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BOTSWANA COMMUNICATIONS REGULATORY AUTHORITY

IPV6 DEPLOYMENT GUIDELINES

IPV6 DEPLOYMENT GUIDELINES	Review Version	**01**
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REGULATORY AUTHORITY
PLOT 50671 INDEPENDENCE AVENUE
PRIVATE BAG 00495 , GABORONE, BOTSWANA
TEL: +267 3957755 FAX: +267 3957976
info@bocra.org.bw I www.bocra.org.bw

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PLOT 50671 INDEPENDENCE AVENUE
PRIVATE BAG 00495 , GABORONE, BOTSWANA
TEL: +267 3957755 FAX: +267 3957976
info@bocra.org.bw I www.bocra.org.bw

DEFINITIONS

In these Guidelines, unless the context otherwise requires, the following expression or word will bear the meaning assigned to them below:

"ACT"
means the Communications Regulatory Act of 2012;

"Authority"
means Botswana Communications Regulatory Authority;

"Content Delivery Network"
means a content distribution network, or a geographically distributed network of proxy servers and their data centers;

"Customer Premise Equipment (CPE)"
means a small office or residential router that is used to connect home users and/or small offices in a myriad of configurations;

"End User"
means the person requesting the telecommunication service and presenting billing information to the operator for payment of telecommunication services;

"Enterprise Customer"
means any business, enterprise or public sector customer of the Company or any Company Subsidiary;

"Host"
means network participant that sends and receives packets but does not forward them on behalf of others. This includes mobile devices attaching to local network infrastructure;

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TEL: +267 3957755 FAX: +267 3957976
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“Internet Engineering Task Force”
means a Standard Development Organisation that produces high quality standards and other relevant technical documents that shape the design, use, management, and development of the Internet;

“Internet Protocol”
means a set of rules and requirements (standards) for identifying, routing, and addressing has been used as an enabling tool for data to traverse across the Internet;

“**IP Address”**
means a numerical label assigned to each networking device that uses the Internet Protocol for communication. This address is used to uniquely identify a device on a network;

“Internet Protocol version 4”
means a 32-bit internet protocol addressing scheme;

“Internet Protocol version 6”
means a 128-bit internet protocol next generation addressing scheme designed to succeed the Internet Protocol version 4;

“Internet Service Provider” or “Service Provider"
means an organization that provides services accessing, managing, and using the Internet;

“Mobile node’’
means a node that can change its point of attachment from one link to another, while still being reachable via its home address;

“Node”
means a device that implements Internet Protocol;

“Rights”
means rights enforceable under the Botswana Law;

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PRIVATE BAG 00495 , GABORONE, BOTSWANA
TEL: +267 3957755 FAX: +267 3957976
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"Router"
means a device that forwards Internet Protocol packets not explicitly addressed to itself;

"Other Operators"
means a physical or virtual licensee who provides mobile or fixed telecommunications, internet and data services to the public;

ABBREVIATION OF TERMS

AAA	Authentication, Authorization, and Accounting
AFRINIC	African Network Information Centre
AH	Authentication Header
AI	Artificial Intelligence
BOCRA	Botswana Communications Regulatory Authority
BGP	Border Gateway Protocol
CRASA	Communications Regulators Association of Southern Africa
CPE	Customer Premise Equipment
DHCP	Dynamic Host Configuration Protocol
DNS	Domain Name System
ESP	Encapsulating Security Payload
IANA	Internet Assigned Numbers Authority
ICANN	Internet Corporation for Assigned Names and Numbers
IETF	Internet Engineering Task Force
IKE	Internet Key Exchange

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IoT	Internet of Things
IP	Internet Protocol
IPv4	Internet Protocol Version 4
IPv6	Internet Protocol Version 6
ITU	International Telecommunication Union
IS-IS	Intersystem to Intersystem
M2M	Machine to Machine
NAT	Network Address Translation
NAT-PT	Network Address Translation - Protocol Translation
ND	Neighbor Discovery
OSPF	Open Shortest Path First
RFC	Request for Comments
RIR	Regional Internet Registry
SADC	Southern African Development Community
SIIT	Stateless IP/ICMP Translation
SNMP	Simple Network Management Protocol
SRS	Shared Registry System
TB	Tunnel Broker
TCP	Transmission Control Protocol
QoS	Quality of Service

Imagine the world without order
Imagine Botswana without BOCRA

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TEL: +267 3957755 FAX: +267 3957976
info@bocra.org.bw I www.bocra.org.bw

1. INTRODUCTION

1.1. Botswana Communications Regulatory Authority, (BOCRA, or the Authority) among other things is mandated by Section 38 of the Communications Regulatory Act of 2012 (hereinafter, the Act 2012) to establish and maintain a non-discriminatory and efficient numbering and Domain Names System regulatory frameworks to be applied by all service and licensed operators.

1.2. Section 6 further mandates the Authority to make industry regulations for the better carrying out of its responsibilities including developing or adopting international standards such as Internet Protocol Version 6 (IPv6) standard to be applied to its regulated sectors. This is undertaken to ensure fair access to such services and efficient allocation of numbering and domain names.

1.3. In pursuit of this mandate, the Authority has enacted the IPv6 Guidelines. These Guidelines shall provide the processes and steps to be followed by any organisation seeking to deploy IPv6 in their network. The said Guidelines shall describe the planning and implementation requirements for the deployment of IPv6 at organisational level.

1.4. The Authority shall continually review and implement guidelines to align with best practices, standards, technology trends and policies

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PLOT 50671 INDEPENDENCE AVENUE
PRIVATE BAG 00495 , GABORONE, BOTSWANA
TEL: +267 3957755 FAX: +267 3957976
info@bocra.org.bw I www.bocra.org.bw

from institutions like the Internet Corporation for Assigned Names and Numbers (ICANN), Internet Engineering Task Force (IETF), International Telecommunication Union (ITU), and regionally, the Southern African Development Community (SADC) among others.

2. OBJECTIVE

2.1. The objective of these Guidelines is to provide guidance to service providers and the industry at large for successful adoption and deployment of IPv6 in their respective networks.

3. BACKGROUND

3.1. The Internet makes use of critical resources called Internet Protocol (IP) addresses, which are addresses that uniquely identify devices connected on the Internet. Currently there are two types of IP addresses in use being the Internet Protocol Version 4 (IPv4) and Internet Protocol Version 6 (IPv6). IPv4 as the predecessor of IPv6 and was initially deployed in the early 1980's and it has been serving the internet community to date.

3.2. Since its inception, IPv4 has experienced and failed to address the following issues:

3.2.1. Exponential growth of the internet;

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3.2.2. Impeding exhaustion of the IPv4 address space;

3.2.3. Digital Transformation Agenda which accelerated the deployment of emerging digital technologies, applications including Internet of Things (IoT), Machine to Machine (M2M), Artificial Intelligence (AI), Big Data, Cloud Computing and Mobile network Evolution among others;

3.2.4. Maintenance of large routing tables by internet backbone router;

3.2.5. Complex and Manual configuration of IP addresses;

3.2.6. Security requirements at the IP layer as more and more devices connect;

3.2.7. Quality of Service as some applications require better real time data delivery;

3.2.8. The use of NAT can negatively impact network performance, particularly for real-time protocols like VoIP. This is due to the increased switching delays resulting from the translation of IPv4 addresses within packet headers; and

3.2.9. Lack of Multicast Support, while IPv4 supports broadcast, it does not efficiently support multicast, which is important for applications like streaming media.

3.3. The International governing body, Internet Corporation for Assigned Names and Numbers (ICANN) through Internet Assigned Numbers Authority (IANA) as the oversight body has since assigned IP addresses to Five (5) Regional Internet Registries (RIR's) who are

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PRIVATE BAG 00495 , GABORONE, BOTSWANA
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mandated to allocate sub-blocks to Internet Services Providers in a country within their respective regions.

3.4. In Africa, the RIR is the African Network Information Centre (AFRINIC) which oversees the Internet Numbering Management and Assignment for the region. IANA as the oversight body has since allocated the last block of IPv4 addresses to all the Regional Internet Registries in 2011.

3.5. Botswana is lagging in the adoption of IPv6 as shown by recent surveys carried out by the Authority. This necessitated the development of IPv6 Guidelines to enable the country to reap the benefits of IPv6.

3.6. IP addresses are key in connecting online devices, the limitations listed above led to the development of the IPv6 standard which provides 128-bit addresses, therefore providing 3.4×10^{38} total addresses.

4. IPV6 INTERNET ENGINEERING TASK FORCE STANDARDS

4.1. The Internet Engineering Task Force (IETF) as a Standard Development Organisation makes the Internet work better by producing high quality, relevant technical documents that shape the design, use, management, and development of the Internet has

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PLOT 50671 INDEPENDENCE AVENUE
PRIVATE BAG 00495 , GABORONE, BOTSWANA
TEL: +267 3957755 FAX: +267 3957976
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published documents termed Requests for Comments (RFC) to facilitate this mission.

4.2. These are several standards related to IPv6 that have been published to better guide deployment and adoption to the said protocol, some are outlined in **Annexure 1** for reference.

5. IPV6 ADDRESSING

5.1. IPv6 as a successor of IPv4 uses 128bit addressing, introduces a simplified fixed length header that enhances processing of packets and ensures efficient use of bandwidth. This IPv6 header is 40 bytes long and has fields as shown in **Figure 1**, which is an enhancement from the IPv4 header. This is the case as the IPv6 header has fewer fields which enhances processing efficiency.

<table>
<tr><td>Version (4)</td><td>Traffic Class (8)</td><td colspan="2">Flow Label (20)</td></tr>
<tr><td colspan="2">Payload Length (16)</td><td>Next Header (8)</td><td>Hop Limit (8)</td></tr>
<tr><td colspan="4">Source Address (128 bits)</td></tr>
<tr><td colspan="4">Destination Address (128 bits)</td></tr>
</table>

Figure 1: IPv6 Header

6. IPV6 BENEFITS

6.1. Below are the technical benefits of IPv6:

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6.1.1. Increased Address Space

6.1.1.1. IPv6 improves the addressing capacities by using 128 bits for addressing. The 128-bit addressing caters for future use of the internet without the use of address conservation techniques like Network Address Translation (NAT).

6.1.2. Security

6.1.2.1. The IP Security (IPsec) standard /protocol consists of a set of cryptographic protocols that provide for securing data communication and key exchange across all nodes. IPsec uses the Authentication Header (AH) and Encapsulating Security Payload (ESP) header to facilitate this, wherein the:

a. AH provides for authentication and data integrity; and
b. ESP provides for authentication, data integrity and confidentiality.

6.1.2.2. In addition to these two headers, IPsec provides for a third suite of protocol management and key exchange management being the Internet Key Exchange (IKE). This protocol suite provides the initial functionality that is needed to establish and negotiate security parameters

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PLOT 50671 INDEPENDENCE AVENUE
PRIVATE BAG 00495 , GABORONE, BOTSWANA
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between endpoints as well as keep track to guarantee and ensure secure end to end communication.

6.1.3. Neighbour Discovery and address auto-configuration

6.1.3.1. Neighbour Discovery (ND) is a network layer-based protocol responsible for router and prefix discovery, duplicate address, network un-reachability detection, parameter discovery and link-layer address resolution. ND operates in tandem with auto configuration which is used by IPv6 nodes to acquire either stateful or stateless configuration information.

6.1.3.2. Both ND and address auto-configuration contribute to make IPv6 more secure than its predecessor. IPv6 provides for Time To Live (TTL) values of up to 255; it prevents against outside sourcing of ND packets or duplicate addresses.

6.1.4. Mobility

6.1.4.1. Mobile IPv6 is an enhanced protocol that supports roaming for mobile nodes to enable them to move from one network to another without losing IP connectivity.

6.1.4.2. Mobile IPv6 as in RFC 4861 has vast address space and uses Neighbour Discovery (ND) to counteract the handover issue at the network layer and maintain

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PLOT 50671 INDEPENDENCE AVENUE
PRIVATE BAG 00495 , GABORONE, BOTSWANA
TEL: +267 3957755 FAX: +267 3957976
info@bocra.org.bw I www.bocra.org.bw

connections to applications, services if a device changes its temporary IP address.

6.1.4.3. Mobile IPv6 also introduces new security aspects such as route optimisation as in RFC 4449 which ensures secure data flow between the devices.

6.1.5. Route Aggregation

6.1.5.1. IPv6 simplified header and incorporation of hierarchical addressing structure has introduced an improvement on routing of information from source to destination.

6.1.5.2. The large IPv6 addressing space allows organisations with many connections to obtain blocks of contiguous address space. The contiguous address space allows organisations to then aggregate addresses under one prefix for ease identification on the Internet.

6.1.5.3. The structured addressing reduces the amount of information Internet routers must maintain and store which in turn promotes faster routing of data.

6.1.6. Quality Of Service

6.1.6.1. Noting that packets in the IP are usually treated the same way as they are forwarded with best effort with no guarantee for delivery as they traverse through the network. The Transmission Control Protocol (TCP) adds

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PLOT 50671 INDEPENDENCE AVENUE
PRIVATE BAG 00495 , GABORONE, BOTSWANA
TEL: +267 3957755 FAX: +267 3957976
info@bocra.org.bw I www.bocra.org.bw

in delivery confirmations, but it does not have options to control the delay and bandwidth allocation parameters. To help prioritize the delivery of information in networks, Quality of Service (QoS) introduces enhanced policy-based networking options.

6.1.6.2. IPv4 and IPv6 implementations use similar QoS capabilities such as differentiated services and integrated services to identify and prioritise IP-based communication during congestion in the network.

6.1.6.3. IPv6 however in addition to these capabilities within its header has two fields that can be used for QoS which are the Traffic class and Flow Label fields. The new Flow Label field and enlarged Traffic class fields enhance efficiency and better differentiation of various types of traffic.

6.1.7. Built-In Support For Multicast

6.1.7.1. IPv6 has native support for multicast, making it more efficient for applications that need to send data to multiple recipients simultaneously.

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7. IPV6 IMPLEMENTATION AND REQUIREMENTS

7.1. The following are implementation requirements for IPv6 deployment once an IPv6 block has been allocated by the Regional Internet Registry (RIR). These basic requirements are continuously reviewed to accommodate the development and challenges that shall arise in IPv6 deployment as referenced in **Table 2** below:

Table 1: IPv6 Basic Requirements

Title	**RFC Number**
Internet Protocol Version 6 (IPv6) Specification	RFC 8200
Neighbour Discovery for IP version 6 (IPv6)	RFC 4861
IPv6 Stateless Address Auto Configuration	RFC 4862
Internet Control Message Protocol (ICMPv6) for the Internet Protocol Version 6(IPv6) Specification	RFC 4443
Path MTU Discovery for IP version 6	RFC 8201
Use of BGP-4 Multi-protocol Extensions for IPv6 Inter-Domain Routing	RFC 2545
IP Version 6 Addressing Architecture	RFC 4291
IPv6 Global Unicast Address Format	RFC 3587
DNS Extensions to support IP version 6	RFC 1886

NB: The above requirements can be extended to other optional requirements depending on capabilities and nature of networks, respectively as recommended in the RFCs in **Annexure 1**.

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8. IPV6 TRANSITION TECHNIQUES

8.1. Three (3) main techniques have been identified and defined by the IETF that service providers shall use during IPv6 adoption. These techniques are aimed at allowing the existing IPv4 networks to coexist and interoperate with IPv6 networks, systems, and services. These techniques are:

8.1.1. Dual Stack

8.1.1.1. This is an essential technique for introducing IPv6 in existing IPv4 architectures, it allows hosts, routers, applications to implement and support both IPv4 and IPv6 protocol stacks, The said mechanism enables networks to support both IPv4 and IPv6 services and applications during the transition period in which IPv6 services are implemented and applications made available. Reference on this technique can be made to **Figure 2** below.

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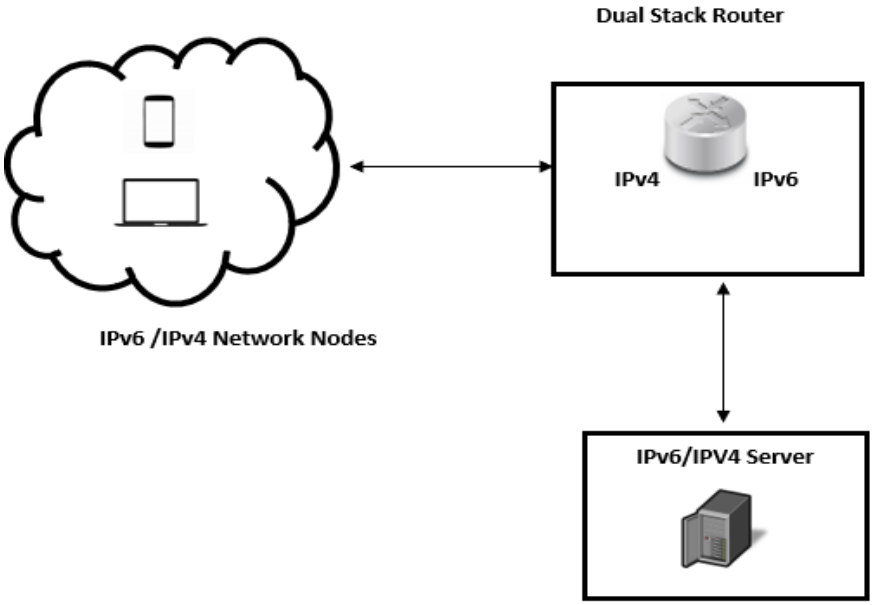

Figure 2: Dual Stack

8.1.2. Tunnelling

8.1.2.1. This is a technique that allows IPv6 packets to be sent over existing IPv4 networks by encapsulating them in IPv4 packets, the opposite applies for IPv4 packets sent over IPv6 networks. A border router facilitates the encapsulation of IPv6 packets before transportation across an IPv4 network and decapsulation at the border of the receiving IPv6 network and vice versa. Reference on this technique is made to **Figure 3**.

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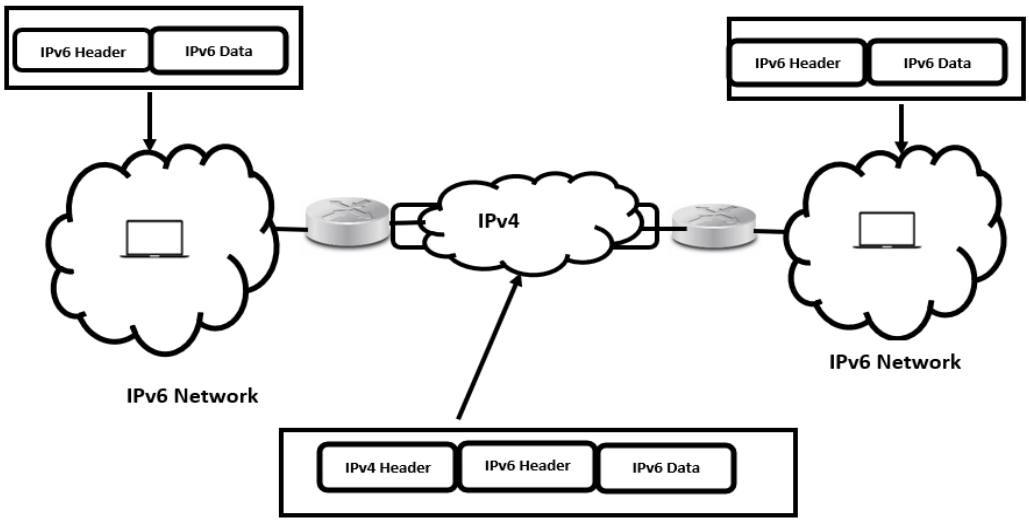

Figure 3 Tunnelling: IPv6 Encapsulation

8.1.3. Translation

8.1.3.1. This a technique that allows the translation of an IP version to another by changing the header of the IP packets, it facilitates communication between IPv6 and IPv4 hosts and vice versa.

8.1.3.2. Like the tunnelling techniques, translation can be implemented in border routers and hosts. An example of Static Network Address Translation-Protocol Translation (NAT-PT) is shown in **Figure 4** below:

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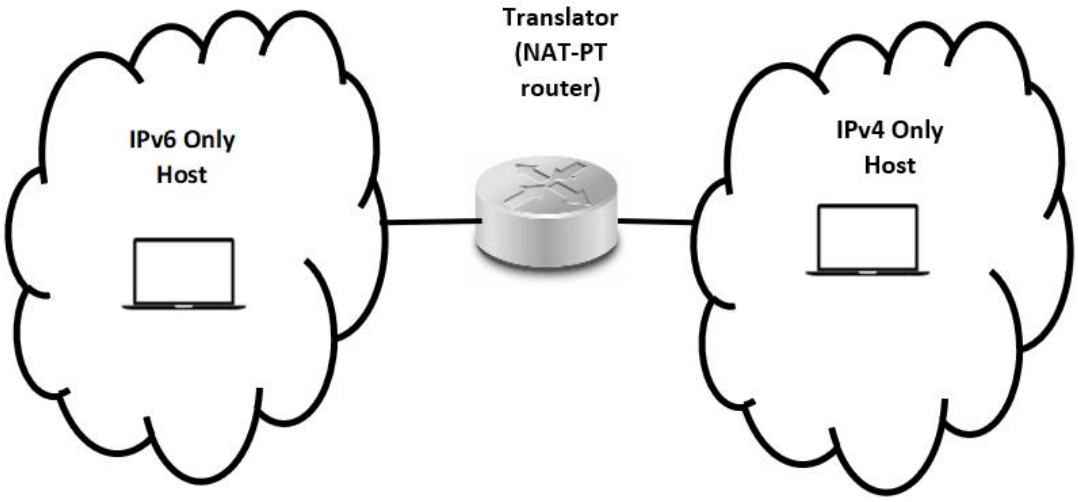

Figure 4 The Translation of IPv4 to IPv6

8.1.3.3. The IPv6 addresses will be matched to IPv4 addresses which will in turn allow IPv4 hosts to send traffic to IPv6 hosts the opposite applies.

8.2. Reference to the techniques discussed above is made to the RFC's listed in **Annexure 1.**

9. MIGRATION PLAN

9.1. In its Vision 2036, Botswana aspires to be a high-income country, with a knowledge-based economy underpinned by diversified, inclusive and sustainable growth driven by high levels of productivity. This has been supported by Botswana Digital Transformation Strategy which

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PLOT 50671 INDEPENDENCE AVENUE
PRIVATE BAG 00495 , GABORONE, BOTSWANA
TEL: +267 3957755 FAX: +267 3957976
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amongst others aims to deliver a smart, sustainable society for Botswana by digitalising across all sectors.

9.2. Migration to IPv6 will propel the country to realise the full benefits of digitalisation. It is imperative that the migration process commences immediately.

9.3. **Annexure 2** gives the migration plan that would ensure Botswana has fully transitioned by 2030. The plan has considered the current realities, including state of infrastructure in Botswana, the Technical Expertise available for IPv6 and the cost of transitioning. It gives the target milestones and timelines that different stakeholders shall adhere to when deploying IPv6 on their respective networks and services.

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10. RESPONSIBILITIES AND OBLIGATIONS

10.1. There are various IPv6 Adoption Stakeholders as shown in **Figure 5** below.

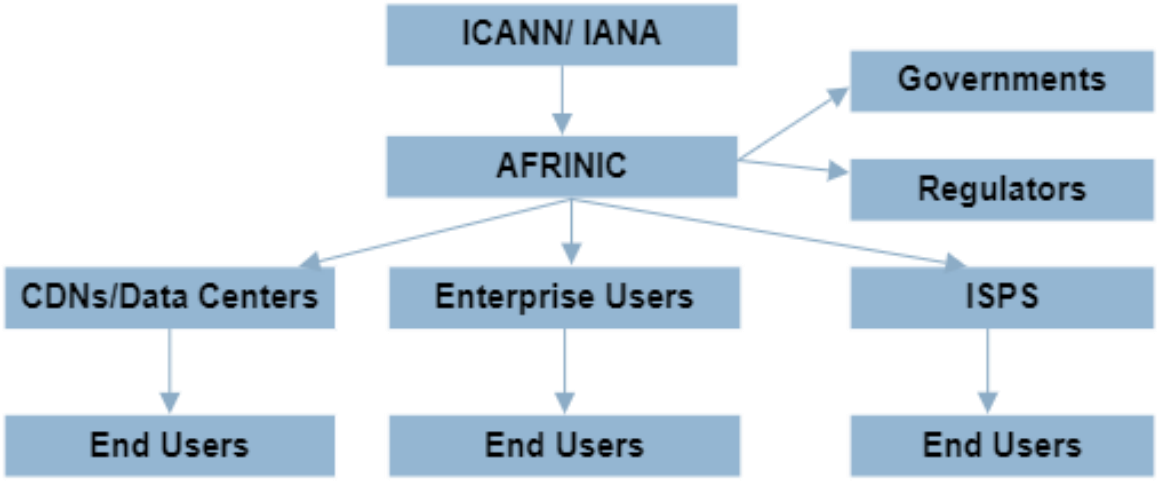

Figure 5: IPv6 Adoption Stakeholders

10.2. The Government Responsibilities

10.2.1. The Government shall:

10.2.1.1. Establish an IPv6 task force that develops the National IPv6 adoption plan and entails stakeholders to work together in leading its adoption;

10.2.1.2. Identify the future needs of IP resources and lead the transition process;

10.2.1.3. Make directives and regulations that shall mandate all relevant stakeholders to deploy IPv6 on their respective networks;

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10.2.1.4. Mandate IPv6 Support in procurement policies and contracts, ensuring that Government-funded projects and services are IPv6 compliant;

10.2.1.5. Champion the IPv6 adoption by implementing it in Government networks;

10.2.1.6. Promote capacity building and public awareness; and

10.2.1.7. Provide incentives and support to hasten the adoption of IPv6.

10.3. The Authority's Responsibilities

10.3.1. The Authority shall:

10.3.1.1. Oversee and facilitate IPv6 adoption process in Botswana by developing regulatory frameworks to be applied by all Internet Service Providers;

10.3.1.2. Organise awareness and education campaigns to inform the nation about IPv4 exhaustion implication and the need to adopt IPv6;

10.3.1.3. Mandate all relevant stakeholders to carry out IPv6 readiness assessment on their respective networks;

10.3.1.4. Have national and global collaborations with organisations like Network Operators Group (NOG's), IETF, ITU and AFRINIC to promote IPv6 adoption;

10.3.1.5. Champion IPv6 adoption by implementing IPv6 on their projects;

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10.3.1.6. Mandate IPv6 Support in procurement policies and contracts. Also, ensuring that the Authority-funded projects and services are IPv6 compliant; (ensure Type approved equipment are IPv6 capable);

10.3.1.7. Enforce IPv6 migration plan with transition deadlines, in consultation with IPv6 taskforce, that can be enforced through regulatory measures for both Government and private sectors; and

10.3.1.8. Encourage and coordinate stakeholder participation in available IPv6 trainings.

10.3.1.9. Monitor and regulate the migration plan for licensees.

10.3.1.10. Include IPv6 obligations on new ISP licences and spectrum allocations.

10.4. Internet Service Providers or Other Operators Responsibilities

10.4.1. Internet Service Providers or Other Operators shall:

10.4.1.1. Carry out IPv6 readiness assessment, to ensure that their networks are IPv6 ready and report to the IPv6 taskforce;

10.4.1.2. Prepare an IPv6 adoption and implementation plan as per the IPv6 Taskforce roadmap for submission to the Authority;

10.4.1.3. Declare and submit their status of IPv6 deployment and implementation as they roll-out their plan;

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10.4.1.4. Organise awareness and Education campaigns to inform their customers about IPv4 exhaustion implication and the need to adopt IPv6 to their customer premises;

10.4.1.5. Adhere to IPv6 transition deadlines set by the Authority;

10.4.1.6. Participate in available IPv6 trainings;

10.4.1.7. Procure network devices that support IPv6 in addition to IPv4;

10.4.1.8. Adopt IPv6 to their Core and Access networks; and

10.4.1.9. Adopt IPv6 to their Enterprise and Residential customers.

10.5. Internet Content Delivery Networks' Responsibilities

10.5.1. Internet Content Delivery Networks shall ensure that their content is reachable to future Internet customers by serving content via IPv6 in addition to existing IPv4.

10.6. Enterprise Customers Responsibilities:

10.6.1. Enterprise Customers shall:

10.6.1.1. Ensure that their services be it email, web, and application servers are reachable via IPv6 in addition to the legacy IPv4;

10.6.1.2. Open a dialogue with their ISP about providing IPv6 services; and

10.6.1.3. Decide on and adhere to timelines for IPv6 adoption to their services.

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10.7. End users Responsibilities

10.7.1. End users shall have the responsibility of ensuring that the devices that they use, and purchase are IPv6 capable.

11. PLANNING PHASE

11.1. The following should be considered by service providers when planning for IPv6 deployment:

11.1.1. Business Planning

11.1.1.1. To facilitate the deployment of IPv6, service providers will have to formulate a business case for submission to the Authority which shall detail and explore the:

i. Business drivers;
ii. Benefits;
iii. Costs; and
iv. Risk anticipated.

11.1.1.2. In addition to this, they should have in place an IPv6 transition working group that shall facilitate the project. The team shall plan, coordinate, track and communicate progress of the adoption project to ensure a smooth and successful transition in their organization.

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PLOT 50671 INDEPENDENCE AVENUE
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info@bocra.org.bw I www.bocra.org.bw

11.1.2. Technical Planning

11.1.2.1. To facilitate the deployment of IPv6 service providers should carry out an inventory of all their IP based equipment's and applications to identify which of their assets will need to be upgraded or replaced to support IPv6.These equipment's may include but not limited to:

i. Network hardware devices such as routers, switches, firewalls, intrusion detection systems among other;

ii. Network services such as Domain Name Systems (DNS), Dynamic Host Configuration Protocol (DHCP), Authentication, Authorization, and Accounting (AAA) among other;

iii. Network management systems such as Simple Network Management Protocol (SNMP), NetFlow among other; and

iv. Applications entailing Operating Systems, Databases, Operational and Business Support Systems, other applications being developed or procured.

11.1.2.2. Prepare an IPv6 address plan that shall identify the organisations IP addressing requirements which covers allocation, management and acquisition for current needs and forecast on the years to come;

11.1.2.3. Identify the changes required to support IPv6 routing in their existing IPv4 routing. They shall consider routing

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protocols in use such as static, Open Shortest Path First (OSPF), Intersystem to Intersystem (IS-IS), Boarder Gateway Protocol (BGP) and determine adaptations that need to be made to deploy IPv6; and

11.1.2.4. Identify and train their management and Engineers on IPv6 courses to drive and facilitate the deployment.

12. INCENTIVES

12.1. Service Providers or any person or legal entity that does not comply with these Guidelines shall not be eligible to incentives that would be given to those who have deployed IPv6 in their respective networks and services within the set timelines. Those who are compliant with these guidelines would qualify for the following incentives:

12.1.1. The Authority's subsidies through the UASF Fund provided the bidder is awarded the tender. **NB:** Terms and Conditions shall apply; and

12.1.2. AFRINIC IPv6 trainings using the Authority's vote.

13. COMPLIANCE AND INSPECTION

13.1. The Authority or any person authorised by the Authority shall:

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13.1.1. Conduct audits and monitoring on all concerned stakeholders to ensure compliance to the deployment plan as shown in **Annexure 2**.

14. REPORTING AND RECORD KEEPING

14.1. Service Providers shall:

14.1.1. Keep record of their IPv6 network architecture, roll out reports for monitoring, compliance, and auditing purposes;

14.1.2. Submit progress reports to the Authority at agreed times detailed in the adoption plan.

15. PRIVACY AND CONFIDENTIALITY

15.1. Any information or documentation provided by service providers to the Authority shall be treated with the utmost confidentiality and privacy.

16. MODIFICATIONS TO THE GUIDELINES

16.1. These guidelines shall be continually reviewed to align with technological evolution and/or the Laws of Botswana. Each review will be conducted in consultation with stakeholders and published on the Authority website: https://www.bocra.org.bw/.

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ANNEXURE 1

The following are the standards that shall be adopted to facilitate the deployment of IPv6, the list is not exhaustive more reference can be made to the IETF website: https://www.ietf.org. The latest issue or published version of these standards should be used for deployment.

Table 2: Standards that can facilitate the deployment of IPv6.

Title	Standards/ Request For Comments (RFC's) Number
Internet Protocol, Version 6 (IPv6) Specification	RFC 2460
Neighbour Discovery for IP Version 6 (IPv6)	RFC 2461
IPv6 Stateless Address Auto configuration	RFC 2462
Internet Control Message Protocol (ICMPv6) for the Internet Protocol Version 6 (IPv6) Specification	RFC 2463
OSPF For IPv6	RFC 2740
RIPng for IPv6	RFC 2080
Transmission of IPv6 Packets over Ethernet Networks	RFC 2464
Generic Packet Tunneling in IPv6 Specification	RFC 2473
Definition of the Differentiated Services Field (DS Field) in the IPv4 and IPv6 Headers	RFC 2474
IPv6 over Non-Broadcast Multiple Access (NBMA) networks	RFC 2491
IPv6 over ATM Networks	RFC 2492
Transmission of IPv6 Packets over ARCnet Networks	RFC 2497

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PLOT 50671 INDEPENDENCE AVENUE
PRIVATE BAG 00495 , GABORONE, BOTSWANA
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info@bocra.org.bw I www.bocra.org.bw

Reserved IPv6 Subnet Anycast Addresses	RFC 2526
Transmission of IPv6 over IPv4 Domains without Explicit Tunnels	RFC 2529
Use of BGP-4 Multiprotocol Extensions for IPv6 Inter-Domain Routing	RFC 2545
Path MTU Discovery for IP version 6	RFC 1981
OSPF For IPv6	RFC 2740
Use of BGP-4 Multi-protocol Extensions for IPv6 Inter-Domain Routing	RFC 2545
Dynamic Host Configuration Protocol for IPv6 (DHCPv6)	RFC 8415
Requirements for IPv6 Prefix Delegation	RFC 3769
IPv6 Global Unicast Address Format	RFC 3587
RIPng for IPv6	RFC 2080
IPv6 Multicast Address Assignments	RFC 2375
Security Architecture for the Internet Protocol	RFC 2401
IP Authentication Header	RFC 2402
IPv6 Addressing of IPv4/IPv6 Translators	RFC 6052
IP Version 6 Addressing Architecture	RFC 4291
Significance of IPv6 Interface Identifiers	RFC 7136
IP Encapsulating Security Payload (ESP)	RFC 4303
The Internet Security Domain of Interpretation for ISAKMP	RFC 2407
IP Version 6 over PPP	RFC 5072

RADIUS and IPv6	RFC 3162
IPv6 Multicast Address Assignment	RFC 2375
Security Architecture for Internet Protocol	RFC 4301
Definition of the differentiated Services Field (DS Field) in the IPv4 and IPv6 Headers	RFC 2474
An Architecture for Differentiated Services Framework	RFC 2475
Mobility Support in IPv6	RFC 6275
Multi-Protocol Extensions for BGP-4	RFC 2858
Network Address Translation - Protocol Translation (NAT-PT)	RFC 4966
Basic Transition Mechanisms for IPv6 Hosts and Routers	RFC 4213
Connection of IPv6 Domains via IPv4 Clouds	RFC 3056
Security Architecture for the Internet Protocol	RFC 4301
Mobility Support in IPv6	RFC 3775

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Neighbour Discovery for IP version 6 (IPv6)	RFC 4861
Securing Mobile IPv6 Route Optimization	RFC 4449

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ANNEXURE 2

Table 3: IPv6 General Deployment Plan

	Target % of IPv6 Network/Services						
Stakeholders	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**
Government of Botswana	10%	25%	50%	70%	90%	100%	100%
Botswana Fibre Networks	10%	25%	50%	70%	90%	100%	100%
Botswana Telecommunications Corporation Limited	10%	25%	50%	70%	90%	100%	100%
Mascom	10%	25%	50%	70%	90%	100%	100%
Orange	10%	25%	50%	70%	90%	100%	100%
Operators	10%	25%	50%	70%	90%	100%	100%
Internet Service Providers	5%	20%	35%	60%	85%	100%	100%
Content Delivery Networks/ Data Centers	5%	20%	40%	65%	85%	100%	100%
Enterprise Customers	3%	15%	35%	50%	75%	80%	100%
End Users	2%	8%	20%	40%	60%	70%	100%

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