



**DECISION ISSUED BY THE
INFO-COMMUNICATIONS DEVELOPMENT AUTHORITY OF SINGAPORE**

INTERNET PROTOCOL “NO ISLANDING” PRINCIPLE

30 April 2012

PART I: INTRODUCTION

PART II: SUMMARY OF RESPONSES AND IDA’S DECISION

PART I: INTRODUCTION

1. Internet Protocol (“IP”) is used extensively in the public Internet today to establish an 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”). With the explosive growth of the Internet, the International Assigned Numbers Authority (“IANA”) exhausted its free pool of IPv4 addresses on 3 February 2011. While Regional Internet Registries (“RIRs”) and Internet Access Service Providers (“IASPs”) do have existing unassigned IPv4 addresses in stock, full depletion of IPv4 addresses in RIRs is likely to occur in the near future. IPv6 is the proposed replacement, but due to lack of backward compatibility, there will be a period during which IPv4 and IPv6 will co-exist. There is no international consensus as to the duration of co-existence, though it is likely to take years.

2. Governments internationally have embarked on programmes to facilitate the transition to IPv6. Government initiatives have typically revolved around using procurement of IPv6-ready systems, and ensuring that government services are accessible through IPv6, to stimulate demand for IPv6 in the market. In Singapore, the government has embarked on similar efforts and is working towards enabling IPv6 users to access Government e-Services from September 2012. In addition to government procurement, the IPv6 Task Force (formed by IDA in 2006) has been actively engaging industry players to raise awareness of IPv6 transition issues, and to build capabilities by encouraging manpower training and the like.

3. Besides the efforts put in place to ensure that the industry is prepared for IPv6 as the underlying Internet protocol, an added issue pertaining to the period of IPv4/IPv6 co-existence is the issue of “islanding”. During the initial transition period, when IPv4 addresses are still available, there will be a small group of IPv6 early adopters using dual-stack systems, where both IPv4 and IPv6 are enabled. The majority of users and content will still be on IPv4, maintaining their legacy systems. When IPv4 addresses are fully exhausted, new users and content sites 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 providers on IPv4-only systems or IPv6-only systems. While it is possible for IPv4 and IPv6 to co-exist, they are not compatible and cannot interoperate. Without translation mechanisms in place, users on IPv4 or IPv6 will likely be limited to services and content within their respective protocols, creating separate IPv4 and IPv6 Internet “islands”.

4. The issue of “islanding” is likely to be addressed by market forces in the longer term when there is sufficient consumer demand for content on both protocols which will give IASPs the commercial incentive to deploy translation mechanisms to allow consumers to reach content in all forms. IDA considered whether a targeted “No Islanding” Principle, in the form of a regulatory measure, would be necessary as an interim measure to prevent “islanding” at the early stage of IPv4/IPv6 co-existence, before demand becomes mature. To this end, IDA initiated a public consultation on a proposed IP “No Islanding” Principle (hereinafter referred to as the “**Principle**”) in June 2011. At the close of the consultation, IDA received comments from two respondents, M1 Limited and Singapore Telecommunications Limited.

5. IDA thanks the respondents for their inputs. IDA has reviewed the comments received, and this document sets out IDA’s decision.

PART II: SUMMARY OF RESPONSES AND IDA'S DECISION

Likelihood of “Islanding” and Need for IDA Intervention

6. One respondent commented that market forces will drive IASPs and content providers to provide content and services over both IPv4 and IPv6. The same respondent acknowledged that “islanding” was possible as a niche market for IPv6-only services might develop. This was because an IPv6-only service running without translation technology would incur lower costs and risks than one running over both IPv4 and IPv6.

7. Both respondents indicated that there was a limit to the extent to which IASPs alone could prevent “islanding”. One noted that other efforts such as public communications and endorsement of IPv6-enabled devices would be necessary to support a seamless transition to IPv6. Similarly, the other respondent commented that a collective effort from end-users, service providers and content providers would be needed to prevent “islanding”.

8. On the need for IDA intervention, both respondents opined that there was sufficient competition in the IASP market to ensure seamless access to Internet content regardless of the address type. One respondent further asserted that there was no evidence of market failure and any intervention by IDA could hinder IASPs or content providers from developing and offering new and innovative services to differentiate their offerings in the market.

9. IDA reiterates its belief that the transition to IPv6 should be driven largely by market forces. However, IDA remains concerned that market forces alone may be insufficient to motivate IASPs to act quickly enough to prevent end-users suffering from “islanding” during the initial period of IPv4 and IPv6 co-existence. Therefore, IDA intends to introduce the Principle, with several adjustments described in the following paragraphs in view of feedback from the consultation.

Scope, Limitations and Applicability of IP “No Islanding” Principle

IASPs’ responsibilities

10. A respondent opined that “islanding” may still occur in end-user-to-end-user applications even if translation mechanisms were put in place, due to causes which would vary with each application. This was a point also noted by IDA in the public consultation, recognising the limitations of the Principle. IDA agrees that it would not be reasonable to require IASPs to address “islanding” issues caused by applications outside the IASPs’ control, e.g. in situations where the underlying protocol is hardcoded into the consumers’ browser, software, or application. IDA will thus maintain that the Principle would only apply in relation to the systems, equipment and networks within the control and operation of the IASP.

11. IDA notes that interpretation of IASPs’ responsibilities may vary as a result of differing interpretation of systems, equipment and networks within their control and operation. To give greater certainty to IASPs, and to manage consumer expectations, IDA further clarifies that IASPs’ responsibilities to ensure that there is no “islanding” do not extend to end-user devices not controlled by the IASPs (e.g. wireless routers installed by end-users) or to transit providers carrying the IASPs’ traffic. IASPs should however ensure that parties with whom they have a direct contractual relationship (e.g. equipment suppliers or wholesale broadband providers) are able to support traffic delivered using their chosen solution for “No Islanding”. The scope of the IASPs’ responsibilities under the said Principle for basic Internet access over wired infrastructure is depicted in Exhibit 1. Essentially, it will include IASP-issued customer-premise equipment (“CPE”), IASPs’ edge routers and their core network.

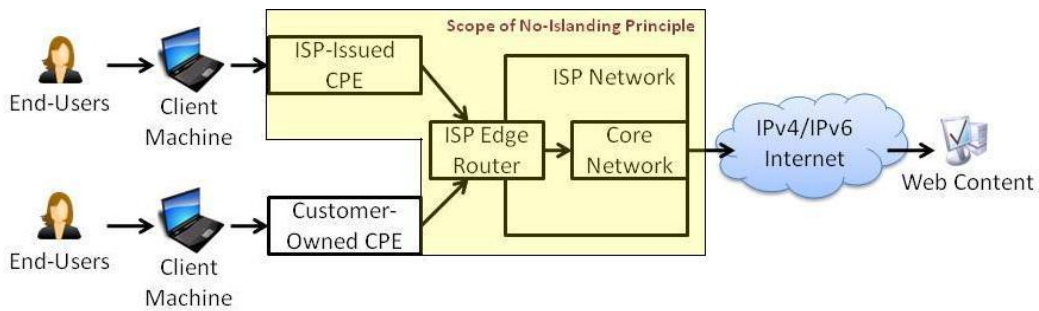


Exhibit 1: Scope of IASPs' responsibilities (wired infrastructure)

12. In relation to IASP-issued CPEs, IDA clarifies that an IASP is responsible for any CPE issued to its end-users, once the Principle is in force. Each IASP will therefore be required to ensure that CPEs sold or otherwise issued to its end-users, as part of its provision of Internet access services to them, will be able to support “No Islanding” after the Principle comes into force. Where CPEs were issued by an IASP prior to the Principle coming into force, the IASP will be required to ensure that the CPEs are able to support “No Islanding” at the first revision or extension of contract after the Principle comes into force, or when there is a need to replace or upgrade the CPEs issued to its end-users (after the Principle comes into force), whichever is earlier.

Applicability to other parties

13. IDA proposed in the Consultation Paper that the Principle:
- a) Be applied only in relation to residential customers using wired or wireless Internet access, given that business customers may have or require more specific and customised solutions, and would have greater ability to discuss or negotiate arrangements specific to themselves;
 - b) Be imposed on IASPs but not Internet Exchanges (“IXs”), because with demand from IASPs, IXs are likely to also upgrade their infrastructure to support “No Islanding” if they have not already done so, and because IASPs have the option of working with the SGIX which is fully IPv6-capable; and
 - c) Not apply to providers of free and localised wireless Internet access.

14. Both respondents did not raise specific issues pertaining to the application of “No Islanding” to residential customers only. There were also no specific comments on not applying the Principle to providers of free and localised wireless Internet access. IDA therefore intends to retain these positions. However, in relation to the latter, IDA notes that “islanding” is likely to pose greater consumer concern as public use of free and localised wireless Internet access services increases. Therefore, IDA clarifies in this Decision that the exemption of providers of such services will be subject to future review depending on market conditions and public concerns.

15. The two respondents were divided on the applicability of the “No Islanding” policy to IXs. The respondent in favour of including IXs observed that it would be contradictory for IDA to impose regulations on IASPs but not IXs, as both have commercial incentives to put in place transition mechanisms to support their customers. In addition, the application of the Principle to IXs would simplify traffic routing, improve overall network performance and imply a shorter implementation timeline due to less extensive network upgrades.

16. In relation to the applicability of “No Islanding” to IXs, IDA notes that local IXs currently offer connection services below the IP layer, and are therefore unlikely to affect whether content or users are “islanded”¹. A requirement to comply with the Principle may therefore not be applicable to IXs. Nonetheless, as a precaution, IDA will require each IX to ensure that it will not be in a position to cause traffic (whether on IPv4 or IPv6) from IASPs peering at the IX to be disrupted, due to the IX’s inability to support IPv4 and IPv6.

17. IDA will also apply a similar obligation to providers of wholesale broadband as to IXs. Such providers could potentially cause IP traffic to be ‘islanded’ as they offer Layer 3 services. However, IDA considers that they would have a commercial incentive to support the Principle due to demand from retail IASPs. Balancing these considerations, IDA views that a precautionary obligation to not cause ‘islanding’ would suffice as a start, and will therefore limit the obligations of

¹ The IXs offer services that operate at Layer 2 (the data link layer), which is responsible for procedures and protocols for transferring data between network entities. IP operates at Layer 3 (the network layer), which is responsible for routing data across networks.

such providers to that similar to IXs'. That is, IDA will require each wholesale broadband service provider to ensure that it will not be in a position to cause traffic (whether on IPv4 or IPv6) from IASPs to be disrupted, due to the inability of the wholesale products and services to support IPv4 and IPv6.

Technical limitations to addressing "islanding"

18. Both respondents indicated that there were limitations to the use of existing technical solutions to address "islanding". One respondent noted that several technical options were available to prevent "islanding", but as these were not yet recognised as international technical standards, vendors could potentially provide varying solutions based on these technologies. The respondent further opined that the impact of such solutions on end-users was not well-understood since these technologies were new. The other respondent commented that the deployment of transition technologies and upgrading of network infrastructure to cater to IPv4 and IPv6 co-existence would put tremendous stress on the underlying network systems, and potentially introduce challenges pertaining to latency, network responsiveness etc. that may compromise service levels.

19. IDA is cognisant that technical standards for some translation mechanisms (e.g. NAT64) have been ratified recently². Initial industry feedback also shows that there are areas to be improved (e.g. in the provision of VoIP over NAT64). On the other hand, solutions such as dual-stack may be more readily available for deployment³. IDA understands that it is possible for operators to put in place translation mechanisms in an incremental fashion, which may entail measures limited to software upgrades of existing translation equipment in the first instance. In keeping with the principle of technology neutrality, IDA reaffirms that it does not intend to prescribe the type of solutions which IASPs may use to comply with "No Islanding". IASPs may therefore decide on the solutions that are most suitable for their circumstances.

² A NAT64 system translates IPv6 packets to IPv4. NAT64 specifications (*RFC 6146: Stateful NAT64: Network Address and Protocol Translation from IPv6 Clients to IPv4 Servers*) were finalised in Apr 2011 by the Internet Engineering Task Force. However, IDA understands that there may be challenges in deploying NAT64 solutions as issues such as interoperability and audit trail logging have not yet been fully resolved.

20. More broadly, IDA notes that the limitation of the Principle to local IASPs, while necessary, implies that it would not be possible to eliminate “islanding” entirely. End-users may still fail to reach destinations hosted on overseas networks which are not IPv6-ready, or if their traffic passes through any part of the overseas network which is unable to support the right IP version. Nonetheless, IDA believes that the Principle is necessary to put in place reasonable safeguards to mitigate the problem of “islanding” for end-users in Singapore.

Costs and Implementation Considerations

21. IDA is aware of the compliance costs that IASPs may incur under the proposed Principle, as well as the potential limitations of applying the policy only to IASPs. To a large extent, given that the Principle is meant to address issues related to the initial period of IPv4/IPv6 co-existence before market forces take over, the incremental costs of the regulatory measure to IASPs can be mitigated by providing a longer lead time for IASPs to implement the measure.

22. IDA had proposed 1 September 2012 as the effective date of the Principle in order to provide sufficient lead time for IASPs and mitigate compliance costs. Nonetheless, both respondents requested a later effective date should the said Principle be implemented. One respondent proposed that end-2012 would be a more realistic date given the costs of implementation. The other respondent suggested that the timeline be extended at least a further 18 months to allow for the development of technical standards, the development of corresponding equipment/solutions, and the implementation of the requisite network changes. It also proposed that the Principle be implemented in phases, with priority placed on content providers identified through selected scenarios based on IPv6 technology readiness.

23. The same respondent also commented that the costs of compliance with the Principle would be in terms of millions of dollars if the start date of 1

³ For example, in Nov 2011, Comcast began a pilot deployment of dual-stack solutions for

September 2012 was maintained. Alternatively, the cost would be significantly lower if the implementation of technical solutions were to be incorporated into the technology refresh cycle over the years. The respondent also suggested that IDA fund the IASPs' implementation costs in whole or in part, asserting that the compliance costs would likely be passed to consumers.

24. IDA recognises that determining the commencement date for “No Islanding” involves balancing consumer interest and compliance costs. Bearing this in mind, IDA proposes that the Principle be effective from 1 June 2013. This provides a longer timeframe for the development and procurement of effective solutions at reasonable prices, while ensuring that measures to prevent “islanding” will be in place by the time demand for IPv6 is expected to intensify⁴.

25. Given that the Principle is meant to be an interim measure for the initial stages of IPv4/IPv6 co-existence, IDA will also maintain the position of reviewing the necessity of the Principle three years after it becomes effective, as proposed in the Consultation Paper. This will also ensure that the measure does not perpetuate the use of IPv4 when IPv6 becomes predominant.

26. While IDA considered applying the Principle in phases to further mitigate implementation costs, IDA does not intend to do so as that would detract from the policy intent of ensuring seamless access to content and services across the Internet. A phased approach may also be more complicated for IASPs to administer.

27. Finally, IDA recognises the importance of stakeholder engagement in facilitating a smooth shift from IPv4 to IPv6. To date, the IPv6 Task Force has undertaken several initiatives to educate stakeholders on the IPv6 transition, including conferences, seminars, workshops, electronic digests and an online information portal. The IPv6 Task Force will continue to develop awareness among relevant stakeholders going forward.

residential users in Pleasanton, California.

⁴ While existing IASPs will have some IPv4 addresses in stock, new RSPs on the Next Generation Nationwide Broadband Network are likely to operate primarily on IPv6 given IPv4 exhaustion at the regional level, increasing the likelihood that “islanding” becomes a more prominent issue for consumers and content players.

Summary of IDA's Decision

28. In summary, as laid out in this Decision, IDA will proceed with the IP “No Islanding” Principle, as follows:

- a) Each IASP will be required to ensure that systems, equipment and networks within its control and operation for the provision of Internet access services to residential or non-business 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);
- b) Each IX will be required to ensure that it will not be in a position to cause traffic (whether on IPv4 or IPv6) from IASPs peering at the IX to be disrupted, due to the IX's inability to support IPv4 and IPv6;
- c) Each wholesale broadband service provider will also be required to ensure that it will not be in a position to cause traffic (whether on IPv4 or IPv6) from IASPs to be disrupted, due to the inability of the wholesale products and services to support IPv4 and IPv6;
- d) The IP “No Islanding” Principle will be effective from 1 June 2013; and
- e) IDA will review the necessity of the IP “No Islanding” Principle three years after it becomes effective.