Organisational Readiness Element to Develop Readiness Model for IPv6 Migration

Aspalilla Main, Nurul Azma Zakaria and Robiah Yusof

Faculty of Information and Communication Technology, Universiti Teknikal Malaysia, Melaka Hang Tuah Jaya, 76100, Durian Tunggal, Melaka, Malaysia

**ABSTRACT**

**Background:** Internet Protocol (IP) is one of the Internet addressing protocol that allows devices to connect to each other. Now, the existing IPv4 protocol gradually been replaced by a new version of the protocol which is IPv6 to provide a larger scale and to facilitate various improvements of the protocol. In our prior work, we have studied the previous research in order to identify the factor that may influence the organizational readiness to migrate to IPv6. From the previous finding, the factors can be classified into two categories which are physical factors; IPv6 deployment (planning), equipment and cost, while human factors involve of knowledge, training and motivation. Thus, the contribution of this paper is to explore the elements that can clarify all the factors which have been identified before. Same approach which is document review has been used as the methodology for achieving those objectives. The result indicate that the factor of (i) cost will involve infrastructure upgrade and deployment operation, (ii) networking equipment is the element of equipment, and (iii) deployment can be clarify detail by planning and implementation. For the human factor, (i) advantages of IPv6 and IPv4 address exhaustion are the motivation for organization to migrate to IPv6. (ii) Training will involve of technology and staff training, and (iii) knowledge that will be needed for IPv6 migration are implementation and technology. All the elements can be used to develop a readiness model for an organization to migrate to IPv6.

**INTRODUCTION**

For many years, the Internet addressing protocol known as IPv4 is sufficient to meet existing demand, but over the past few years, the number of IPv4 addresses will probably fail to meet the increasing demand of internet users. Therefore, IPv6 was designed by the Internet Engineering Task Force (IETF) in the 1990s to offer space for a bigger number of address (Suresh V. Limkar, Jha, Patil, & Maroti Kalbande, 2010). Besides offering this greater space, IPv6 development also facilitated other features that not existing in IPv4 (Van Der Pal, 2013) such as automatic configuration for addresses and IPsec support.

In general, there are three techniques for migrating from IPv4 to IPv6 protocol, before a full IPv6 deployment is complete, which are: dual stack (Nguyen Phu Minh Nguyen, Rantapuska, Utriainen, & Matilainen, 2012); tunneling (Bahaman, Hamid, & Prabuwono, 2012); and, translation (Zhai, Bao, & Li, 2011). Unfortunately IPv4 and IPv6 are incompatible protocols, and it is impossible to make the migration from IPv4 to IPv6 in a short time (Al-ani & Haddad, 2012) since making an abrupt replacement from IPv4 to IPv6 platform is fraught with risk. Moreover, nowadays many organizations depend on the Internet for their daily work, so the user cannot tolerate any downtime for replacement of the IP protocol (Abu Ali, 2012). As an alternative, adopted by the co-existence can occur, in which the two protocols will exist at the same organization at certain period of time (Hovav, Patnayakuni, & Schuff, 2004), until full deployment of IPv6.

Consequently, in an organization, the technical staffs are required to assess all existing applications to see how they would work with IPv6. In addition, they need to plan and update each network infrastructure for tested with IPv6-compliant client devices because the most important aspects of integration between IPv4 and IPv6 is planning (Che & Lewis, 2010). Thus, planning education for IT support in organization should be done according to job tasks to support a smooth migration of IPv6 (Che & Lewis, 2010). However, this task will require time and effort on the part of the organization to ensure that the organization is fully prepared before starting the IPv6 migration process.

The study of organizational readiness for migration to IPv6 has been discussed by several previous researcher before. According to Gold(2011), any organization that is planning to migrate to IPv6 must assess the
readiness of their organization as a first step in the planning process. In fact, organizations that are not ready for IPv6 and have a low level of readiness can contribute a key problem in the ICT industry (Dell, 2012).

In our prior work, we have studied the previous research in order to identify the factor that may influence the organizational readiness to migrate to IPv6. From the previous finding, the factors can be classified into two categories which are physical factors; IPv6 deployment (planning), equipment and cost, while human factors involve of knowledge, training and motivation. Thus, the contribution of this paper is to explore the elements that can clarify all the factors which have been identified before. Elements that are identified in this paper will represent each factor that could explain more clearly all the factors involved in influencing the level of organizational readiness to migrate to IPv6.

The rest of this paper is structured as follows. Next section will summarize the methodology to identify the elements, Section 2 presents the results and analysis, Section 3 will be the discussion, Section 4 is the conclusion and lastly is acknowledgment.

Methodology:
In order to attain the objective, a qualitative research method was implemented by referring to several prior studies (as a literature review). This method was used because it is an organized process to review and evaluate printed documents and electronic materials (Sallabas, 2013). It offers for exploration and analysis of criteria from previous researchers to measure the organization’s readiness towards IPv6 migration. Literature reviews from conferences, proceedings and journals, which summarized organization readiness, were analyzed. By referencing existing literature reviews, it appears that the relevant methods have been identified (Haug & Pedersen, 2011). Given the credibility of the journal and the proceeding in which they were published, it appears reasonable to deduce that the most relevant findings were discussed. The elements identified are analyzed and discussed to clarify the factors that influence the organization readiness towards IPv6.

Results:
From prior work, we already identified six factors that influence the organization readiness as mentioned above. Therefore, this section will describe the elements that will represent each of the factors. These elements can explain more clearly the factors that have been identified before.

2.1 Physical Factor:
A. Deployment Status:
i. Planning:
Planning is the process of thinking about and organizing the activities needed to achieve the desired goal. Dell (2012) concluded that any organization that plan to deploy to IPv6 must start plan towards IPv6, including training, inventory work, and ensure long-term investment on their infrastructure is IPv6 ready. This is supported by Kapetanovic & Ribi (2012), where in their study, planning is one of the element in deployment stage for the IPv6 implementation in Bosnia Herzegovina. Besides, a study conducted by Nguyen Phu Minh Nguyen et al. (2012) for large enterprise suggested that any organization that would like to start for IPv6 address transition, need to be prepared for the budget that can be used for planning, design, testing and training.

ii. Implementation:
Implementation is one of the phase in IPv6 deployment. According to Arkko & Baker (2011), it is important to initiate the deployment process in a timely manner. The effort is include - a network audit, selection of network components, network management, planning, and execution (implementation). Other than that, Kapetanovic & Ribi (2012) has incorporated elements of the (i)understanding of the new standards, (ii) level of implementation and (iii) opinion of the participants about IPv6 while conducting their research on IPv6. In addition, Nguyen Phu Minh Nguyen et al. (2012) and van der Pal (2013) integrated the element of testing in the implementation phase to clarify the deployment status.

B. Cost:
i. Infrastructure upgrade:
IPv6 and IPv4 are two different protocols, so the cost of overhauling the existing IPv4 infrastructure is high for most of network operators and service providers (Omae & Adeya, 2011) as well as any organization. Though upgrading from IPv4 to IPv6 in the Internet today requires cost but still we need to minimize the cost (Dai, 2011) by investing on IPv6 compliance devices for the future use. The infrastructure involve the end user device (Dobrijevic, Svedek, & Matijasevic, 2012), hardware and software upgrade (Hanumanthappa, Manjaiah, & Kumar, 2009) and application upgrade (Dell, 2012).
ii. Deployment operation:
In addition, the cost that will be involved for migration is the cost during the deployment operation. According to Nguyen Phu Minh Nguyen et al. (2012), organization that plan to initiate the IPv6 address transition need to provide the significant budget used for planning, design, testing, training, deployment operation, and operating costs. Deployment operation cost include the cost for transition (Zhai et al., 2011), configuration (Dobrijevic et al., 2012), labour (Dell, 2012) and unpredictable cost (Hanumanthappa et al., 2009).

C. Equipment:
i. Networking equipment:
The equipment need to be considered in the preparation for the migration process is the networking equipment. The main goal of the network equipment is to provide connectivity and it acts as a bridge between communication medium and the applications. Though, compatibility with IPv6 protocol is becoming the key issue, a lot of older hardware can be upgraded or is likely to be replaced instead. Tseng, Lu, Ku, Chu, & Tsai (2012) in their study used the networking equipment as one of the measurement criteria for IPv6 readiness model. It is define as the ratio of the equipment that supports IPv6 network for the access. Moving an organization to IPv6, the major points of concern is the network equipment; server, workstation, or end user device need to properly configured, for local area network (LAN) and wide area network (WAN) infrastructure (Dobrijevic et al., 2012). While, (Suresh V. Limkar et al., 2010) instantiated the networking equipment as router. Additionally, Hou, Zhao, & Ma (2010) agreed that networking equipment will complete all of the work involve in the migration, including the protocol and address translation between IPv4 and IPv6.

2.2 Human Factor:
A. Advantages of IPv6:
i. Advantages of IPv6:
The main motivation behind the deployment of IPv6 is its advantage in which they are able to expand the address space (Omoe & Adeya, 2011) available in the Internet. This will allow communication of billions of new devices. Kapetanovic & Ribi (2012) used the motivation of IPv6 advantage as one of the measurement criteria in their study. The finding reveals that larger address space and new type of addresses network as the reason why most of the organization deploy this new protocol. While Nawaz, Ashraf, Hong, Wu, & Lin (2009) explained the advantages of IPv6 as prominent features of IPv6 such as manageable routing table growth, more larger space for addressing, auto configuration in server, security i.e., solid IP-layer encryption and authentication as well as Quality of Service (QoS), etc. Moreover, SV Limkar & Jha (2010) added other features with hierarchical assignment of unicast addresses, well support for non-unicast addressing and hierarchical address space as the advantages of IPv6 that has become the motivation to organization to migrate.

ii. IPv4 address exhaustion:
Besides the advantages of IPv6, the key driver behind IPv6 was the exhaustion of IPv4 address space (Dobrijevic et al., 2012). With an ever growing computing industry, IPv4 is nearly exhausted and needs to be replaced by a newer version. Tseng et al. (2012) stated that the regional organization i.e., Asia-Pacific Network Information Centre (APNIC), announced that IPv4 addresses are exhausted and that they will stop the normal portion of IPv4 addresses in Asia-Pacific on April 15, 2011. In fact, IPv4 address exhaustion is very obvious and it can lead to future addressing problem (Nguyen Phu Minh Nguyen et al., 2012).

B. Training:
i. Technology:
IPv6 is the next version for Internet Protocol (IP) and consider as a new technology. Therefore, training on this new technology is needed for an organization. In the case of IPv6, the lack of training conducted by the organization may be a barrier for IPv6 adoption. Therefore, Dobrijevic et al. (2012) use the technology as a measurement criteria in their study to acquire response from the respondent about the IPv6. They suggested that technology demonstration can be used as part of training to build up knowledge among technical staff. Other than that, van der Pal (2013) proposed that organization have to set an IPv6 technology training modules to gather specific IPv6 knowledge as a knowledge transfer way. While, Dell (2012) clarify the technology training as application development, equipment and operating system configuration as well as security.

ii. Staff training:
Training can be necessary for IT support if their knowledge are not sufficient for IPv6 transition (Che & Lewis, 2010) as IPv6 is more complex than existing protocol. The 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 (van der Pal, 2013). Additionally, organizations must consider developing their own IPv6 capability by
providing training to staff before embarking on the IPv6 transition (Dell, 2012). Nguyen Phu Minh Nguyen et al. (2012) in their study divided the staff training with general, engineer, operational and special training.

C. Knowledge:

i. Implementation:

Implementation is the process of deploying the IPv6 in the network. Therefore, implementation knowledge in deployment strategy is needed by technical staff as a preparation to migrate. SV Limkar & Jha (2010) suggested that organization need to always keep up-to-date on IPv6 activities as one of the solution to gain knowledge on latest deployment strategy. In fact, lack of knowledge on migration strategy among network administrators is one of the reason why the progress of migration become slow (Nowicki, Stankiewicz, Mrugalska, Wozniak, & Mrugalski, 2011). Afterward, knowledge in implementation is used by Kapetanovic & Ribic (2012) as a criteria in their study to measure the level of IPv6 implementation in Bosnia Herzegovina.

ii. Technology:

The lack of new technology knowledge such as practical knowledge and experience (Dobrijevic et al., 2012) are the biggest challenge for technical staff to adopt a new protocol in their organization. This can contribute to slow growth of IPv6 network. SV Limkar & Jha (2010) define the technology knowledge as technical knowledge among local researcher. Thus, user must always develop their technical knowledge as this can be as barrier if not taken seriously in any technology adoption (Dell, 2012).

Discussion:

The Figure 1 below shows the outcome of this study.

![Figure 1: Organization Readiness Elements.](image)

Based on Figure 1, the results confirmed the elements identified can clarify the factors that influence the organization readiness towards IPv6. In this study we have identified the elements are (i) infrastructure upgrade and deployment operation for cost factor (ii) networking equipment is the element of equipment, and (iii) deployment can be clarify detail by planning and implementation. For the human factor elements, (i) advantages of IPv6 and IPv4 address exhaustion are the motivation for organization to migrate to IPv6 (ii) training will involve of technology and staff training, and (iii) knowledge that will be needed for IPv6 migration are implementation and technology.

Meng, Elliott, and Hall (2010) concluded that by knowing the factors that influence readiness, the organisation is able to propose any activities that are needed before the implementation of any IT project, so in this case are IPv6 adoption. Failure to measure the readiness could cause project managers to spend more time managing the problem or at worst, lead to failure.

Conclusion:

The factors elements defined in previous sections can be used to develop a readiness model for organisation heading towards the IPv6 migration. By referring to each elements, it will help organisation plan and take any action before they decide to implement the IPv6 in their network.

ACKNOWLEDGEMENT

This research paper has been funded by Centre for Research and Innovation Management, Universiti Teknikal Malaysia Melaka.

REFERENCES


