGE RESEARCH AND INVESTMENT IN THIS PROMISING BUT STILL NASCENT TECHNOLOGY

To date, the U.S. government has consistently pursued a "hands-off" regulatory policy concerning the development of the Internet and its associated technologies. The ability for the marketplace to react unfettered has largely been credited with the rapid development and success of the Internet space. Particularly with respect to nascent technologies like IPv6, the U.S. government should continue its hands-off approach and allow the marketplace to be the primary driver of this new protocol's development and deployment. That said, it would be appropriate and advantageous for the government to encourage further exploration of this promising technology. Motorola submits that this could best be accomplished through support of IPv6 research, federal government deployment and experience with the technology, incentives for private sector investment, and policies facilitating the introduction of new services and equipment that might drive IPv6 demand.

A. At this time, a government mandate to implement IPv6 is premature

As discussed above, IPv6 appears to be a promising new Internet technology. However, in the absence of compelling evidence that the benefits of this still nascent protocol will outweigh the costs and risks, a government mandate to deploy IPv6 is premature. It is also wholly inconsistent with the government's traditional and successful reliance on marketplace forces for Internet development and evolution. Given the high cost of migrating to IPv6, the absence of an imminent need for additional address space, and the questions remaining about the extent of IPv6's other benefits, more aggressive action by the government to implement the technology lacks a sufficient rationale.

Concerns about maintaining U.S. competitiveness with other countries also do not provide a rationale for such mandated implementation. Even where foreign governments appear

to be intervening to speed IPv6 deployment, an IPv6 equipment market has not developed. Further, any new IPv6 deployment would need to build in IPv4 compatibility – and thus compatibility with U.S. networks – to ensure full interoperability during what is likely to be a lengthy transition.

B. The U.S. Government should instead encourage further IPv6 research and investment

Given the nascent state of IPv6 technology, there is currently a lack of understanding about the extent of the benefits of this new protocol and how it will interact with existing systems. Considering the promising nature of the technology, these issues clearly bear further exploration. Accordingly, Motorola urges the U.S. government to take steps to encourage additional research in and experience with IPv6. Motorola believes this can best be accomplished through support of IPv6 research, federal government deployment and experience with the technology, incentives for private sector investment, and policies facilitating the introduction of new services and equipment that might drive IPv6 demand.

Support for IPv6 Research. Government funding of IPv6 research and development would encourage U.S. information technology companies to investigate further the benefits and ramifications of this new protocol. With uncertainty surrounding whether IPv6 advantages will overcome the technology's costs, U.S. companies are hesitating to invest heavily in IPv6 networks and products. Government-funded research and testing would therefore be helpful, especially with respect to how mixed IPv4/IPv6 environments would function and the extent of IPv6's security benefits.

Testing of IPv6's interoperability with existing IPv4 systems is especially necessary before these IPv6-driven applications can be brought to market. Transition studies may help determine whether the benefits of IPv6 can be realized while IPv4 remains the dominant protocol. In order to take advantage of many IPv6 features, an end-to-end IPv6 infrastructure

appears to be necessary. As most of the public Internet's components are equipped only with IPv4 technology, the effect and inefficiencies of "tunneling" in IPv6 need to be better understood.

The availability of government support would encourage the U.S. information technology industry to direct its attention toward resolving these important remaining questions. Further, the mere existence of government funding for research will likely encourage further private investment in IPv6 testing.

U.S. Government deployment of IPv6. Motorola is aware that there is tremendous interest in IPv6 within the Department of Defense, as well as in other parts of the federal government. In some areas of the government, deployment of this technology is already beginning. Motorola believes that the government's experience with IPv6 could incentivize further interest and investment in this technology by U.S. industry. If the Defense Department's implementation of an IPv6-capable system is successful, other parts of the government and private-sector actors likely would follow suit. Motorola and the information technology industry will be watching the Defense Department's experience with IPv6 closely in order to learn whether it could spark further demand for IPv6. If so, industry investment in the advanced protocol could substantially expand.

Incentives for private sector investment. As experience with IPv6 technology grows, the federal government should consider offering U.S. companies incentives to invest in IPv6 networks. As discussed above, U.S. infrastructure is overwhelming built on IPv4. As a result, private network owners in the United States face migration costs not incurred by their foreign counterparts, whose initial build-out is based on IPv6. In addition, some foreign governments are actively subsidizing the deployment of IPv6 infrastructure, especially in the Asia-Pacific

region.[4] Accordingly, tax or other incentives for infrastructure upgrades could help U.S. companies overcome the high costs of system migration. Such incentives may be necessary to achieve full IPv6 implementation, as most advantages of IPv6 cannot be achieved in the absence of an end-to-end IPv6 network.

Support of policies that facilitate communications services that could drive IPv6 demand. Federal support for further testing of IPv6 should be part of an over-arching government policy to promote promising new technologies. Achieving the benefits of IPv6 will depend on more than the development of this protocol technology alone. Next generation wireless communications also will rest on advances in 3G and wireless Internet technology. The government's pursuit of policies that foster and encourage advanced wireless technology will in turn encourage the development and deployment of key network maximization technologies, such as IPv6. Together, these technologies may drive more sophisticated Internet applications and network capabilities.

IV. CONCLUSION

At this stage in its development, IPv6 appears to be a promising technology for increasing Internet functionality. However, concerns about this technology's migration costs, the value of its benefits, and its effectiveness in real-world settings have limited the U.S. deployment of IPv6 to date. While further exploration of IPv6 is clearly warranted, a government mandate to implement this new protocol is premature. Instead, Motorola urges the U.S. Government to take

[4] *See* http://www.ipv6forum.com/navbar/documents/eu_ipv6_mar01.pdf for a list of IPv6 projects funded by the European Union; "March on with a new vision – e-Taiwan" http://www.nici.nat.gov.tw/doctemp/English%20Version%209112_FIND.pdf (Taiwan pledges $30 Billion over six years for e-Tiawan); "Japan, China and South Korea to develop IPv6 in Asia", http://asia.cnet.com/newstech/systems/0,39001153,39162960,00.htm (Japan's Ministry of Public Management, Home Affairs, Post and Telecommunications has allocated US$18.643 million annually for implementation of an IPv6 network).

steps to encourage further research and investment in this new protocol – through funding of IPv6 research, federal government deployment and experience with the technology, incentives for private sector investment, and policies facilitating the introduction of new services and equipment that might drive IPv6 demand. This approach would provide needed encouragement for further exploration of this promising technology, while appropriately leaving development issues and implementation timetables to the marketplace.

Respectfully submitted,

/s/

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