International Journal of Advances in Computer Networks and Its Security– *IJCNS*
Volume 4 : Issue 3 *[ISSN 2250 – 3757]*
Publication Date : 30 September, 2014

Readiness Factors on Migrating to IPv6

[Aspalilla Main[1], Nurul Azma Zakaria[1], Robiah Yusof[2], Nin Hayati Mohd Yusoff[3]]

***Abstract*— IPv6 was created in the 1990s by the Internet Engineering Task Force (IETF), as a next generation network layer protocol, to overcome the limitations of IPv4. However, organizations that plan to implement IPv6 should really be ready for deployment with proper planning; because non-preparation may contribute towards slowing down the migration process. Based on literature from previous research, this study discusses that organization readiness contributes to a slowing down of the migration process, and to identify the factors that influence an organization's readiness towards IPv6 migration. The findings reveal that the level of organization readiness contributes to the speed of the migration process. The factors that influence organization readiness are migration cost, infrastructure (including hardware and software), knowledge, technical staff skills, and IPv6 awareness from all levels of personnel within the organization.**

Keywords—*IPv6, Migration, Readiness*

I. Introduction

IPv6 was created in the 1990s, with 128 bits that could provide up to 2^{128} (or approximately 3.4×10^{38}) addresses. IPv6 was created by the Internet Engineering Task Force (IETF) to provide space for a larger number of addresses [1]. Besides providing this larger space, IPv6 also facilitated other features that did not exist in IPv4 [2]. However, migrating from IPv4 to IPv6 quickly was impossible, due to the large number of Internet and IPv4 users. In addition, because many organizations relied on the Internet for their daily work, they could not tolerate any downtime for the required IP protocol transition [3]. In fact, because IPv6 requirements are extremely demanding, transition could not be easily achieved in a short time, and required a large amount of careful planning and preparation, in order to develop and adapt to the new IPv6 environment [4].

IPv4 to IPv6 transitions generally involve three practices, which are dual stack, tunnelling, and translation; before full deployment to IPv6 is complete. Different requirements are needed for each transition method, and should be studied before implementation is attempted [5]. However, according to [6], IPv6 adoption will be slower if an organization is not given enough information about the benefits and risks that may be encountered during migration.

Aspalilla Main[1], Nurul Azma Zakaria[2], Robiah Yusof[2],
Nin Hayati Mohd Yusoff[3]
Universiti Teknikal Malaysia Melaka (UTeM)
Politeknik Merlimau, Malaysia

In facing the problem of diminishing IPv4 addresses, the IPv4 to IPv6 migration rate is seen to be slow [7]. Many studies have shown that in most places, IPv6 deployment is quite slow - despite changing to the new protocol being deemed as crucial. Even though migration to IPv6 appears to be slower than expected, many reasons have been identified for its need. These include the depletion of IPv4 address spaces [8], with about 5.5% of the world's Internet users using the IPv6 environment [9], even though 184 countries have allocated their IPv6 addresses [10] until April 2012. In Malaysia, it was reported that in 2012, only 1.4% of Domain Names with IPv6 were enabled [11].

Therefore, this study has been done to verify that a lack of organization readiness contributes to a slow migration process, and to explore the factors that influence organization readiness. Previous studies have been used as references to discuss both issues.

II. Literature Review

Given that IPv6 is a new technology, which will replace the current version of IPv4, transition is seen as a lengthy difficult process for an organization, because it involves many aspects, such as stakeholder, infrastructure [12], technique and method [13], cost [14], and proper planning to ensure a smooth migration [15]. Therefore, migrating from IPv4 to IPv6 quickly is impossible, due to the large number of Internet and IPv4 users. In addition, because many organizations rely on the Internet for their daily work, they cannot tolerate any downtime for the IP protocol transition [3]. In fact, because IPv6 requirements are extremely demanding, transition could not be easily achieved in a short time, and required a large amount of careful planning and preparation, in order to develop and adapt to the new IPv6 environment [4].

IPv6 includes new network standards that will change, not only IT infrastructure, but also the management personnel that operate it at different levels [16], including top management, technical staff, and end-users within organizations. Therefore, migration to IPv6 needs high organizational readiness with proper planning, methodology, and implementation tools, so that the costs and risks involved can be controlled [17]. Some organizations have already undertaken to apply IPv6 on their networks. Organizations that plan to implement IPv6 should be completely ready for the deployment, with proper planning, because IPv6 migration requires appropriate preparation, effort, accurate resources, and expertise, to make sure that the migration goes smoothly.

In order to adopt IPv6 within networks, the Malaysian government has set-up the National IPv6 Council, in order to grant leadership and planning for the implementation of IPv6 in Malaysia. IPv6 is recognized as a major infrastructure

project under the Malaysia Information, Communications, and Multimedia Services 886 (MyICMS 886) strategy, implemented under RMK-9. The deployment of IPv6 in Malaysia is still not widely applied; this is in contrast with the success indicators for MyICMS 886, relevant to IPv6, which are:

- Malaysian ISPs to migrate to IPv6 by the end of 2006
- Government organisations to initiate migrate to IPv6 by 2008
- IPv6 is expected to be proliferated nationwide by 2010 with national network support

In conclusion, migration to IPv6 requires effort, preparation, and consideration. A lack of careful preparation can have a negative impact on security within the network system.

III. Materials and Method

The aim of this study is to identify whether organization readiness contributes to the speed of IPv6 migration or not. We have explored the factors that influence organization IPv6 migration readiness. In order to achieve these objectives, a qualitative research method (i.e., a document review) was performed by referring to several previous studies as a literature review.

This method was used because it is a systematic procedure to review and evaluate printed documents and electronic materials [18]. Literature studies from journals, reports, and working papers were used as materials and resources for our document analysis.

IV. Result and Discussion

A. *Organization Readiness*

Based on previous research, one of the reasons that contribute to a slow IPv6 migration process is a low level of organization readiness. Transition from IPv4 to IPv6 is not easily achieved in a short time, and requires a great deal of preparation and careful planning [4]. This leads to the question of how ready is the entire world to face this process, particularly developing countries [16]. As mentioned previously, transition from IPv4 to IPv6 requires support from several aspects that include cost, stakeholders, method, infrastructure, and planning. All of these aspects should be taken seriously, so that the level of preparation and readiness in terms of technology education, infrastructure, procedures, and business return investment, can be measured [15]. In fact, this can be used to assess the readiness of IPv6 transition planning in terms of technical, organizational, and marketing views [9].

Previous findings show that a low level of readiness and preparation influenced the progress of IPv6 deployment; especially when most of the network environment is still not available for IPv6 [10]. In terms of transition strategy, where network administrators have a problem choosing the best method to implement IPv6 transition [4], because of limited transition mechanism options [19], network managers tend to be confused; especially those who lack experience [13]. Furthermore, network administrators with limited knowledge, can be a major factor contributing to slowing down the migration progress [8]. Other than that, facilities that can affect the migration progress, which is the percentage of network equipment supporting IPv6, is still low at less than 50% [10]. According to [20], any organizations that start planning towards IPv6 must first assess their readiness, because organizations that are not quite ready, could contribute to a significant problem in the ICT industry [21].

Therefore, from the literature, we can conclude that preparation and a high level of readiness is extremely important for organizations, before they start to migrate to IPv6.

B. *Factors Influence the Organization Readiness*

According to previous literature, the factors that influence organization readiness include:

i. Infrastructure compatibility

Since IPv6 is a new protocol, which is completely different to IPv4, an organization's major concern is existing infrastructure compatibility. Cases of infrastructure failure could cost organizations millions of dollars. Examples of infrastructures include software and networking devices, such as gateways, routers, servers, switches, and computers. During the IPv6 transition, network infrastructures and hosts should be compatible with IPv6, and network applications should be migrated to run IPv6 [22].

ii. Training and skills

The lack of new technology technical skills is the biggest challenge for technical staff to adopt a new protocol in their organization. Technical staff need support, training, and expertise from external agencies to train to manage a new protocol. Knowledge, skill, and experience are major aspects that can affect the successful adaptation of a new technology. Having theoretical knowledge but lacking practical experience is one of the weaknesses found by many local researchers [1]. Correct programs and training, established by the organization, will ensure that IPv6 is always in mind, and its complexity will not hinder technical staff when in place [23]. Furthermore, maintenance staff lacking IPv6 address experiences and familiarity will contribute to increased costs and lower development efficiency [24].

iii. Lack of awareness among top management

An organization's top management awareness of IPv6 is a critical factor to ensure the success of IPv6. If the awareness level remains low, the level of readiness will not increase. This would be even more complicated for the migration process.

According to [25], organisations should know their IT environments, in order to determine IPv6 readiness.

iv. Unclear about the total cost of the migration

Cost implications for the IPv6 transition are not well understood by the organization [26]. Certain organizations think that the total cost of IPv6 migration involves a large amount of money if their current infrastructure is incompatible with the IPv6 protocol. However, they were unclear about cost estimation. According to A. H. Arifin, et al. [27], changing from IPv4 to IPv6 is very expensive, since current network applications run on IPv4. Moreover, appropriate cost estimations for planning, design, testing, deployment, staff training, and operational overheads need to be considered in advance [24].

v. Lack of user demand

Most hardware vendors, service providers, and security vendors, do not promote and move actively on IPv6, due to a lack of user demand. In reality, some providers show that they are not interested in IPv6 deployment [16]; even though their awareness is high. Meanwhile, security vendors only carry a limited investment in IPv6; because of the low demand from commercial enterprises [28] and because some operations solutions and monitoring systems currently do not have support for IPv6. In fact, many claim that suppliers lack timely IPv6 compliance in their core kit, as there is little demand from users [29]. Lack of user demand causes the vendors and service providers to be unready for the migration process.

v. Conclusion

Since migration to IPv6 needs to occur sooner rather than later, organizations have to accept and manage proactively within a fixed time frame. Most organizations are aware of the urgent need to apply IPv6 within their network. However, according to Dell [21], very few organisations have made preparations for IPv6 deployment, because they do not see an immediate need. This shows that they unready the migration process. Consequently, companies that continue to rely on IPv4, with no plans for implementing IPv6 in the future, may face negative impacts to their businesses; especially for cost increases and limited website functionality.

Several factors, which need to be considered seriously and prepared for by organizations before they start the migration process, include migration cost, infrastructure (including hardware and software), knowledge, skills among technical staff, and IPv6 awareness from all levels of personnel within the organization.

In conclusion, full support from all stakeholders, including service providers, vendors, the government, and all personnel within organizations, can help to smoothly initiate the migration process.

Acknowledgment

This research paper has been funded by Higher Education Sector, Ministry of Education, Malaysia.

References

[1] S. V. Limkar, R. K. Jha, T. Patil, and Maroti Kalbande, "IPv6: Features, Current Deployment Scenario, Issues and Migration Status in India," in *2010 International Conference on Software and Computing Technology (ICSCT 2010)*, 2010, no. Icsct, pp. 149–153.

[2] M. Van Der Pal, "IPv6 Preparation and Deployment in Datacenter Infrastructure – A Practical Approach," *J. Telecommun. Inf. Technol.*, vol. 2013, no. 1, p. 20, 2013.

[3] A. N. Abu Ali, "Comparison Study Between IPV4 & IPV6," *Int. J. Comput. Sci. Issues*, vol. 9, no. 3, pp. 314–317, 2012.

[4] M. Nguyen, N. Anh, T. Rantapuska, J. Utriainen, and M. Matilainen, "Transition From IPv4 To IPv6: The Method for Large Enterprise Networks," in *INNOV 2012, The First International Conference on Communications, Computation, Networks and Technologies*, 2012, no. c, pp. 5–14.

[5] P. Wu, Y. Cui, J. Wu, J. Liu, and C. Metz, "Transition from IPv4 to IPv6: A State-of-the-Art Survey," *Commun. Surv. Tutorials, IEEE*, vol. 15, no. 3, pp. 1407–1424, 2013.

[6] A. Hovav and Y. J. Kim, "Determinants of IP Version 6 Adoption," in *Computing in the Global Information Technology, 2006. ICCGI '06. International Multi-Conference*, 2006, vol. 00, no. c, p. 9.

[7] N. M. Ahmad and A. H. Yaacob, "IPSec over Heterogeneous IPv4 and IPv6 Networks: Issue and Implementation," *Int. J. Comput. Networks Commun.*, vol. 4, no. 5, pp. 57–72, 2012.

[8] K. Nowicki, M. Stankiewicz, A. Mrugalska, J. Wozniak, and T. Mrugalski, "Extension Management of a Knowledge Base Migration Process to IPv6," in *Applications and the Internet (SAINT), 2011 IEEE/IPSJ 11th International Symposium*, 2011, pp. 497–501.

[9] V. Svedek, O. Dobrijevic, M. Matijasevic, I. Golub, and T. Stivojenic, "Towards assessment of IPv6 readiness, deployment and transition plans in Croatia," in *Software, Telecommunications and Computer Networks (SoftCOM), 2011 19th International Conference*, 2011, pp. 1–7.

[10] S. Tseng, A. Lu, C. Ku, C. Chu, and G. Tsai, "A Study of the Service-based IPv6 Readiness Model for Government Agencies," in *2012 16th WSEAS International Conference on Computers*, 2012, pp. 386–391.

[11] G. R. Sinniah, "IPv6 in Malaysia," no. October. 2012.

[12] W. George, C. Donley, and L. Howard, "IPv6 Support Required for all IP-capable Nodes," USA, 2012.

[13] J. Arkko and F. Baker, "Guidelines for Using IPv6 Transition Mechanisms during IPv6 Deployment." pp. 1–21, 2011.

[14] K. Dai, "IPv4 to IPv6 Transition Research Based on the Campus Network," in *2011 2nd International Symposium on Intelligence Information Processing and Trusted Computing*, 2011, pp. 199–202.

[15] X. Che and D. Lewis, "IPv6: Current Deployment and Migration Status," *Int. J. Res. Rev. Comput. Sci.*, vol. 1, no. 2, pp. 22–29, 2010.

[16] S. Kapetanovic and S. Ribi, "The Analysis of Implementing the IPv6 Protocol in Bosnia and Herzegovina," in *Telecommunications Forum (TELFOR)*, 2012, pp. 52–55.

[17] S. Limkar and R. Jha, "IPv6: Features, Current Deployment Scenario, Issues and Migration Status in India," in *Proceeding of the International Conference on Software and Computing Technology*, 2010, no. Icsct, pp. 149–153.

[18] M. E. Sallabaş, "Analysis of Narrative Texts in Secondary School Textbooks in Terms of Values Education," *Acad. Journals*, vol. 8, no. 8, pp. 361–366, 2013.

[19] R. Khan and H. Sindi, "Necessity to migrate to IPv6," in *Information Society (i-Society), 2012 International Conference*, 2012, pp. 210–215.

[20] S. Gold, "IPv6 migration and security," *Network Security*, vol. 2011, Elsevier Ltd, pp. 15–18, Mar-2011.

[21] P. Dell, "Australian IPv6 Readiness : Results of a National Survey," *J. Res. Pract. Inf. Technol.*, vol. 44, no. 1, pp. 3–15, 2012.

[22] J. Hanumanthappa, D. H. Manjaiah, and B. I. D. Kumar, "Economical and Technical costs for the Transition of IPv4 – to-IPv6 Mechanisms," in *National Conference on Wireless Communications and Technologies(NCWCT-09)Theme: Mobile and Pervasive Computing, At Nitte,Karnataka,Udupi Dist,Karnataka,India.*, 2009.

[23] M. van der Pal, "IPv6 Preparation and Deployment in Datacenter Infrastructure–A Practical Approach," *J. Telecommun. Inf. Technol.*, vol. 2013, no. 1, pp. 20–24, 2013.

[24] N. Q. A. Nguyen Phu Minh Nguyen, T. Rantapuska, J. Utriainen, and M. Matilainen, "Transition From IPv4 To IPv6: The Method for Large Enterprise Networks," *INNOV 2012 First Int. Conf. Commun. Comput. Networks Technol.*, pp. 5–14, 2012.

[25] P. Dell, "Two economic perspectives on the IPv6 transition," *Info*, vol. 12, no. 4, pp. 3–14, 2010.

[26] C. E. Caicedo, J. B. D. Joshi, and S. R. Tuladhar, "IPv6 Security Challenges," *Perspective*, vol. 42, no. 2, pp. 36–42, Feb-2009.

[27] A. H. Arifin, D. Abdullah, S. M. Berhan, and R. Budiarto, "An Economical IPv4-to-IPv6 Transition Model : A Case Study for University Network," *IJCSNS Int. J. Comput. Sci. Netw. Secur.*, vol. 6, no. 11, pp. 170–178, 2006.

[28] C. Saran, "How to manage the IPv6 transition," *computer weekly*, pp. 10–11, Feb-2012.

[29] Stephen McClelland, "IPV6: Still not there?," *Intermedia*, vol. 38, no. 4, pp. 10–12, 2010.

About Author (s):

Aspalilla Main started her career as a lecturer for Electrical Engineering and Computer based subjects since 2003 at Merlimau Polytechnic. Her background is Communication & Information System Engineering and her research interest are network management, communication and e-learning. Currently, she is pursuing her doctoral's degree at Universiti Teknikal Malaysia, Melaka.

Nurul Azma Zakaria,PhD is a senior lecturer at Faculty of Information and Communication Technology, Universiti Teknikal Malaysia Malacca (UteM) and actively doing research and published articles in several journals. Her research interest are Network Management, System-Level Design Methodologies, Embedded System Design, and Communication Design for Distributed Embedded Systems Refactoring-based

Robiah Yusof,PhD is a senior lecturer at Faculty of Information and Communication Technology, Universiti Teknikal Malaysia Malacca (UteM). Being in the network field for the past several years, she has published numerous articles in several journals. Her research interest are Network Security, Network Administration and Network Management.

Nin Hayati Mohd Yusof, who has been teaching in the Department of Electrical Engineering, since 2005 teaches computer subject for diploma programs in polytechnic. She has an educational background in Electrical Engineering (IT) at the undergraduate level and Technical & Vocational Education at postgraduate Level. Her research interest are network management, e-learning and operating system.