COMMUNICATIONS AUTHORITY OF KENYA

IPv4 to IPv6 Migration Strategy

1 INTRODUCTION

Internet Protocol (IP) refers to a suite of rules and requirements for routing and addressing data on the Internet. The addresses using this protocol are called IP addresses. The initial length of the address was 32 bits, providing an address pool of 4 billion addresses.

IP addresses are critical for connection to the Internet because they represent the numbers that uniquely identify devices connected to the Internet therefore every device connected to the internet will have a unique IP address.

The proliferation of electronic devices with capabilities to connect to the Internet for data sending, and the innovative use of IP addresses on non electronic devices for tracking purposes, among other intentions, coupled with Internet of Things (IoT) and Machine to Machine (M2M) Communications advancements, have led to an exponential demand for IP addresses.

The initial set of IPv4 addresses were developed in the early 1980s and served the global Internet community for more than three decades and have now been exhausted despite innovative efforts like Network Address Translation (NAT), where a set of private IP addresses are mapped to a single Public IP address, thereby minimizing the need for public IP addresses.

With the imminent exhaustion of IPv4 address space, the length of IP addresses was increased from 32 bits to 128 bits, creating almost 340 undecillion addresses. The two address sets are not compatible, implying data sent using IPv4 address can not be delivered to a recipient using IPv6 addresses.

The IPv6 was developed and standardized, as the next-generation Internet Protocol in 1996, with initial assignments for use in 1999, had the main goal of massively increasing the number of IP addresses available. Over the past year, major content providers and access networks have started offering IPv6 services to ordinary Internet users.

Due to non compatibility between IPv6 and IPv4 protocols, communication between systems using the different address formats would require software changes and address translations at every non-IPv6 device the data traverses or hardware changes, dual stacks, for the communication to proceed from end to end.

2 MANAGEMENT OF THE IP ADDRESS SPACE

IP addresses are globally managed by the Internet Corporation for Assigned Names and Numbers (ICANN), which has the Internet Assigned Numbers Authority (IANA) functions. These addresses are distributed in a hierarchical system, where blocks of IP addresses are assigned to the five Regional Internet Registries (RIRs) around the world, who then allocate in sub-blocks to various country Internet registries for consequent assignments to users, mostly Internet Service Providers, in the particular country. The current assignment structure is depicted in figure 1.

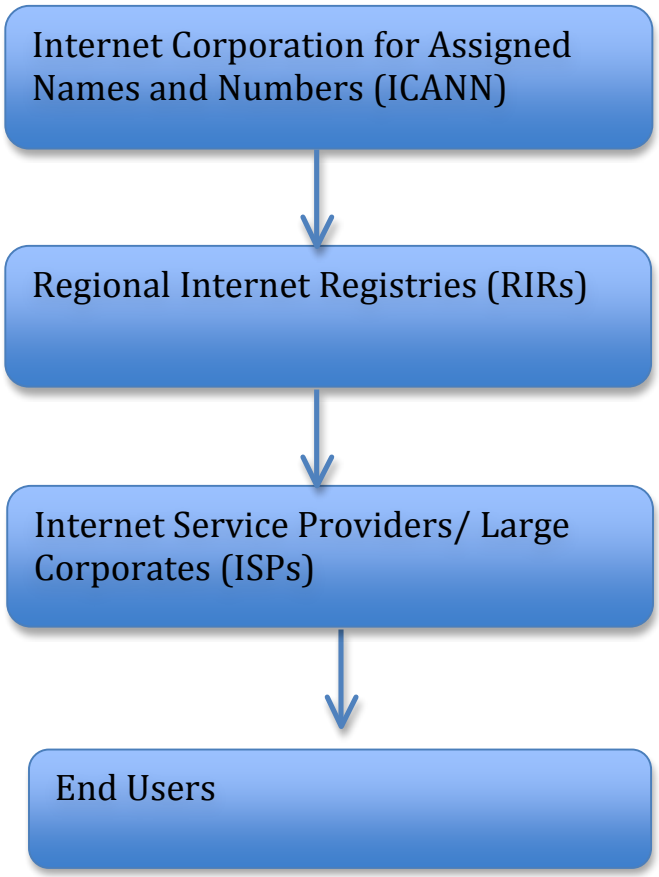

Figure 1: IP address Assignment Structure

The five regional registries are: African Network Coordination Centre (AFRINIC), for Africa Region, based in Mauritius; Asia-Pacific Network Coordination Centre (APNIC), for Asia Pacific region, based in Australia; American Registry for Internet Numbers (ARIN), based in USA; Latin American and Caribbean Internet Addresses Registry (LACNIC), based in Uruguay; Réseaux IP Européens Network Coordination Centre (RIPE NCC), based in Netherlands.

3 MANDATE OF THE AUTHORITY

The Authority draws its mandate from the Kenya Information and Communication Act, No 2 of 1998 and more particularly, the Kenya Information and Communications (Licensing and Quality of Service) Regulations, 2010; the Kenya Information and Communications (Numbering) Regulations, 2010; the Kenya Information And Communications (Consumer Protection) Regulations, 2010, The Kenya Information And Communications (Importation, Type Approval and Distribution of Communications Equipment) Regulations, 2010 among other regulations.

These proposed regulatory interventions have been developed by the Authority as part of measures to protect consumers in the ICT Sector from potential negative impact of delayed or non-migration to IPv6 networks by telecommunication service providers.

4 BASELINE ON IPv4 MIGRATION AND IPv6 DEPLOYMENTS

ICANN assigned the last block of IPv4 addresses to Regional registries in 2011. The various regional registries have thus been assigning the last IPv4 addresses to Internet Service providers since then.

As per figure 2 from AFRINIC, the exhaustion of IPv4 is projected in the year 2022.

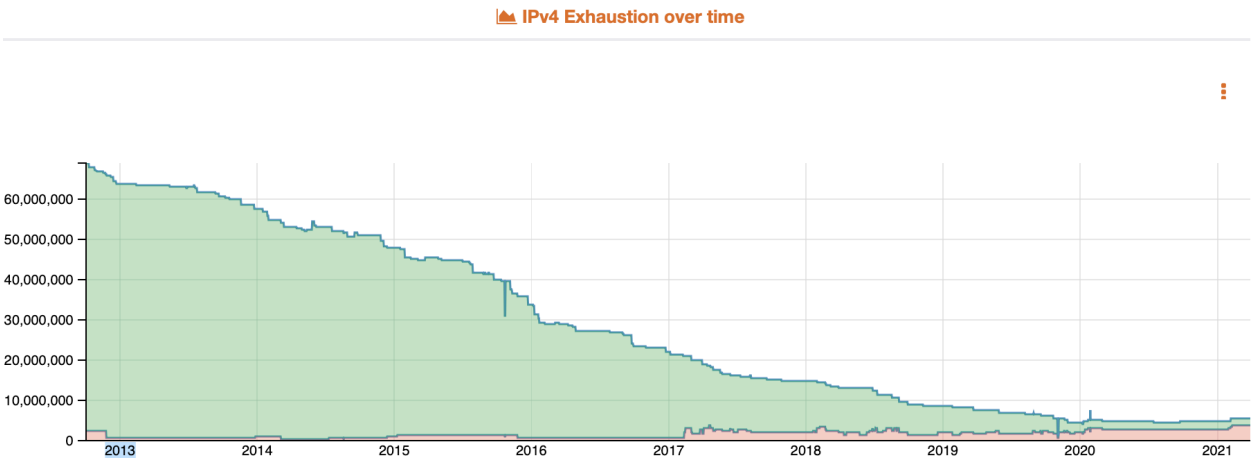

Figure 2: Projections on IPv4 Exhaustion

Source: AFRINIC

With regards to IPv6 uptake in Africa, figure 3 provides an uptake of IPv6 by various African Counties in blocks.

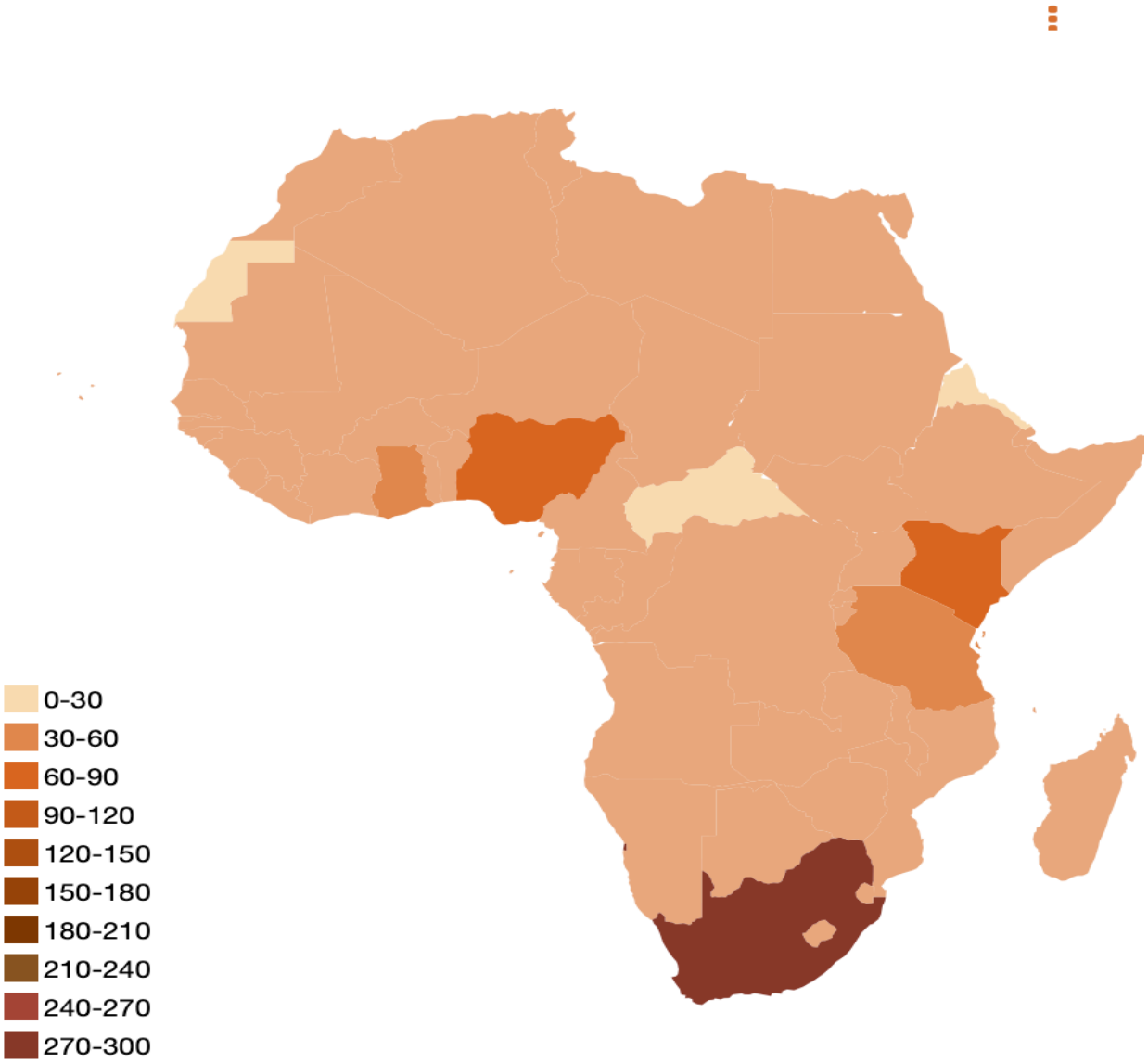

Figure 3: Issued blocks of IPv6 addresses per country

Source: AFRINIC , March 2021.

The global adoption of globally by Google, based on statistics collected from its users , is shown in figure 4.

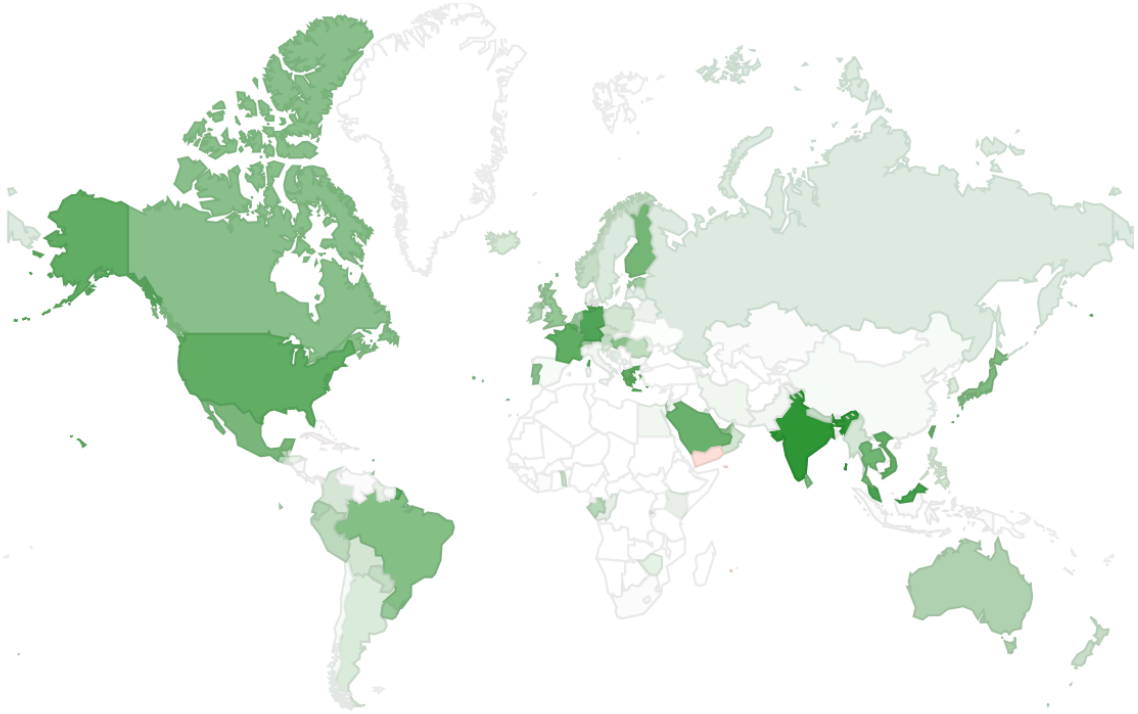

Figure 4: Global IPv6 Adoption
Source: Google, August 2021.

	Regions where IPv6 is more widely deployed (the darker the green, the greater the deployment) and users experience infrequent issues connecting to IPv6 enabled websites
	Regions where IPv6 is more widely deployed but users still experience significant reliability or latency issues connecting to IPv6 enabled websites
	Regions where IPv6 is not widely deployed and users experience significant reliability issues connecting to IPv6 enabled websites

From figure 3, Africa's adoption of IPv6 is still low and hence the need for interventions to spur the adoption of IPv6.

Based on google's statistics, the IPv6 adoption rates for Kenya is currently at under 8%, Uganda at 0.3 %, Tanzania (0.11%), Rwanda at 6.34 %, Burundi and South Sudan at 0%.

5 BENEFITS OF MIGRATING TO IPv6

a) Sufficient IP addresses, IPv6 will create sufficient IP address pool for use by persons, as well as machines, facilitating the Internet of Things networks.

b) Efficient Routing, due to reduced size of routing tables, elimination of the need for address translators in the network, and elimination of the need to perform error checking at various stages of data routes.

c) Transparency in Network due to the fact that each node in the network has a distinct address, which also makes troubleshooting easier

d) Enhanced Security, by the fact that IPv6 supports end to end IP Security protocol mode

e) Efficient use of network bandwidth, due to use of multicast as opposed to broadcast, when sending data to multiple destinations

6 IMPLICATIONS OF NOT MIGRATING

Should Kenya delay in full adoption of IPv6, then serious technological challenges may befall the country's ICT sector, namely:

a) Lack of Access the Internet

   For new devices that may require Internet access and have no IPv4 addresses due to exhaustion will not be able to access the Internet.

b) Lag in technological advancements

   With the advent of Internet of Things (IoT) devices, most manufacturers are developing IPv6 devices due to the fact that the IoT devices will be numerous and will each require access to internet and will therefore call for IPv6 usage. Kenya will therefore not be able to take advantage of the IoT devices.

c) Complex Networks

If adoption to IPv6 is not realized in Kenya, network providers will have to put up with complicated deployment of networks that require address translations, tunneling and dual stack to communicate with IPv6 networks. Should the developers of translation, tunneling and dual stack technology cease support or further enhancements of those technologies, the networks will have difficulties in communicating with IPv6 networks, blocking out users from the Internet.

d) Increased Cyber Security Incidences

With most countries having migrated, networks for countries that will not have migrated will have to use strategies like tunneling which introduce attack vectors on the networks. This is likely to deter uptake of e-commerce in the country.

7 THE APPROACH

To mitigate against the possible identified implications of non adoption or delayed adoption, the following approach is proposed

a) Regulatory Intervention:

i. The Authority plays a critical role in the evaluation of telecommunication equipment imported in the country through Type Approval. To spur the uptake of IPv6, only devices with IPv6 capability will be type approved for use in Kenya effective July 2023.

ii. Further assignments of resources, namely, numbering resource, frequency assignments and Top level Domain Name assignment documents will contain in them a regulatory requirement for adoption of IPv6 addresses.

iii. Inspection and Certification of Operator systems and networks will involve a check on the transition to IPv6 component and those found not to have adopted IPv6 would be deemed non-complaint.

iv. Network Readiness Assessment report will form part of compliance returns, to be assessed, where the operator will report on what network components are IPv6-ready, what network components need to be upgraded to support IPv6 and what network components need to be replaced to support IPv6. An assessment report of less than 50 % readiness will be deemed non complaint and license renewed only after attainment of a minimum 50%, for the first year of 2022, after which the percentages will rise annually in 10% steps up to 100%.

b) Communications and Stakeholder Management Plan

The Authority by virtue of its responsibility to protect consumers will continually educate consumers on the need to acquire IPv6 ready or compliant devices. The Authority will develop an awareness campaign plan targeting the operators, vendors and the consumers as appropriate. This will be done through online platforms, pamphlets, newspapers, radios and any outreach programs.

c) Trainings

To ensure rapid adoption by the various industry players, the Authority will continually organize hands-on physical trainings, where trainees from the service providers will be taken through hands-on trainings on IPv6 migration and related technologies by Authority sourced experts.

d) Report Submissions

To monitor adoption rates, the Authority will define reporting templates, on mechanisms on how service providers will be reporting on the steps taken to adopt IPv6 including equipment inventories and a plan towards full adoption of IPv6

8 ROADMAP FOR MIGRATION

To ensure full migration, the following milestones and measures of success have been identified, and timelines for their accomplishments provided.

a) Milestones

No	Milestone	Timelines
1.	Public Awareness	September to December 2022
2.	Trainings	January to December 2023
3.	Submission of Network IPv6 readiness reports from service providers	October 2022 to June 2023
4.	Type Approval requirement for IPv6 devices only	As from July 2023 onwards
5.	Inclusion of IPv6 Adoption requirement in telecommunication Resource Assignment	As from July 2023 onwards
6.	Inspections and Certification of New and Existing Service Providers for IPv6 Adoption	As from July 2023 onwards

b) Measures of Success

Increase the percentage of Telecommunication Licensees whose staff have undergone Authority facilitated IPv6 trainings from [0%] to [80%] of the licensees by December 2023

Increase the percentage of IPv6 fully compliant Telecommunications Licensees from [0%] to [50%] by [July 2023]

In addition to the above milestones and measures of success, telecommunication service providers are encouraged to adopt emerging IPv6 Enhanced Innovation ("IPv6+") which offers additional advantages to the networks such as IPv6 segmented routing (SRv6), network slicing, deterministic forwarding, and path associated detection.

9 POTENTIAL NEGATIVE IMPACTS

During the envisioned rapid migration and after full migration to IPv6, there is a high likelihood of increased e-waste in the country. To mitigate against this, the Authority, using a framework of cooperation it has with National Environmental Management Authority, the regulator on matters relating to the environment, will jointly agree on how to address the e-waste issue.