



**CONSULTATION PAPER ISSUED BY  
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**PUBLIC CONSULTATION ON  
INTERNET PROTOCOL “NO ISLANDING” PRINCIPLE**

**20 June 2011**

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## CONSULTATION DOCUMENT

### PUBLIC CONSULTATION ON INTERNET PROTOCOL “NO ISLANDING” PRINCIPLE

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#### PART I: OBJECTIVE

1. The objective of this consultation is to obtain views and comments from the public on the proposed Internet Protocol (“IP”) “No Islanding” Principle during the IP version 6 (“IPv6”) transition.

#### PART II: BACKGROUND

2. IP is used extensively in the public Internet today to establish end-to-end communication path between clients and hosts across networks globally. The version of IP address most widely deployed today is IP version 4 (“IPv4”), which provides for approximately 4 billion unique addresses. With the explosion of growth of the Internet, the global pool of unallocated IPv4 addresses has been depleting rapidly. Global exhaustion<sup>1</sup> of IPv4 addresses occurred on 3 Feb 2011. In the Asia Pacific region, distribution of the last batch of unallocated IPv4 addresses began on 15 April 2011, limiting each qualified organisation to a maximum of 1024 IPv4 addresses. While the onset of regional exhaustion<sup>2</sup> may be delayed by stringent allocation by Regional Internet Registries (“RIRs”), full depletion of IPv4 addresses is inevitable.

3. IPv6 is designed to replace IPv4, using 128 bit addresses to allow for  $3.4 \times 10^{38}$  unique addresses. It is designed to co-exist with IPv4, but is incompatible with

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<sup>1</sup> A global exhaustion of IPv4 addresses refers to when the International Assigned Numbers Authority (or IANA) distributes all its free pool of IPv4 addresses to the Regional Internet Registries (or RIRs).

<sup>2</sup> Regional exhaustion of IPv4 addresses refers to when the RIRs have allocated all of their free pool of IPv4 addresses. The RIR of the Asia Pacific region is the Asia Pacific Network Information Centre (or APNIC). It should be noted that, even with regional exhaustion, Internet Access Service Providers (or IASPs) are likely to have residual holdings of IPv4 addresses. Exhaustion at the IASP level would therefore be later than regional exhaustion.

IPv4. Thus, networks that use IPv4 addresses are not able to communicate with networks using IPv6 addresses without transitional mechanisms. Given the incompatibility, the public Internet will need to deploy transition mechanisms as it moves towards a full replacement of IPv4 addresses with IPv6 addresses.

4. However, given the maturity of IPv4 today, with the majority of the public Internet still on IPv4, the shift from IPv4 to the nascent IPv6 is expected to be multi-year. This period of overlap where both IPv4 and IPv6 systems will be active concurrently or co-existent has been predicted to last at least 5 years by APNIC<sup>3</sup>. Depending on market trends, IPv4 could take longer to be completely phased out.

5. As previously indicated in IDA’s Information Paper on “IPv6 Phase 2 Transition Plans for Singapore”, the transition to IPv6 would largely be industry-led, but government facilitation in several areas will contribute to a smooth transition<sup>4</sup>. Firstly, to maintain the accessibility of government services to citizens regardless of the underlying protocol used, the Singapore Government will work towards enabling the access of Government e-Services by IPv6 users from September 2012. Work has also been underway in getting Singapore’s key infrastructure networks like the Next Gen Nationwide Broadband Network and other government systems to be IPv6 ready.

6. Secondly, IDA formed an IPv6 Task Force in 2006 to assist Singapore’s transition from an IPv4 environment to an IPv4/IPv6 environment, and to engage key stakeholders such as the Internet Service Providers (ISPs), hardware and software vendors, businesses and institutes of higher learning in this process. To date, the Task Force has undertaken several initiatives to educate stakeholders, support the development of relevant skills, and facilitate the management of existing IPv4 and IPv6 addresses. This will help minimise the business impact of IPv4 address exhaustion and the shift to IPv6.

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<sup>3</sup> “A Rough Guide to Address Exhaustion (in 12 easy questions), Geoff Huston, September 2010: <http://www.potaroo.net/ispcol/2010-09/exhaustguide.html>

<sup>4</sup> IDA’s Information Paper on “IPv6 Phase 2 Transition Plans for Singapore” published in April 2011: [http://www.ida.gov.sg/doc/Policies%20and%20Regulation/Policies\\_and\\_Regulation\\_Level2/20060928171439/IPv6%20Public%20Update%20Paper%202011.pdf](http://www.ida.gov.sg/doc/Policies%20and%20Regulation/Policies_and_Regulation_Level2/20060928171439/IPv6%20Public%20Update%20Paper%202011.pdf)

7. IDA also formed an industry working group to develop and standardise terms of reference for IPv6 here. The Singapore IPv6 Profile was developed with the industry’s comments and aims to define the ‘working language’ for IPv6. It was released in February 2011<sup>5</sup>.

### IPv4 and IPv6 “Islanding”

8. In addition to the above-mentioned plans for government demand for IPv6 and industry capability building, IDA is considering whether there is a need for further measures to address issues arising from the IPv6 transition. Specifically, as Singapore moves towards adopting IPv6 and enters the IPv6 transition period, it is important to ensure that consumers are not unduly affected, such as being limited in their ability to access Internet content. During the initial stages of the transition period, when IPv4 addresses are still available, there will be a small group of IPv6 early adopters who would likely run dual-stack systems<sup>6</sup>, where both IPv4 and IPv6 are enabled. The majority of users and content will still be on IPv4, maintaining their legacy systems. Over time, when IPv4 addresses are fully exhausted, new users and content may have to take up IPv6 addresses without a corresponding IPv4 address. This may lead to a situation where there are groups of users and content on IPv4-only and IPv6-only systems. Users on IPv4 or IPv6 will likely be limited to services and content within their respective protocols, which will limit consumers’ ability to access Internet content. Such a situation is termed “islanding”, as this creates separate IPv4 and IPv6 Internet “islands”.

9. “Islanding” is of particular concern in the mobile market, where the large and increasing subscriber base may lead to more IPv6-only consumers when the local Internet Access Service Providers (“IASPs”) deplete their allocated IPv4 addresses. There are also unique technical characteristics of mobile, for example limited battery power, that may make the simultaneous running of IPv4 and IPv6 on a single device

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<sup>5</sup> The Singapore IPv6 Profile is available at [http://www.ida.gov.sg/doc/Policies\\_and\\_Regulation/Policies\\_and\\_Regulation\\_Level2/20060424161505/IDARSIPv6.pdf](http://www.ida.gov.sg/doc/Policies_and_Regulation/Policies_and_Regulation_Level2/20060424161505/IDARSIPv6.pdf).

<sup>6</sup> Dual stack, also known as Dual IP layer, is a technique for providing complete support for both IPv4 and IPv6 in hosts and routers. The IPv4/IPv6 dual-stack enables applications to choose the protocol to use or automatically select it according to address type. It implements IPv4 and IPv6 protocol stacks either independently or in a hybrid form.

unattractive. “Islanding” would also disadvantage early adopters of IPv6 in the initial stages of the transition period when the IPv4 addresses are exhausted, since it is likely that the majority of content would still only be accessible by the IPv4 protocol.

10. Today, some IASPs have put in place measures to contain the impact of “islanding”, in the form of dual stack or other systems. Others have developed plans to implement such measures in the near future. However, there are still networks which are unable to ensure that IPv4-only consumers can access IPv6-only content and vice versa. While IASPs may have incentives to prevent ‘islanding’ at some point in time, it is unclear whether IASPs will act quickly enough to ensure that consumers are not left “islanded” in the interim, if motivated solely by market forces.

11. It is important that the users and content on the IPv4-only systems and IPv6-only systems are able to communicate with each other, given that “islanding” will impede the growth and use of the Internet. Given that the longer term outlook for Internet addressing is likely to be a situation where IPv6 is native, it is also important that users be encouraged to adopt IPv6 without the concern of being stranded from legacy content and services accessible through IPv4. IDA is thus assessing the possibility of requiring IASPs to ensure seamless Internet connectivity during the IPv6 transition period in order to prevent “islanding” to the extent feasible.

12. Preventing “islanding” is also aligned with IDA’s position on net neutrality, which advocates that consumers should have reasonable access to all legitimate Internet content and services and be able to reap the full benefit of access to Internet content and services independent of the IASP they subscribe to, or the type of IP technology their IASP uses.

### **Question 1**

(a) *IDA invites views and comments on the likelihood of “islanding” occurring to Singaporean consumers, irrespective of wired, wireless or mobile modes of Internet access. To what extent can the existing networks prevent the occurrence of “islanding” and ensure that Internet access is seamless independent of the IP used?*

- (b) IDA also invites views and comments on the need for IDA to ensure that the IASPs provide seamless Internet connectivity during IPv6 transition.

### **PART III: INTERNET PROTOCOL “NO ISLANDING” PRINCIPLE**

#### **SECTION 1 – Regulatory Principle and Technical Implementation**

13. To prevent the scenario when an end user with an IPv4 address is unable to access content addressable by IPv6, or vice versa, IDA proposes an IP “No Islanding” Principle where IASPs must enable systems, equipment and networks within their control and operation to ensure that the Internet Access services provided to residential or non-corporate end-users in Singapore are capable of allowing access to content on the public Internet, regardless of the address type of the end user (IPv4 or IPv6). This policy position recognises that there are situations beyond the IASPs’ control in which “islanding” could happen. IASPs should also provide “seamless connectivity”, where the connectivity experienced by an end user with an IPv6 address should be at least similar to the connectivity currently experienced by an end user with an IPv4 address, and vice versa.

14. IDA does not intend to prescribe the technological solutions to be deployed by the IASPs to prevent “islanding”. IDA notes that various technical options are available to IASPs to do so. In relation to ensuring that IPv6-only consumers are able to access IPv4-only content, and vice versa, IASPs may adopt measures including dual stacking, NAT64<sup>7</sup> and IPv6 tunneling in complementary manners, though the most optimal option would depend on the IASP’s specific network characteristics, including whether it is a fixed or mobile network. While IDA notes that some technologies and equipment like NAT64 have been standardised only recently, IDA is also aware that there are proprietary systems available in the market from reputed vendors. Each option has varying impact, cost and technical competency expectations. However, importantly, such options can be undertaken by IASPs without any action by end-users, minimising the impact to consumers.

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<sup>7</sup> Network Address Translator translating IPv6 to IPv4.

15. IDA notes that while it would be feasible for “no islanding” to be imposed for accessing websites on the open Internet, there may be technical limitations to the accessibility of certain applications on the Internet. For example, some common applications which make use of the Internet, such as VoIP applications (e.g., Skype, Google Talk) and online games (e.g., World of Warcraft) may not be accessible because of the specialised servers they access using Internet connectivity, which are often hard-coded into the software. Browsers and operating systems of earlier release (e.g., Windows 98 and Mac OS 9) will also have issues accessing IPv6 content or servers as these products of earlier versions do not support IPv6. In the cases where the IASPs are technically unable to ensure access or seamless connectivity, they should not be required to do so. Consumers facing problems with these applications should be encouraged to upgrade their software or contact the application developers for help.

16. IDA recognises that preventing “islanding” involves a concerted effort from multiple stakeholders, including consumers. In particular, given the wide range of possible exceptions, IDA notes the importance of educating consumers and managing their expectations of the IP “No Islanding” Principle. IDA thus clarifies that the policy only requires IASPs to put in place measures for systems, equipment and networks that are solely within the IASPs’ direct control and operation. However, IDA would also encourage the IASPs to explore other options in order to complement their eventual IPv6 migration. These could include replacing existing Consumer Premise Equipment (“CPEs”) to dual-stack capable CPEs, or incentivising consumers to upgrade.

## **Question 2**

(c) *IDA invites views and comments on the scope of the IP “No Islanding” Principle. What are the possible technical options for IASPs to achieve “no islanding” and what is the possible impact to consumers during implementation?*

- (d) IDA also invites views and comments on the types, nature and categories of applications, content and services that would experience “islanding” even if translation mechanisms are put in place, and the corresponding reasons for why “islanding” would still occur.

## SECTION 2 – Types of Internet Access Services Applicable

17. The IP “No Islanding” Principle is proposed to apply only in relation to residential consumers (wired or wireless), which would include individual or non-corporate wireless or mobile broadband users at the onset. Business or corporate customers would be savvier in requesting customised technical solutions from the IASPs for their specific Internet access needs. Thus, it is proposed that the IP “No Islanding” Principle apply to all IASPs who offer services to residential customers, regardless of whether IASPs are offering services via fixed networks, wireless networks like Wireless Broadband Access, or mobile networks<sup>8</sup>. This would include the newer Retail Service Providers (“RSPs”) on the Next Gen NBN, in order to reach out to all residential customers in the initial stages.

18. Besides the IASPs, IDA is cognisant that the Internet Exchanges (“IXs”) will also need to upgrade their infrastructure in order to fulfill the IP “No Islanding” Principle. There are arguments for and against imposing regulatory obligations to require IXs to also upgrade their infrastructure to achieve this outcome. On one hand, similar functionality from IXs will complement the IASPs’ capabilities to achieve “no islanding”. On the other hand, IDA recognises that the IXs will have strong commercial incentives to put in place transition mechanisms (such as a dual-stack system to handle either IPv4 and IPv6 traffic, or some form of translation mechanism similar to NAT64) to support their customers (including IASPs) who need to provide seamless Internet connectivity. On balance, taking all factors into consideration, IDA’s current proposal is not to impose regulation on IXs to enable “no islanding” at this juncture. However, IDA will continue to monitor the market situation and the progress of IXs in upgrading their platforms.

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<sup>8</sup> It would however not include providers of free and localised wireless Internet Access.



**Question 3**

- (e) *IDA invites views and comments on the limitation of the IP “No Islanding” Principle to only IASPs offering services to residential or non-corporate consumers. Should “no islanding” apply equally in relation to business users?*
- (f) *IDA invites views and comments on the applicability of the IP “No Islanding” Principle to all residential consumers using wired and wireless Internet access, including individual or non-corporate mobile broadband users.*
- (g) *IDA also invites views and comments on the non-applicability of the IP “No Islanding” Principle to IXs.*

**SECTION 3 – Implementation Cost and Timeline**

19. IDA is aware that there will be costs involved in implementing the IP “No Islanding” Principle. Industry estimates of the cost of acquiring the necessary equipment range from several hundred thousand dollars to over a million dollars, although the cost to an IASP will depend on the actual network and business requirements. However, IDA notes that at some point in time, IASPs are likely to have to invest in such systems to cater to consumer demand, during the period of co-existence of IPv4 and IPv6. Further, we understand that the major IASPs have already begun to implement some form of IPv6 trial or, in some cases, limited commercial deployment. IDA is also of the view that the cost of implementing the IP “No Islanding” Principle can be mitigated with sufficient lead time, so that IASPs can cater to these requirements as part of their business and technology planning cycles.

20. IDA also considered whether the IP “No Islanding” Principle should be applied only to a specified set of websites, rather than all websites, to reduce the costs associated with implementing the policy. However, such an approach would not be aligned with the intent of the IP “No Islanding” Principle in the first place, which is to ensure that consumers are able to access Internet content as far as practicable. Given the rapid proliferation of new websites, if left to market mechanisms, there would be no feasible way of preventing consumers from being “islanded” from new

and innovative content and services. This would ultimately degrade consumers’ ability to access such content and services on the public Internet.

21. Balancing the costs to IASPs and consumer interest, IDA proposes for the IP “No Islanding” Principle to take effect from 1 Sep 2012. This considers that the eventual exhaustion of IPv4 addresses at the RIR level would not mean actual exhaustion of all IPv4 addresses available to the local IASPs, because of additional supply currently held by the IASPs.

22. IDA recognises that the proposed IP “No Islanding” Principle works both ways. This means that, with the IP “No Islanding” Principle in place, Singapore users and content hosts on IPv4 will still be catered to by IASPs even during the advanced stage of IPv6 transition where IPv6 users and content are the majority. This may in turn retard the adoption of IPv6 in Singapore. IDA thus views the IP “No Islanding” Principle as a transitional or interim measure, to ensure that consumers are not adversely affected during the IPv6 transition period. Given that there is currently no consensus on when IPv6 becomes the predominant Internet addressing protocol, IDA intends to review the IP “No Islanding” Principle three years after implementation in order to ensure its continued relevance.

#### **Question 4**

- (h) *IDA invites views and comments on the possible costs of implementing technical solutions to support the IP “No Islanding” Principle.*
- (i) *IDA invites views and comments on whether there are other non-cost considerations when implementing technical solutions to support the “no islanding” principle, what those considerations are, and why they apply to the situation.*
- (j) *IDA also invites views and comments on the proposed timeline for the start date of the IP “No Islanding” Principle.*

**PART IV: PROCEDURES AND TIMEFRAME FOR SUBMITTING COMMENTS**

23. IDA would like to seek views on the issues and proposals raised in this consultation paper. This will allow IDA to have a better understanding of the issues and the requirements of the interested parties. The questions are listed again below:

- (a) *IDA invites views and comments on the likelihood of “islanding” occurring to Singaporean consumers, irrespective of wired, wireless or mobile modes of Internet access. To what extent can the existing networks prevent the occurrence of “islanding” and ensure that Internet access is seamless independent of the IP used?*
- (b) *IDA also invites views and comments on the need for IDA to ensure that the IASPs provide seamless Internet connectivity during IPv6 transition.*
- (c) *IDA invites views and comments on the scope of the IP “No Islanding” Principle. What are the possible technical options for IASPs to achieve “no islanding” and what is the possible impact to consumers during implementation?*
- (d) *IDA also invites views and comments on the types, nature and categories of applications, content and services that would experience “islanding” even if translation mechanisms are put in place, and the corresponding reasons for why “islanding” would still occur.*
- (e) *IDA invites views and comments on the limitation of the IP “No Islanding” Principle on only IASPs offering services to residential or non-corporate consumers. Should “no islanding” apply equally in relation to business users?*

- (f) *IDA invites views and comments on the applicability of the IP “No Islanding” Principle to all residential consumers using wired and wireless Internet access, including individual or non-corporate mobile broadband users.*
- (g) *IDA also invites views and comments on the non-applicability of the IP “No Islanding” Principle to IXs.*
- (h) *IDA invites views and comments on the possible costs of implementing technical solutions to support the IP “No Islanding” Principle.*
- (i) *IDA invites views and comments on whether there are other non-cost considerations when implementing technical solutions to support the “no islanding” principle, what those considerations are, and why they apply to the situation.*
- (j) *IDA also invites views and comments on the proposed timeline for the start date of the IP “No Islanding” Principle.*

24. Respondents are also invited to comment on any other issues not covered in this consultation document but which are considered to be relevant to the “islanding” issue. IDA will consider the inputs submitted and make its policy decisions thereafter.

25. All submissions should reach IDA **before 12 noon on 31 July 2011**. Comments must be submitted in both hard and soft copy (in Microsoft Word format). All comments should be addressed to:

**Ms. Aileen Chia**  
**Deputy Director General (Telecoms & Post)**  
**Infocomm Development Authority of Singapore**  
**10 Pasir Panjang Road**  
**#10-01 Mapletree Business City**  
**Singapore 117438**  
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**AND**

Please submit your soft copies, with the email header “Internet Protocol “No Islanding” Principle”, to this e-mail: [IDA\\_Consultation@ida.gov.sg](mailto:IDA_Consultation@ida.gov.sg).