Towards IPV6 Adoption in Developing Arab Countries in Western Asia Region

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Abstract: This study presents the current state of Internet Protocol Version 6 (IPv6) adoption in the different regions focusing on Western Asia and Arab countries to identify opportunities that are presented by the new protocol. The new IPv6 is of great importance, mainly with the depletion of the standard Internet Protocol Version 4 (IPv4) in most countries; thus, the main objective of this study is to encourage the different stakeholders in the region to seize the early benefits of adopting the new protocol. The research has identified challenges and opportunities of migrating to the new Internet Protocol (IP) protocol in terms of accessibility, innovation, and economic growth. Despite its wealth and above world average Internet penetration, the research findings indicate that the region is slow in adopting and deploying the new protocol such as many regions in the world. The findings could help emerging technologies, especially the Internet of things, smart grids, innovative infrastructure, and intelligent buildings, which require a large number of IP addresses to accommodate the growing need to connect more things for all kinds of purposes.

I. INTRODUCTION

The IPV6 is gaining momentum for many reasons, mainly the depletion of the standard IPV4 in most countries in addition to satellite communication, emerging technologies, and especially the Internet of Things (IoT). These technologies which require a large number of IP addresses to accommodate the growing need to connect more things for all kinds of purposes. However, the adoption or the readiness of many countries for the IPV6 is slow and this is mostly noticeable in developing nations. This might lead to a new digital divide and would have great effects on economic growth especially for digital dependent economics [1, 2, 3]. The issue of ipv6 adoption is of high importance to many international organizations such as the International Telecommunication Union (ITU) and the Internet Corporation for Assigned Names and Numbers (ICANN) and Regional Internet Registries (RIRS) that include AFRINIC covering Africa, APNIC for: Asia and Pacific region, Canada, many Caribbean and North Atlantic islands, and the United States (ARIN), Latin America and parts of the Caribbean (LACNIC), RIPE NCC (Europe, the Middle East and parts of Central Asia). The continuous growth of Internet users, mainly in China, India, and in developing nations, is putting pressure on the old and depleted addresses of the IPv4 protocol. In addition to the high demand of Internet connectivity, many initiatives aim at increasing the 4.3 billion current connected users to 5.2 billion by the year 2025 [4]. This high demand is also driven by the rapid development of new emerging technologies in light of the expansive smartphone uses and the 4th industrial revolution and its existing pillars mainly IoT, and Artificial Intelligence (AI).

Governments and Local organizations in cooperation with international and regional groups in developing countries are very active in creating awareness of the

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importance of ipv6 adoption and in training technical staff on the different issues of the protocol. For example, RIPE-NCC, is very active in promoting ipv6 adoption by conducting many free workshops to raise awareness and technical training to build the required capacities for ipv6 readiness and configuration [5]. For example, the Basic and advanced IPv6 training course about the need for IPv6 include basic information on deployment. Other training courses are more advanced that covers areas like Interior Gateway Protocol (IGP), Border Gateway Protocol (BGP), security and configuration.

The Internet Society (ISOC) [6] identified a number of key issues in ipv6 adoption in order to scale-up the Internet infrastructure to accommodate more users and devices. These keys are:

- Direct addressability to provide a true IP addresses in order to connect directly to the internet and have control over the management and security of resources.
- To reduce cost and complexity of supporting legacy ipv4
- Provide default ipv6 support to help in eliminating actions by users
- Translating and tunneling traffic between the two protocols while phasing out old ipv4 machines
- Economic growth and innovation in which an ipv6 enabled infrastructure would have the edge to advance digital economies and support and encourage innovation.

In this study we focus on some of the third world countries to evaluate the state of IPv6 adoption, deployment, and readiness. First, we identify the main challenges facing the deployment in these countries which are certainly shared among other countries. Second, we present the current state of IPv6 adoption in the different regions to show the difference in the deployment, and then we show the state of IPv6 deployment in the Western Asia Arab countries.

II. LITERATURE REVIEW

A study made by [7] in Nigeria showed that the adoption and deployment are very low with only 5.88 percent of the network addresses are IPv6, and only 10.8 percent internet users access Google with IPv6 addresses. Moreover, the network operators did not provide IPv6 services for its customers yet. According to the study, the organizations in Nigeria are well aware of the IPv6 technology but they dont believe there is a good reason for the deployment of this technology at this time.

Many challenges facing organizations in Nigeria for the deployment of IPv6 such as lack of training programs,

cost of upgrade, taxation, and most importantly that the IPv4 and IPv6 are not interoperable. The authors found that the size of the organization does not affect the deployment of IPv6 in Nigeria while the IPv6 deployment time depends on planning and preparation. As for the interoperable problem between the IPv4 and IPv6, the authors present both the dual-stack and 6to4 tunnel as solutions for this problem.

An important factor for the IPv6 deployment is the users acceptance as it considered a key factor for the success of the deployment process. A study made by Putri and Sucahio [8] showed that the users can be from an academic background, enterprise practitioners or internet service providers. The study showed that an important factor for the users to start the deployment is to be convinced of the IPv6 reliability based in knowledge and experience, having a previous experience about using IPv6 will give the user a feel of its benefits. Another factor that affects the users acceptance is the availability of facilities and infrastructure, in order to start the IPv6 deployment users must be sure that the network is secure and content providers desire the institutions to start using IPv6.

[9], conducted a study in Indonesia to investigate the low deployment efforts of IPv6 technology as they are still progressing slowly. The author concluded that the majority of content providers are still using the IPv4, with only nine providers using the IPv6. This limit the content IPv6 users can access, since the biggest internet service provider in Indonesia is reluctant to start the IPv6 deployment.

An important study conducted on both Australian and Chinese organizations [10], showed that China is planning for the deployment much faster than Australia, even though Australia has a much larger number of IPv4 address per person than China which has a very large po-

pulation that exceeds the number of allocated numbers of IPv4 addresses. After studying the organizations' preparation, progression, motivation, and obstacles in both countries, the study concluded that both countries have low IPv6 deployment despite the growing need for expansion.

III. RESEARCH METHODOLOGY

Our research is not experimental but an exploratory one, in which we explore the state of IPv6 with regard to many important factors. The data used in these analyses is obtained from many sources which monitor and keep updating the number of IPv6 allocations in all regions of the world. Since many countries and mainly in the Middle East have no official authority tracking these numbers, our collected data are mainly from third party sources. Our main data was obtained from Regional Internet Registries which provide significant information and impartial data since they are independent, not-for-profit organizations that support the infrastructure of the Internet through technical coordination in their regions. For comparisons and analysis, we focus on addresses delegated for each region, adoption rate for allocated IP addresses, and the number of deployed addresses. Furthermore, challenges and opportunities that are shared among different regions are explored to help in identify common and shared challenges for the above criteria from literature and reports of the different regional registries.

IV. IPV6 ADOPTION CHALLENGES

The migration from IPv4 to IPv6 is a complicated task that needs considerable efforts and preparation in order to deploy the new protocol efficiently. In this section, we highlight some of the challenges that face an organization in the process of IPv6 deployment [11, 12].

Challenges that face an organization can be classified into three categories. First, pre-deployment challenges mainly in convincing decision makers to endorse an IPv6 deployment [13], usually, the deployment project is pro-

posed by the technical department in the organization, but they have to convince the higher management about the importance of adopting a new protocol. Moreover, external factors may also affect such a decision like having a competitor that already started the deployment [12, 14].

Second, challenges facing the organization during the deployment. IPv4 and IPv6 cannot communicate together, and since the existing network devices and applications have the IPv4 installed, they need to be replaced or upgraded [15] which is a very hard process to be done at once, therefore, IPv4 need to co-exist with IPv6 in the same network [16].

Finally, Post-deployment challenges concerned with maintenance, support, and other technical issues that are common after the deployment especially for the early adopters [17]. Engineers must be ready to handle any unexpected technical issue that might appear after the deployment [18, 19].

V. THE STATE OF IPV6 ADOPTION

In this section we will show the degree of IPv6 adoption in multiple regions of the world to highlight the big difference between developed and developing countries while the next section compares and analyzes the readiness of Arab countries in Western Asia.

Developed countries have come a long way in adopting the new protocol since it was first introduced in the late 1990s, and have designed a number of initiatives to promote it [20]. For example, 6NET [21] and 6DEPLOY [22] to advocate ipv6 adoption and ensuring the long-term development of the Internet and connect as many people as possible, and as many objects which is fundamental to any national digital transformation. Fig. 1 below shows the countries with higher Adoption from all continents and clearly shows Malaysia and Germany are leading the efforts in both Asia and Europe.
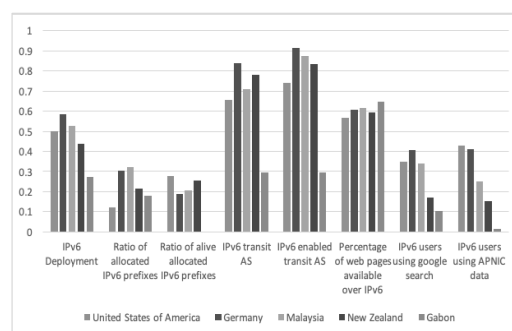

Fig. 1. Top countries with higher adoption in all cotenants

A closer look at the five RIRS addresses delegated to each region, RIPE NCC and APNIC have the highest number of addresses, while AFRINIC have the least number of allocated addresses as shown in Fig. 2.
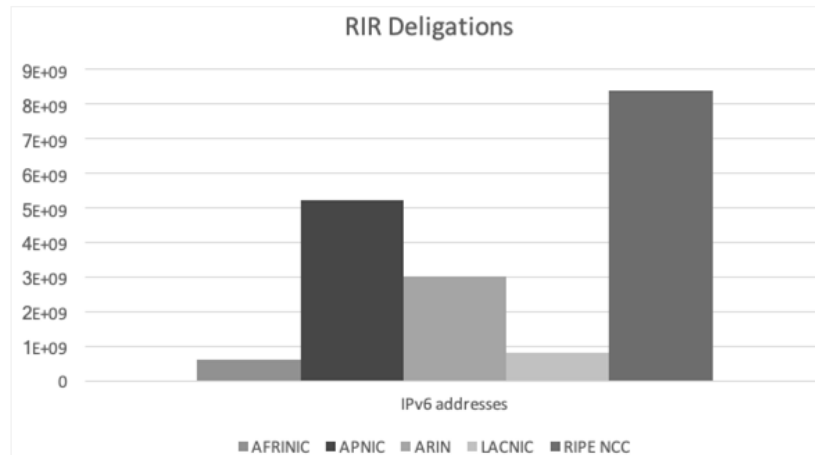

Fig. 2. IPv6 addresses delegated for each region by the regional internet registries

These numbers have significant consequence on IPv6 adoption and the readiness of different nations, and might have a long-term effect on the global connectivity and the growth of the Internet thus the overall technology driven economies and the wellbeing of nations. IPv6 adoption includes awareness, policy initiatives, development and technical training. While readiness includes the existence of appropriate technical infrastructure, operating systems, network equipment's, and computer and mobile device that can handle the new protocol.

VI. THE STATE OF IPV6 IN ARAB COUNTRIES

Western Asia Arab countries are of great interest in the issue of technology and IPv6 adoption due to its economic and social diversity. The wealth of some of its member states such as Saudi Arabia and the UAE, and the economically challenged states like Jordan and Lebanon, also the war-ravaged Iraq, Yemen, and Syria has an important influence in the IPv6 adoption. This is very apparent as illustrated in Fig. 3 which clearly shows the readiness and adoption of Western Asia Arab countries which highlights the difference between the rich oil states and those economically challenged countries. The allocated IPv6 addresses to these countries is summarized in Fig. 4 below which shows Saudi Arabia with the highest number of addresses which is proportional to the population.
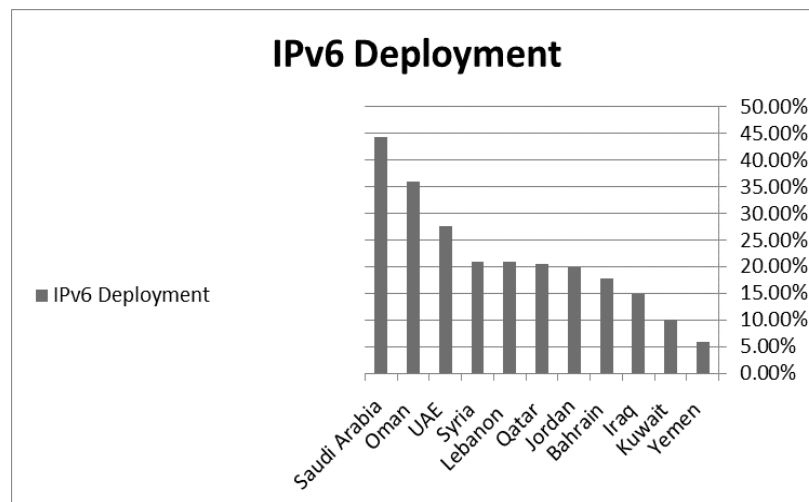

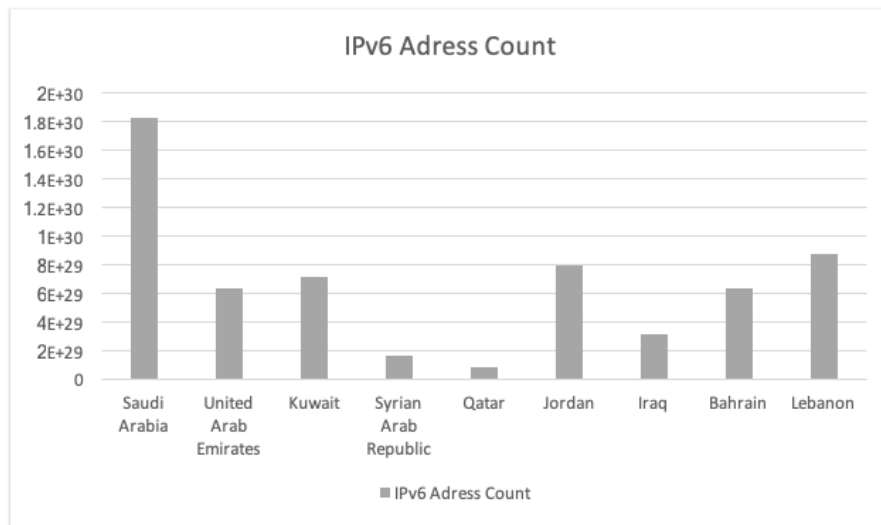Fig. 3. IPv6 deployment in Arab counties

Fig. 4. Total allocated IPv6 addresses

The readiness and adoption between two major countries in the region, mainly Jordan and Saudi Arabia gives a clear outlook on the state of IPv6 for two important countries. Jordan, which is in the middle of rank and a rich country Like Saudi Arabia that is leading in almost all categories, while Yemen on the other hand is lagging behind due to the war taking place there.

While Saudi Arabia has a population of almost 34 million people and a GDP of 683.83 USD Billion; it has an IPv6 deployment is at 44.23%. Jordan; with population 10 (million) that is almost one third of that of Saudi Arabia and GNP of almost 40 Billion USD it had achieved close to 50% rating when compared between the two countries with IPv6 deployment 18.45% and better readiness in other measurements, as shown in Fig. 5. These differences are due to many reasons mainly economic challenges, and the tech savvy nature of the youth in Jordan. In addition to legislative issues and the lower government pressure to migrate to IPv6, the privatization of the communication sector in Jordan played a significant role in the advancement of overall Information and Communications Technology (ICT) issues.
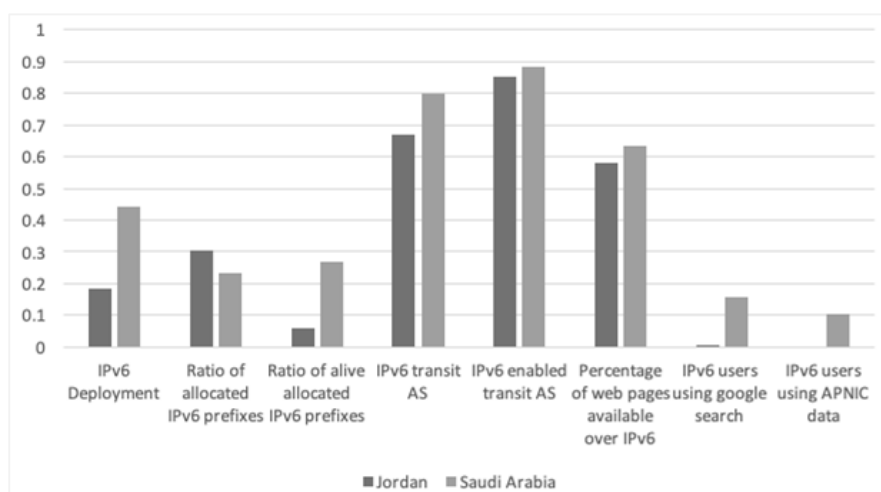

Fig. 5. Adoption and readiness for Saudi Arabia and Jordan

VII. IPV6 ADOPTION OPPORTUNITIES

It's important to note that the total available number of IPv4 addresses is 4.3 billion unique numbers while the new IPv6 offers 340x1036 unique addresses which is a key issue to insure the continual growth and development of the future of the Internet. Adoption of the IPv6 is of high importance in many dimensions including technological advancements, economic opportunities, and technical developments.

Economic growth and innovation stands to benefit immensely from the vast Internet address resources. This is crucial in the evolution and growth of the Internet to reach higher global connectivity and support booming digital economies. Emerging technologies mainly the development of smart devices and IoT, smart grids, smart infrastructure, smart buildings that are expected to reach billions of connected devices in the next few years, require equal number of IPs. This is significant to advance the lives of people all over the world and especially those who acquired enough addresses and with early adoption. In addition, Internet penetration and Internet access would expand to societies and rural areas that never thought to be feasible or possible with IPv4.

On the other hand, economic opportunities would thrive with the implementation of more e-services, e-commerce, and financial services; thus, bridging economic divides, encourage national, regional, and international e-based trade. This would also raise financial inclusion and inspire innovation not only in the tech sector but in all technology driven sectors.

VIII.   CONCLUSION AND RECOMMENDATIONS

The research highlighted the importance of early IPv6 adoption and readiness for economic advancements and in participating in the future of the Internet. We illustrated the state of IPv6 adoption globally with emphasis on Western Asia Arab Countries based on number of criteria including deployment, allocated prefixes, and traffic to popular search engines.

We strongly believe that the challenges facing small nation or developing countries are similar in nature with little local influences. This is very beneficial in sparing going through the same problems. The opportunities presented in migrating to the new IP protocol especially for new economies are tremendous. They encourage public and private business keep up with future emerging technologies and to encourage innovation and higher participation through increased Internet access.

Our future research would survey the readiness of local ISPs and governments to migrate to IPv6 as more e-services and more people are connected to the Internet. We plan to include more countries in the study, and do further analyses to find significant factors in accelerating the deployment.

Declaration of Conflicting Interests

No competing interests are present.

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