NITDA IPv6 FORUM

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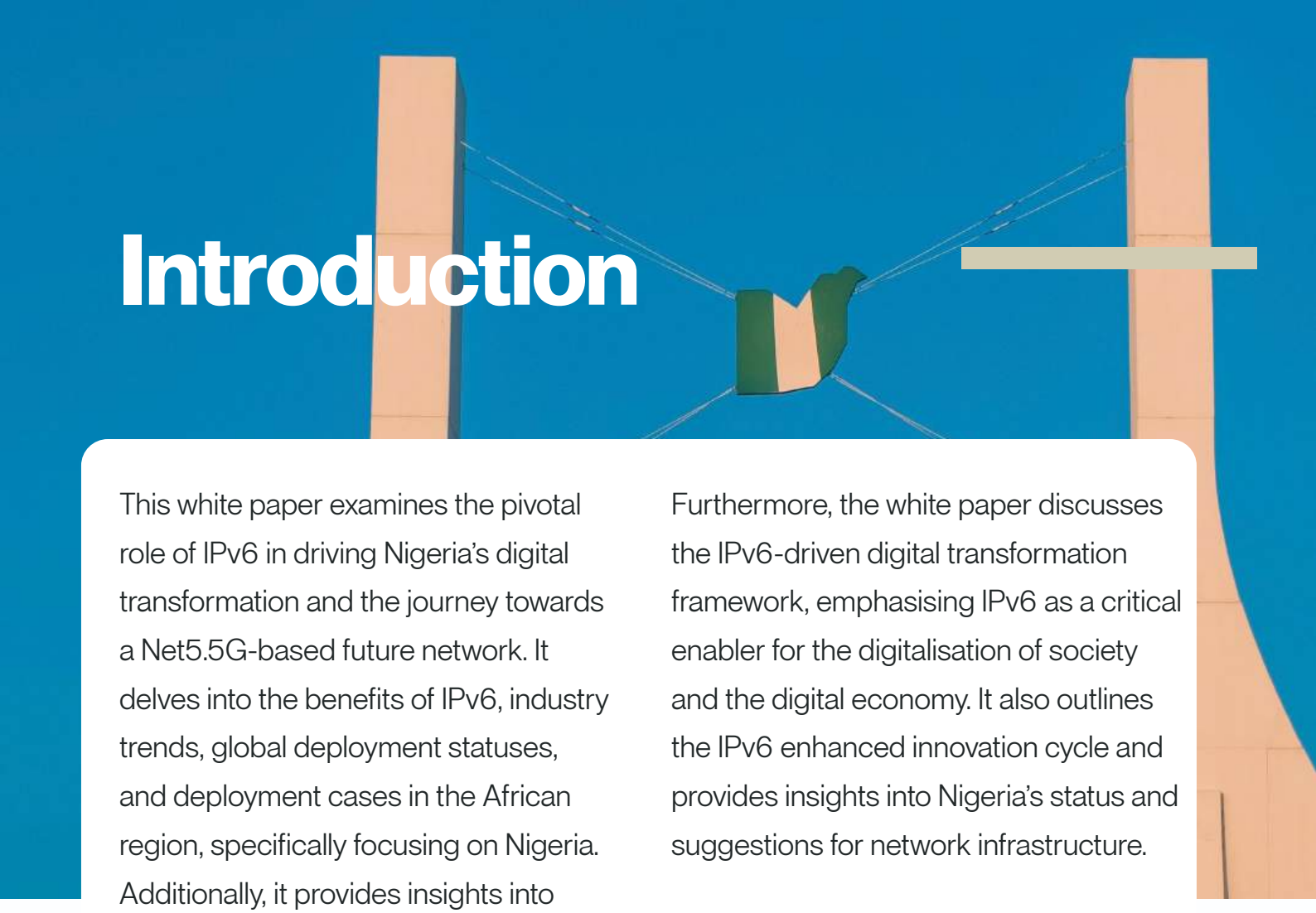
WHITE PAPER

Nigeria's IPv6-driven Digital Public Infrastructure

The Road Towards Net5.5G-based Future Network

August 20th, 2024

Table of Contents



Introduction

This white paper examines the pivotal role of IPv6 in driving Nigeria's digital transformation and the journey towards a Net5.5G-based future network. It delves into the benefits of IPv6, industry trends, global deployment statuses, and deployment cases in the African region, specifically focusing on Nigeria. Additionally, it provides insights into Nigeria's current network infrastructure status and offers recommendations for IPv6 adoption.

The document highlights the significance of IPv6 over IPv4, emphasising its crucial role in supporting the Internet of Things (IoT) growth and addressing the limitations of IPv4's address capacity. It further examines the global trend of IPv6 deployment, citing examples from the United States, the European Union, China, and Kenya. The paper also presents specific deployment cases in Nigeria, showcasing the innovative use of technologies such as 400GE, SRv6, and E2E Slicing by carriers in the region.

Furthermore, the white paper discusses the IPv6-driven digital transformation framework, emphasising IPv6 as a critical enabler for the digitalisation of society and the digital economy. It also outlines the IPv6 enhanced innovation cycle and provides insights into Nigeria's status and suggestions for network infrastructure.

In conclusion, the white paper underscores the critical role of IPv6 in Nigeria's digital evolution and advocates for adopting industry frameworks to ensure a smooth transition to IPv6. It is a comprehensive guide for stakeholders and industry players involved in Nigeria's digital public infrastructure and Net5.5G-based future network endeavours.

For further inquiries or to delve deeper into the topics covered in this white paper, please get in touch with us at **info@nitda.gov.ng.**

Abbreviations and Accronyms

ARCEP	French Regulator (Autorité de régulation des communications électroniques, des postes et de la distribution de la presse)
AfICTA	Africa ICT Association
AFRINIC	Africa Network Information Centre
APNIC	Asia Pacific Network Information Centre
AS	Autonomous System
ATCON	Association of Telecommunications Companies of Nigeria
B2G	Business to Government
B2B	Business to Business
B2C	Business to Customer
BIERv6	Bit Indexed Explicit Replication version 6
CA	Communication Authority (Kenya Regulator)
CITC	Communications and Information Technology Commission
DA	Destination Address
DCN	Data Centre Network
E2E	End-to-End
EANTC	European Advanced Networking Test Centre
GE	Giga Ethernet
GDP	Gross Domestic Product
Hard Slicing	Dedicated approach to services providing guaranteed isolation and predictable performance between slices; ideal for low-latency and mission-critical services

HTTP	Hypertext Transfer Protocol
IAB	Interactive Advertising Bureau
IAB	Information and Communication Technologies
ICT	International Data Corporation
IDC	Internet Engineering Task Force, the standardization body for
IETF	Internet-related protocols (TCP, IP, HTTP)
IFC	International Finance Corporation
IFiT	In-Situ Flow Information Telemetry
IPE	IPv6 Enhanced Innovation (ETSI Industry Specification Group)
IPv6	Internet Protocol version 6
IPv6 En-	IPv6 protocol with support for innovative capabilities (e.g., IFIT,
hanced	SRv6, BIERv6)
IPv6NC	IPv6 Nigeria Council
IoT	Internet of Things
ISP	Internet Service Provider
KPI	Key Performance Indicator
KSA	Kingdom of Saudi Arabia
KVI	Key Value Indicator
LDP	Label Distribution Protocol
MPLS	Multi-Protocol Label Switching
O&M	Operation and Maintenance
OT	Operational Technology
MAN	Metropolitan Area Network
Net5.5G	Network Evolution for 5.5G/6G Era, as specified by WBBA
RFC	Request for Comment
ROI	Return on Investment
RSVP	Resource Reservation Protocol
SA	Source Address

SDG	Sustainable Development Goal
SDO	Standard Development Organisation
SID/CSID	Segment ID / Compressed Segment ID
SLA	Service Level Agreement
Soft Slicing	Flexible approach for dynamic, on-demand shared services, such as VPNs
SRH	Segment Routing Header
SRv6	Segment Routing version 6
TCP	Transmission Control Protocol
TDRA	Telecommunication and Digital Government Regulatory Authority
TESPOK	Technology Service Provider of Kenya
UAE	United Arab Emirates
UN	United Nations
URLLC	Ultra-Reliable Low Latency Communications
USD	US Dollar
VPN	Virtual Private Network
VxLAN	Virtual Extensible Local Area Network
Wi-Fi	Wireless Fidelity
WAN	Wide Area Network
VR	Virtual Reality
WBBA	World Broadband Association
XR	Extended Reality

1.0

IPv4 and IPv6 Enhanced

1.1.0 IP, IPv4 and IPv6

The Internet Protocol (IP) and IP addresses are essential for network communication. IP serves as the foundation that enables computers to communicate within a network. Without IP, devices cannot connect to a network or transmit data. The current version, IPv4, introduced in 1981, uses a 32-bit address system with 4.3 billion addresses, which is insufficient given the increasing number of devices. In 1998, the Internet Engineering Task Force (IETF) officially released IPv6 with 128-bit addresses, offering about 8 x 10^28 times the capacity of IPv4.

This expansion resolves the issue of limited IP addresses and supports the Internet of Things (IoT) growth. Today, countries have launched initiatives to transition from IPv4 to IPv6. For example, the United States plans to upgrade 80% of its network to IPv6 by 2025, the EU has established an IPv6 promotion group, and China plans to build advanced digital infrastructure based on IPv6 technology by 2025.

IPv6 is crucial for the continued growth and evolution of the digital landscape, providing the necessary infrastructure for future technological advancements.

1.1.1 The IPv6 Benefits and its Role in Nigeria's Digital Transformation

In 2022, Nigeria had 84 million internet users with a broadband penetration rate of 38%. By early 2024, the broadband penetration rate had increased to 43.53%, representing 164 million internet users.

This growth reflects rising demand for digital services, streaming, and mobile broadband, leading to IPv4 address depletion. Nigeria urgently needs a scalable solution, and IPv6 can provide this with its virtually limitless 128-bit address space, accommodating all types of devices.

IPv6 offers economic advantages for Nigeria's digital economy, meeting the

increasing demands of the internet and digital transformation. Here's an outline of its key benefits and its role in Nigeria's digital evolution:

i. Enhanced Internet Performance: The adoption of IPv6 improves internet speed and efficiency by streamlining data routing, benefiting real-time services such as streaming, online gaming, and video conferencing, particularly in Nigeria, with the rapid increase in internet usage and the implementation of 5G technology.

ii. Improved Security Features: The IPv6 protocol includes built-in security features such as IPsec, which encrypts and authenticates data across the network. This enhanced security will help safeguard sensitive information as Nigeria progresses toward digital transformation and critical sectors such as finance, healthcare, and government services transition online.

iii. Support for IoT and Smart Cities: IPv6 is vital for IoT growth in Nigeria's digital future, providing unique IP addresses for efficient communication and data management across IoT networks, especially for smart agriculture and smart city projects where devices like traffic sensors, utilities, and public services will depend on continuous connectivity.

iv. Facilitating 5G Networks: IPv6 will significantly impact Nigeria's digital transformation. This technology is crucial for implementing and operating 5G networks as it provides more IP addresses and enables faster, more secure data transmission. IPv6 ensures seamless connectivity and maximises the benefits of 5G networks.

v. Better Network Efficiency and Simplified Configuration: As Nigeria's digital infrastructure expands, IPv6 can simplify network setup and maintenance for administrators, reduce operational costs, and facilitate the scaling of internet services.

1.1.2 Role in Nigeria's Digital Transformation

- Internet Expansion: As the Nigerian digital economy expands, IPv6 adoption is essential to the growth of businesses and people online.

- Support for Innovation: Implementing IPv6 will facilitate innovation in the fintech, edtech, and health-tech sectors, all requiring secure and reliable internet connections. The adoption will improve productivity, economic diversification, and job creation in the technological industry.

- Long-term Scalability: IPv6 assures Nigeria that its digital infrastructure will be able to scale effectively to meet future demands as internet users and connected devices increase.

By adopting IPv6, Nigeria can support its renewed National Digital Economy Policy, develop critical sectors, and provide a safer, more efficient, and more connected digital ecosystem.

2.0

The Standard and Industry Trends of IPv6 and IPv6 Enhanced

The Internet Engineering Task Force (IETF) has been a critical promoter in the deployment of IPv6 since 2016. New protocols are now explicitly tailored for IPv6, gradually phasing out IPv4 compatibility. IPv6 offers advanced features such as segment routing (SRv6), bit-indexed explicit replication (BIERv6), and in-situ flow information (iFIT), collectively referred to as IPv6 Enhanced. These innovations enhance network performance in critical areas such as ultra-high bandwidth, security, automation, and low latency. These improvements are illustrated in **Figure 1** below.

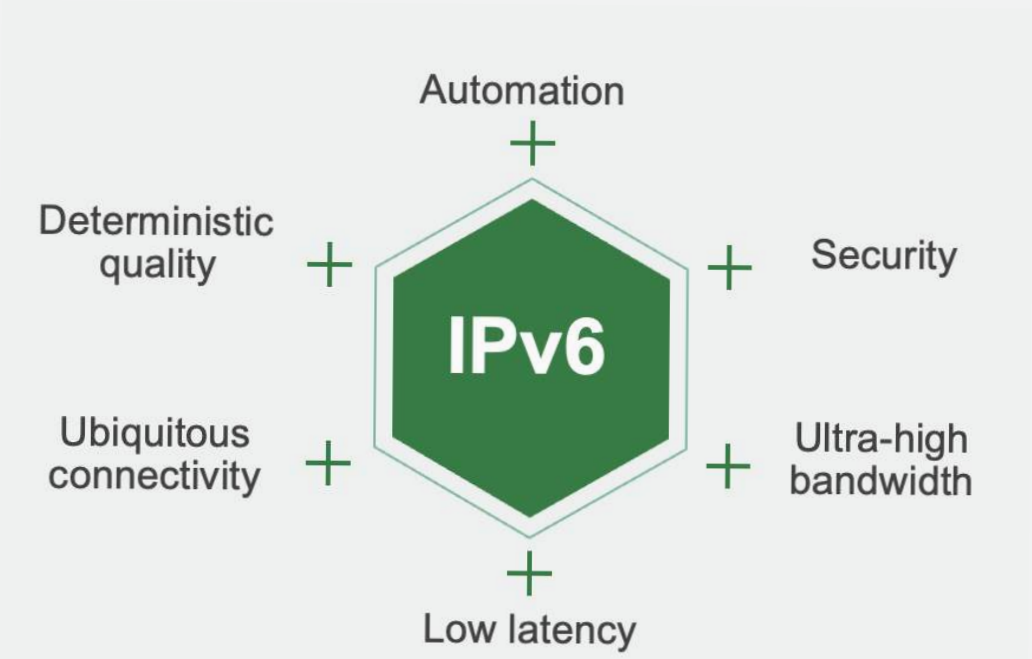


Figure 1 Six key features of IPv6 Enhanced [Source: ETSI IPE

Figure 2 shows the evolution of Internet technologies from IPv4 to MPLS for traditional and multimedia services. Today, modern applications like IoT, industrial automation, and autonomous driving use IPv6 and IPv6 Enhanced technologies.

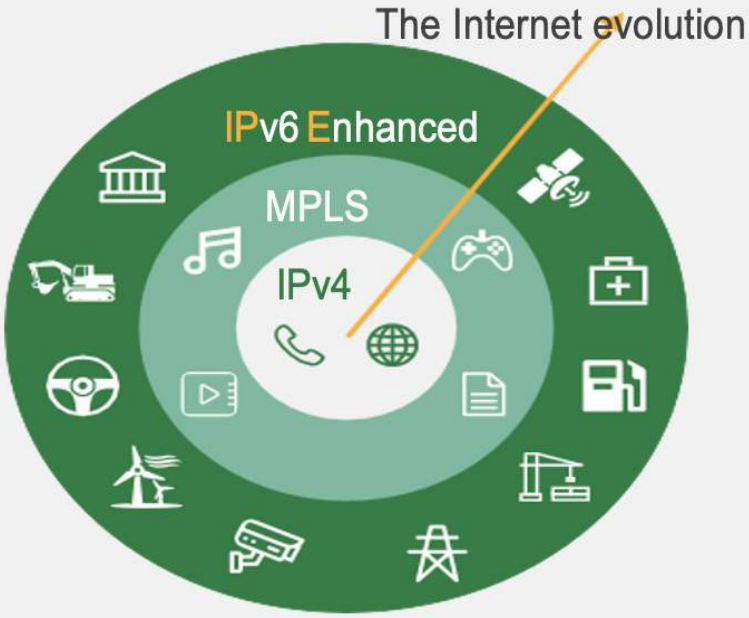


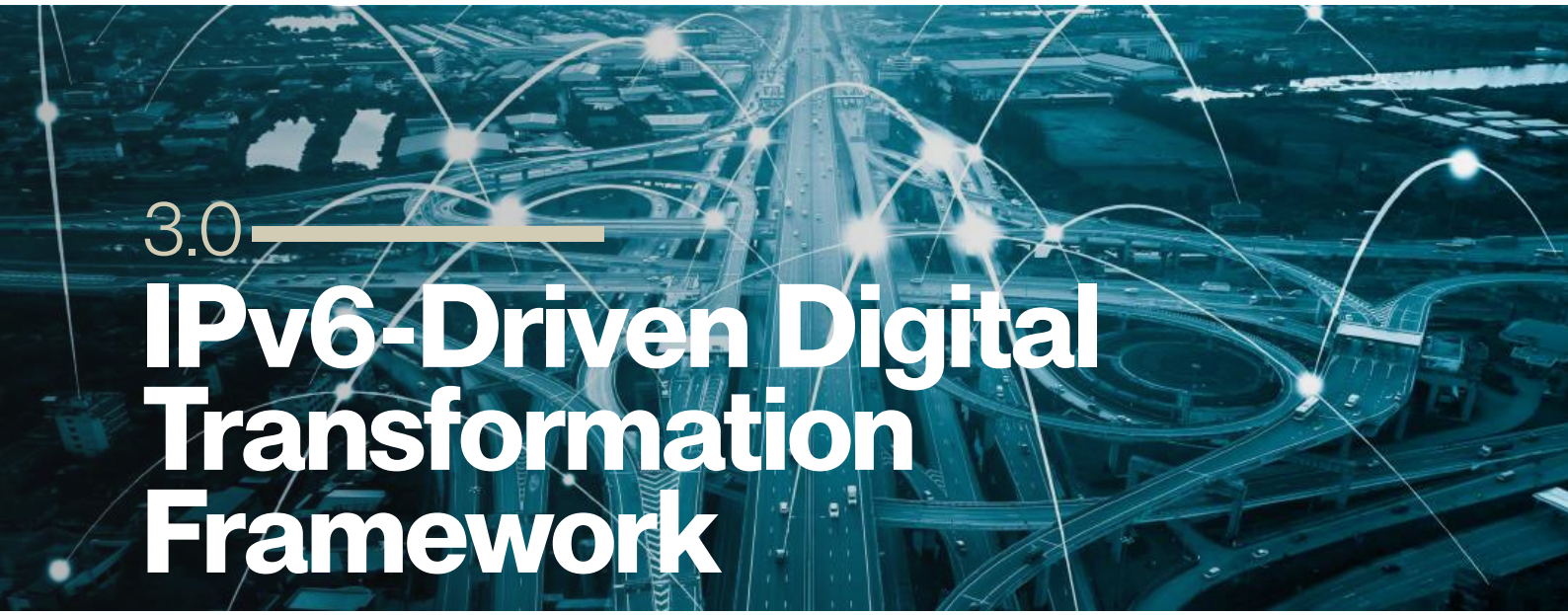
Figure 2: The direction of the Internet evolution: from IPv4 to IPv6 Enhanced

2.1 EANTC IPv6 Enhanced Interoperability Test

The European Advanced Networking Test Centre (EANTC) has conducted SRv6 interoperability tests with industry support since 2018. The 2024 report revealed collaboration between companies like Arista, Cisco, Huawei, Nokia, and ZTE, confirming the maturity of IPv6 Enhanced technology.

2.2 IPv6 Enhanced Council SRv6 Ready program

The IPv6 Forum has introduced the SRv6 Ready Logo Program to certify SRv6 products for compliance with standards and interoperability. Successful products will display the “SRv6 Ready” logo. The testing process will encompass IETF RFCs (8402, 8754, and 8986) and is set to begin in September 2024.



3.0 IPv6-Driven Digital Transformation Framework

The IETF, IPv6 Enhanced Council, and Wireless Broadband Alliance (WBBA) actively promote IPv6-based infrastructure to meet market demands. This section highlights the necessity of IPv6 as a critical enabler for society's digitalisation and presents the IPv6-driven digital economy and transformation framework.

3.1 IPv6 as Key Enabler for Digitalisation of the Society

In today's shift to a digital economy, IPv6 adoption will drive digital transformation. Governments worldwide, including in Africa, are expected to establish policies to facilitate this transition across various sectors. IPv6 is fundamental for innovations like IoT, AI, cloud computing, and blockchain. For instance, Nigeria's "Agenda 2050" emphasises the importance of digital transformation and high-speed Internet infrastructure, fulfilled by IPv6. IPv6 ownership empowers individuals to participate in the global digital economy and contributes to strengthened cybersecurity.

Upon activating IPv6 addresses on personal devices, individuals become "prosumers," engaging in data exchange and transactions through IPv6-based applications. This global open data environment yields valuable insights through AI and ML algorithms, fostering new markets and aligning with the UN's Sustainable Development Goals. IPv6 ownership empowers individuals to influence the development of a secure and sustainable digital economy.

3.2 Digital Economy and Digital Transformation Framework

The IPv6 Enhanced Council developed a framework to model how IPv6 and IPv6 Enhanced will drive the digital economy. It presents two complementary perspectives:

- **Society-oriented:** Led by the public sector, focusing on inclusive digital societies and sustainable development.
- **Business/market-oriented:** Led by the private sector, emphasising ROI, value creation, and new market opportunities.

While these perspectives have different agendas, they complement each other. Public sector progress often catalyses private sector efforts through incentives and regulatory frameworks. For private sector stakeholders, the business-to-government (B2G) segment offers significant opportunities, expanding IPv6-based products and services.This framework, adaptable to local contexts, serves as a metamodel for IPv6 Forum members, with Nigeria's digital transformation as an example for Africa.

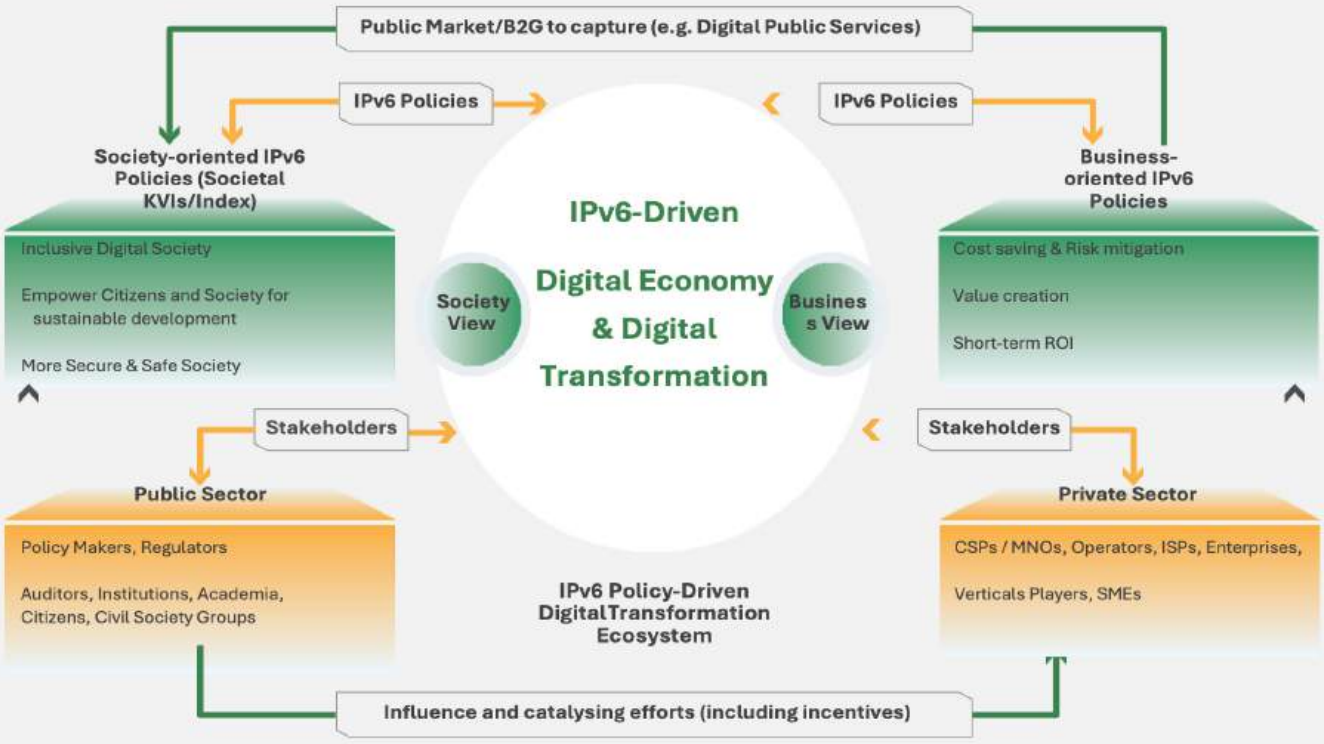


Figure 4 IPv6-Driven Digital Transformation Ecosystem

3.1 IPv6 Enhancing Innovation Cycle in the Digital Transformation Ecosystem

This section emphasises the vital role of innovation in the IPv6-driven digital economy by implementing the "IPv6-Driven Digital Transformation Framework" into an innovation process. This process can follow two approaches: a requirements-driven or an intent-driven model, with the latter being proposed in the document.

In this model, two levels of innovation work together in a hybrid structure that combines centralised (federal) and distributed (local) governance, reflecting a system like Nigeria's. The IPv6 Enhanced Innovation Cycle operates at two different speeds:

i. Federal Level: At the federal level, large amounts of data are processed to provide strategic insights and actions.
ii. Local Level: At the local level, immediate reactions to local needs are addressed by analysing local data in real time.

Building IPv6 skills through educational programs is also required.

3.3.1 IPv6 Enhancing Innovation Cycle in the Digital Transformation Ecosystem

The intent-based innovation framework enables stakeholders to express their requirements and map to IPv6-enhanced capabilities. The "Federal IPv6 Enhanced Innovator" ensures execution by the IPv6-driven transformation platform.

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3.3.2. Main phases of the Intent-based IPv6 Enhanced Innovation life cycle

The main phases of the intent lifecycle include:

1. Design: The intent owner designs the blueprint.
2. Conflict Resolution: Resolve conflicts between multiple intents.
3. Translation: Convert Intent into executable language.

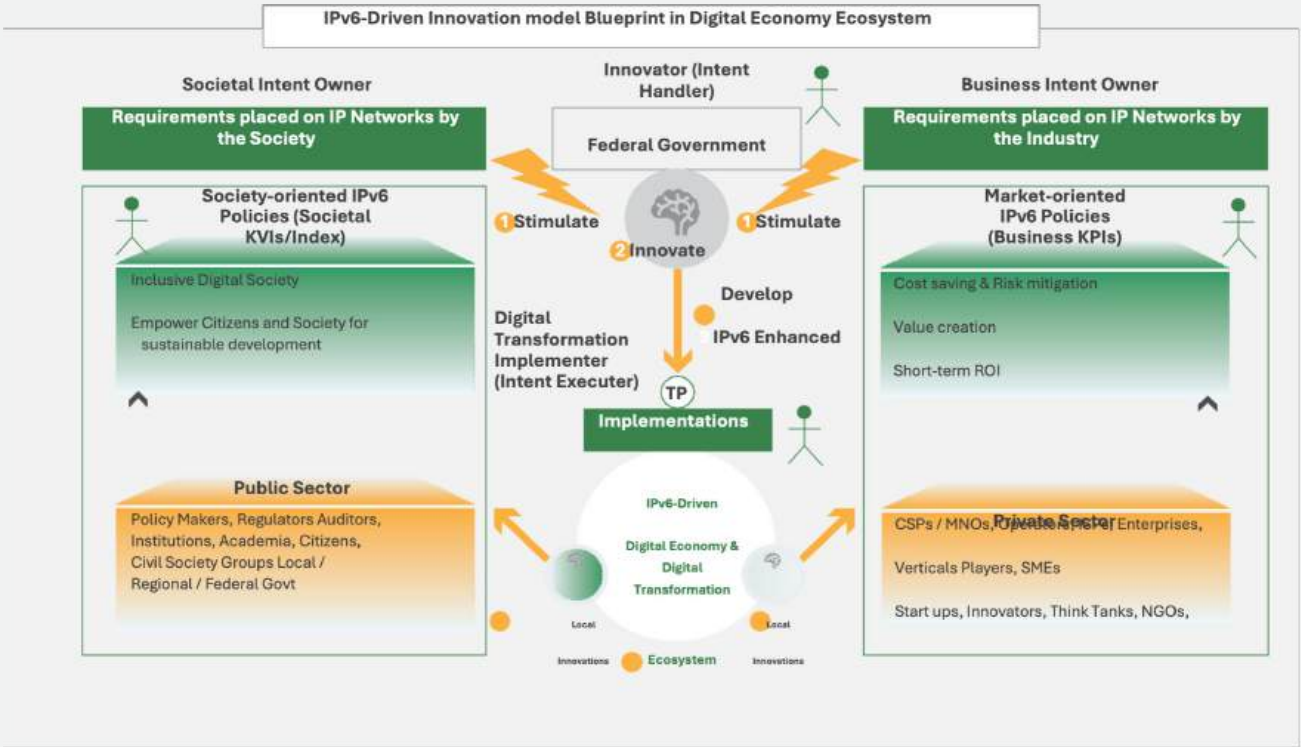


Figure 5: IPv6 Enhanced Innovation Cycle in the Digital Transformation Ecosystem: Intent-Driven Approach

4. Execution: Implement the Intent on the network.
5. Monitoring: Track execution and ensure fulfilment.
6. Evaluation: Assess results and adjust strategies based on feedback from local innovators.

This cycle allows local adjustments, feeding back into the federal strategy and ensuring a dynamic, responsive innovation process.

IPv6 Enhanced Innovation Workflow	Actor	Intent Role	Action
	Public Sector	Societal Intent Owner	1 Stimulate / Inject Intent
	Private Sector	Business Intent Owner	1 Stimulate / Inject Intent
	Federal Level IPv6 Enhanced Innovation	IPv6 Enhanced Intent Handler	2 Innovate
	IPv6-Driven Digital Transformation Ecosystem / Platform	IPv6 Enhanced Intent Executor	4 Implement / Execute
	Local Innovator	IPv6 Enhanced Intent Handler	2 / 5 Innovate / Feedback

Table 1: Summarizes the IPv6 Enhanced Innovation Workflow.

4.0

Global IPv6 Deployment Status and Policy Experience

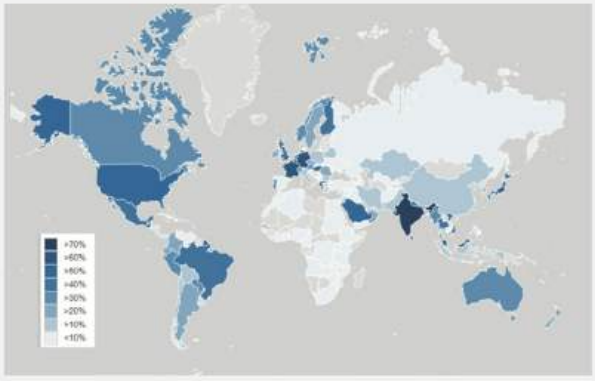


Figure 9 IPv6 Adoption Rate by country [Source: ARCEP the French IPv6 Barometer: February 2024]

The map uses varying shades of blue to represent the level of IPv6 deployment in each country. ARCEP published ranking tables by country and region, highlighting the progress of IPv6 adoption. The top 100 rankings serve as a helpful tool for comparing progress across countries and assessing the speed of IPv6 adoption, as shown in Figure 7

According to the World IPv6 Day (June 6, 2012), the global deployment of IPv6 has experienced substantial growth, reaching nearly 50% by January 2024. However, the deployment of IPv6 is notably disparate across the world, with high adoption rates in countries like India (77%), Belgium (63%), the U.S. (49%), and France (41%), and limited

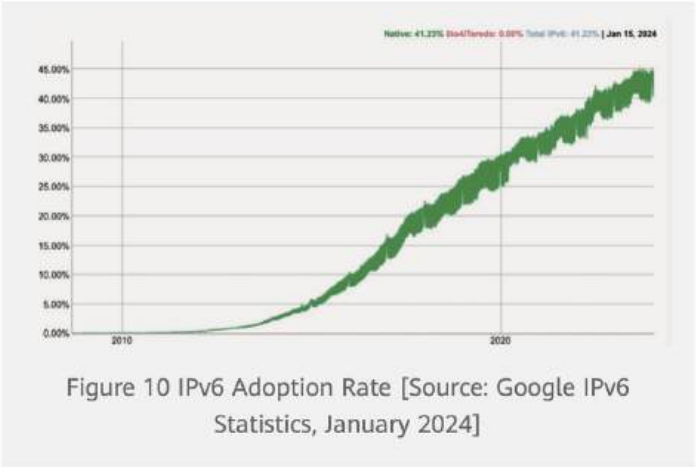


Figure 10 IPv6 Adoption Rate [Source: Google IPv6 Statistics, January 2024]

deployment rates in many African countries (below 3%). Future internet expansion and investments are likely to concentrate on regions like Africa. The International Finance Corporation (IFC) has estimated that enhancing internet coverage to 75% of Africa's population could create 44 million new jobs.

4.1 IPv6: the Global Trend of Internet

The rapid growth of the internet demands advanced access technologies like 4G/5G and fibre and the continued use of IP as a fundamental protocol. With the IPv4 address pool exhausted and standards for IPv4 gradually becoming obsolete, IPv6 is now the only viable option for the sustainable development of the internet. However, not all countries have fully recognised this trend.

As shown in Figure 10, the IPv6 adoption rate in West Africa is meagre at just 1.7%, which mirrors the overall rate across Africa. In Nigeria, the adoption rate is even lower, at only 0

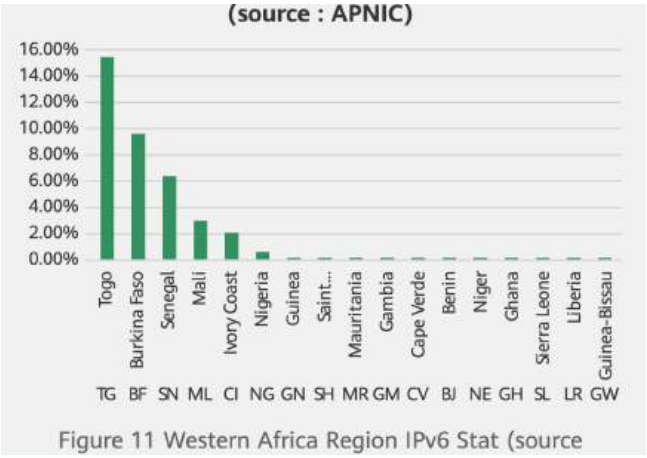


Figure 11 Western Africa Region IPv6 Stat (source

4.2 The United States

Released multiple policies since 2009 and set up an agenda for IPv6-only transition in federal networks

Several countries have implemented strategies to accelerate IPv6 adoption. In the United States, through the Office of Management and Budget (OMB), the federal government issued OMB-M21-07 in 2020, which outlines a clear target for IPv6-only transition in federal networks, aiming for 80% IPv6 adoption by 2025.

4.3 France: Regulator released IPv6-5G binding policy

The French telecommunications regulator ARCEP recognises the essentiality of the IPv6 transition for competitiveness and innovation. In November 2019, ARCEP tied IPv6 adoption to 5G deployment, ensuring that 5G networks are IPv6-compatible.

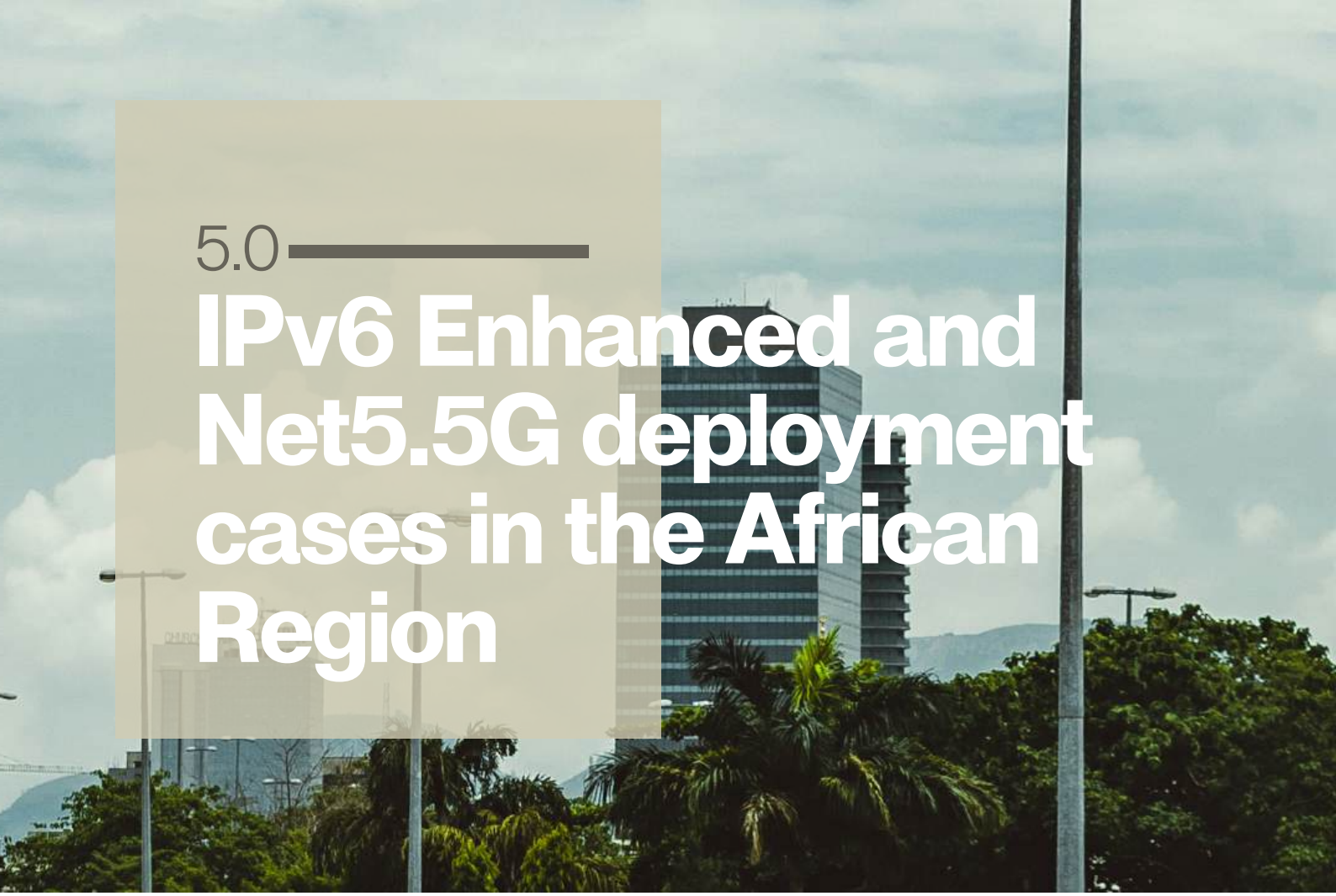
4.4 China

Set up the national IPv6 Promotion and Deployment Commission to release policies and formulate a development strategy

Due to its large population, China has made IPv6 adoption a national priority, aligning the transition with its broader development goals to expedite progress. The government established the National IPv6 Promotion and Deployment Commission. It launched the "Special Action Plan of IPv6 Traffic Promotion (2021-2023)," which aims to achieve over 50% IPv6 traffic in mobile networks, triple IPv6 traffic in fixed networks compared to December 2020, ensure over 70% IPv6 adoption among the top 100 commercial websites, and reach over 80% IPv6 coverage for fixed terminals.

4.5 Kenya: Preparation of national IPv6 migration strategy

In July 2022, the Communications Authority of Kenya (CA) introduced the National IPv6 Migration Strategy to boost IPv6 adoption in Kenya. This National IPv6 Migration Strategy mandates IPv6 compliance for new devices and network resources, emphasising regulatory intervention and awareness campaigns.



5.0

IPv6 Enhanced and Net5.5G deployment cases in the African Region

While African countries generally have lower IPv6 adoption rates compared to regions with advanced deployments, many are beginning to explore the potential of IPv6 Enhanced technologies such as SRv6, BIERv6, and iFit, along with Net5.5G, to unlock significant commercial value. IPv6 provides a larger address space and introduces extensibility to the internet through innovations that enhance IP network capabilities.

These capabilities include ultra-high bandwidth, ubiquitous connectivity, enhanced security, automation, deterministic quality, and low latency., as depicted in Figure 1.

Specifically, SRv6 enables programmable networks, streamlining management while improving security and reducing latency, vital for Nigeria's transition to 5.5G and overall digital growth. BIERv6 simplifies multicast traffic management, optimising bandwidth usage for large-scale content distribution, which is crucial for the media and entertainment sectors. Meanwhile, iFIT offers real-time insights into network performance, facilitating better quality of service (QoS) and proactive network management.

Integrating these technologies in telecommunications and public administration will significantly improve

network performance, service delivery, and cybersecurity, supporting Nigeria's digital transformation and economic growth.

As illustrated in Figure 2, Internet technologies have evolved from using IPv4 for traditional services to adopting MPLS (Multi-Protocol Label Switching) for multimedia applications. Today, the shift towards IPv6 and its enhanced technologies supports a range of advanced applications, including the Internet of Things (IoT), industrial automation, satellite communication, and autonomous driving.

This evolution positions African countries to leverage IPv6 Enhanced technologies for digital transformation and economic growth.

5.1 Nigeria Carrier A: Use 400GE + SRv6 + Network Digital Map, building Net5.5G benchmark in Africa.

The rapid growth of the internet demands advanced access technologies like 4G/5G and fibre and the continued use of IP as a fundamental protocol. With the IPv4 address pool exhausted and standards for IPv4 gradually becoming obsolete, IPv6 is now the only viable option for the sustainable development of the internet. However, not all countries have fully recognised this trend.

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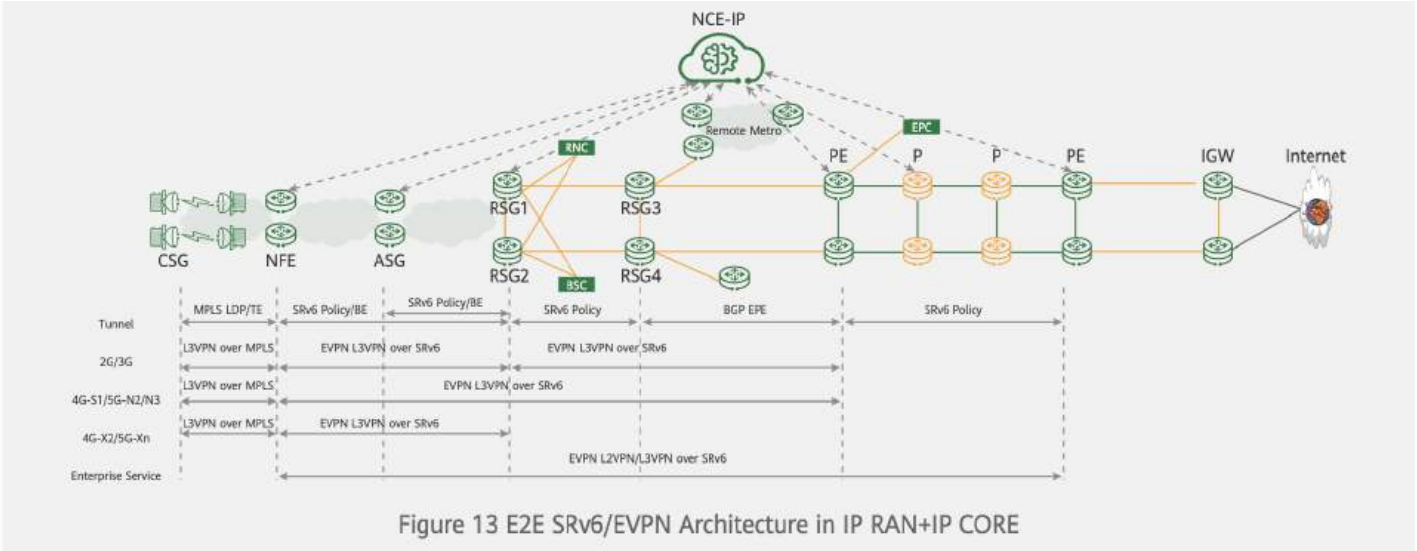


Figure 13 E2E SRv6/EVPN Architecture in IP RAN+IP CORE

Figure 9: E2E SRv6/EVPN Architecture in IP RAN+IP CORE

Carrier A launched Nigeria's first 5G network in August 2022, covering 190 sites across seven cities and achieving a 60% annual traffic growth. To maintain leadership in the 5.5G and 6G eras, Carrier A is upgrading its network with technologies like 400GE routers, SRv6, and digital mapping.

These enhancements have increased bandwidth utilisation by 30% and reduced power consumption by 50%. By leveraging AI-based security, ultra-broadband, and green energy designs, Carrier A sets a new standard for connectivity in Africa, ensuring scalability, security, and energy efficiency.

5.2 Nigeria Carrier B: Using 400GE + SRv6 + Network Digital Map, building an Intelligent IP Network for 5G and Cloud era

Carrier B's existing infrastructure, which served 3G and 4G needs, faced reliability and performance issues as mobile traffic surged. Carrier B is building a Net5.5G-oriented IP backbone network to overcome these challenges. This includes expanding the number of P nodes and upgrading to 400GE, which cuts fibre costs by 30%. With SRv6 technology, Carrier B has streamlined cloud access, improving bandwidth utilisation by 30% and simplifying network management. The new dual-plane architecture ensures stability and future scalability, supporting Nigeria's 5G and cloud-era growth.

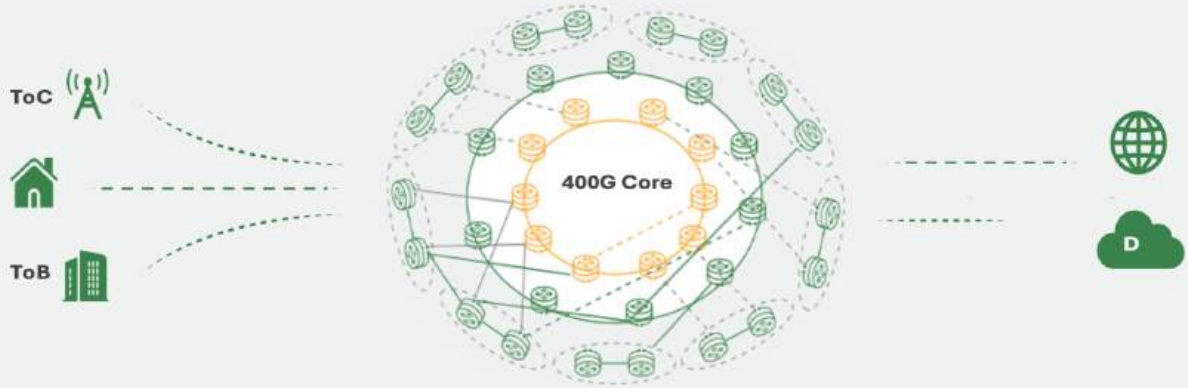


Figure 10 Net5.5G Intelligent IP Transport Network Architecture

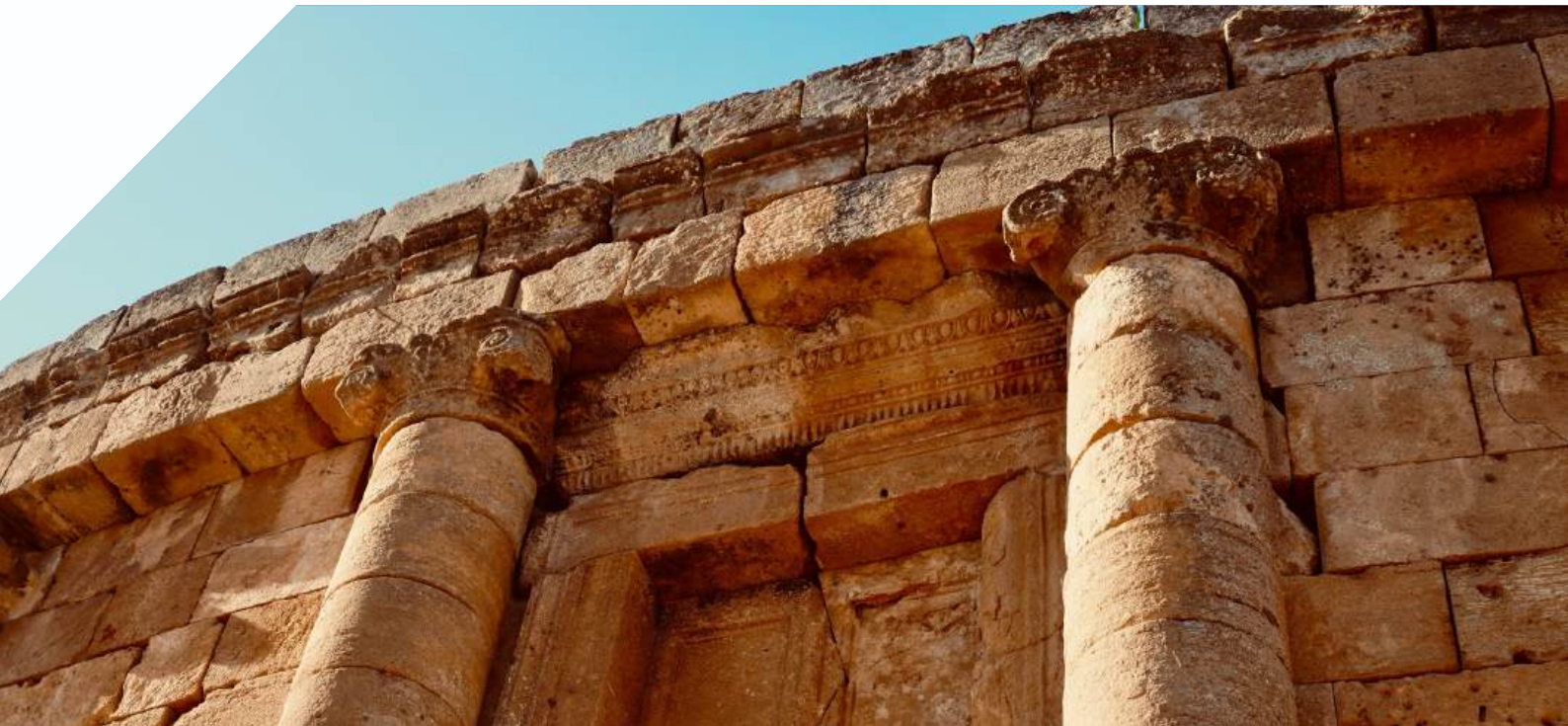
5.3 Algeria Carrier D: Using E2E Slicing + SRv6, Ensuring the Success of the Mediterranean Games

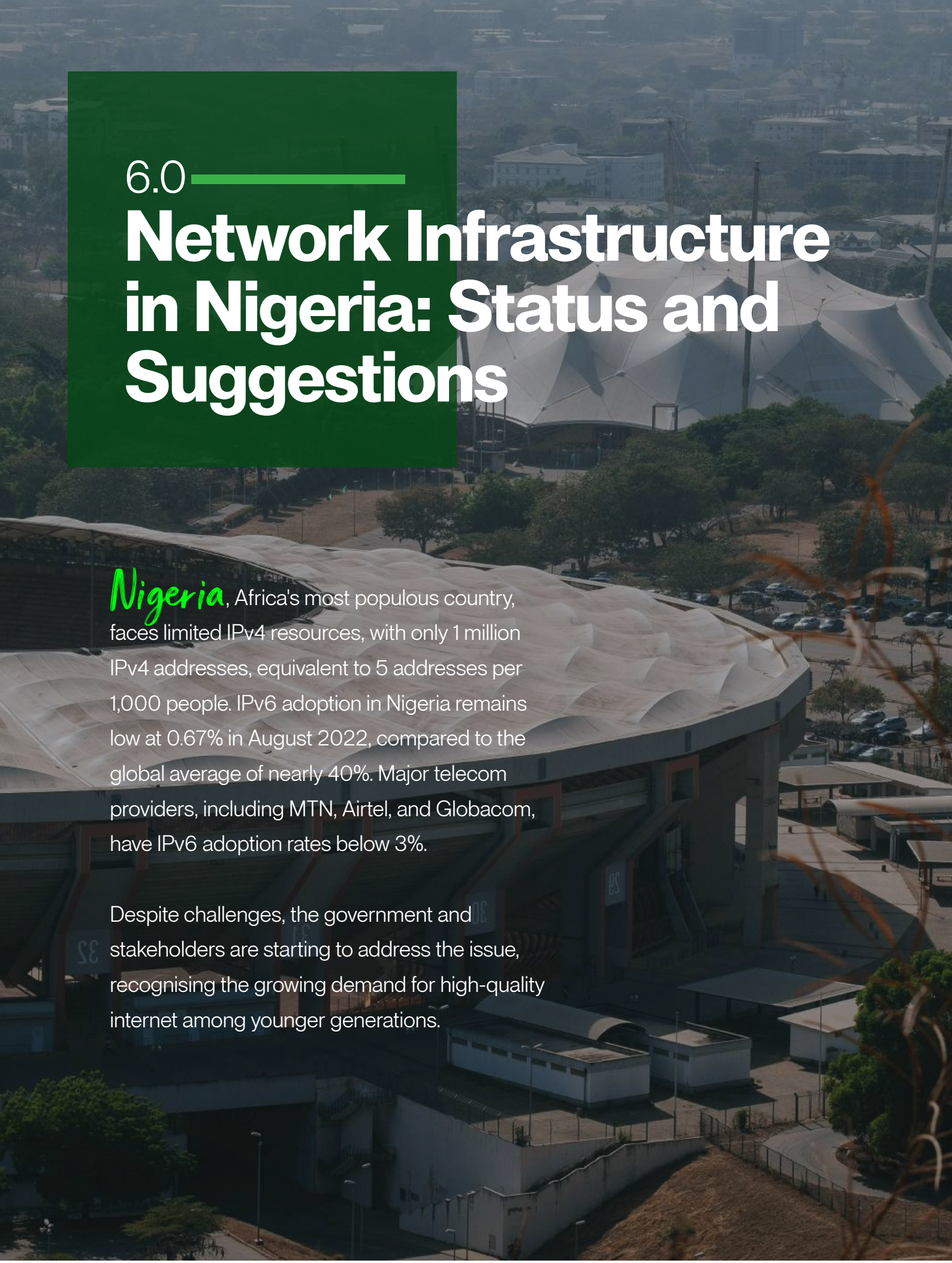
In June 2022, Carrier D successfully built the network infrastructure for the Mediterranean Games, providing high-speed Wi-Fi for 40,000 concurrent users, real-time score tracking with less than 20ms latency, and uninterrupted HD streaming. Using SRv6 and slicing technology, Carrier D ensured seamless service provisioning and network management. The deployment of Wi-Fi 6 and advanced radio technology-enhanced user experience, doubling internet speeds to 200 Mbps while reducing video latency to 10ms. Carrier D plans to expand SRv6 technology across its entire network by 2024, improving service reliability and user satisfaction.

Figure 11: Carrier D's network architecture for the Mediterranean Games

Carrier D deployed Wi-Fi 6 with high-density access points and smart directional coverage to support 40,000 simultaneous connections, reducing signal interference. The Smart Radio Dynamic Turbo technology decreased 4K video latency from 20 ms to 10 ms, while download/upload rates increased from 80 to 200 Mbps, significantly enhancing the user experience.

The success of this deployment demonstrated the maturity of SRv6 technology. In its 2024 plan, Carrier D aims to expand SRv6 across its entire network to improve the user experience further.





6.0 Network Infrastructure in Nigeria: Status and Suggestions

Nigeria, Africa's most populous country, faces limited IPv4 resources, with only 1 million IPv4 addresses, equivalent to 5 addresses per 1,000 people. IPv6 adoption in Nigeria remains low at 0.67% in August 2022, compared to the global average of nearly 40%. Major telecom providers, including MTN, Airtel, and Globacom, have IPv6 adoption rates below 3%.

Despite challenges, the government and stakeholders are starting to address the issue, recognising the growing demand for high-quality internet among younger generations.

6.1 Key Actors in the Nigeria IPv6 Ecosystem

- Ministry of Communication, Innovation, and Digital Economy: Minister Dr Bosun Tijani has expressed his commitment to collaborating with global partners and unlocking opportunities for Nigerian citizens. He emphasises digital inclusivity as a key priority.

- NITDA (National Information Technology Development Agency) promotes inclusive access to digital infrastructure and works on developmental regulation, digital literacy, and building solid infrastructure.

- IPv6 Council Nigeria: Established in 2015 with support from the IPv6 Forum, the council, led by Muhammed Rudman, promotes IPv6 adoption in Nigeria through awareness campaigns and international collaboration.

- ATCON: ATCON, in partnership with IPv6 Council Nigeria, organised an IPv6 webinar in 2021, addressing challenges like lack of technical know-how, equipment compatibility, and the absence of IPv6 upstream service providers. ATCON advocates for increased awareness and training on IPv6.

- ISPON and NSDI: ISPON supports local software development and innovation. It is recommended that IPv6 be incorporated into ISPON's training and that NSDI be empowered to bolster digital transformation in Nigeria.

6.2 IPv6 Adoption: Recommendations of Industry Framework

Governments worldwide have demonstrated that policy plays a crucial role in IPv6 transition. NITDA is committed to driving IPv6 deployment by collaborating with regulatory bodies, ministries, and industry stakeholders.

The initial phase involves establishing critical metrics and developing a comprehensive roadmap to accelerate digitalisation across Nigeria, as outlined in Figure 12 below:

Type	Strategies	Key Indicator (2024-2027)
Framework Research (Year 1)	➢ Introduce a national IPv6 strategy outlining the responsibilities of service providers and stakeholders. ➢ Build a nationwide IPv6 awareness and training program involving partners like AFRINIC and the IPv6 Forum, and incorporate IPv6 education into university curricula. ➢ Engage universities and stakeholders to develop local IPv6 content, fostering local talent and champions. ➢ Collaborate with regional and international organisations to adopt best practices.	➢ By 2025, 60% of MDA's network engineers or administrators will be IPv6 certified. ➢ At least **five** campuses should support IPv6 slicing by 2025
Framework Design (Year 2)	➢ Establish national regulatory frameworks for ultra-broadband immersive applications, ensuring that technologies like the Metaverse align with international standards and promote competition and innovation. ➢ Encourage pilot IPv6 projects within government and operator networks, starting small and scaling up. ➢ Establish metrics and compliance goals for service providers, with clear milestones and enforcement mechanisms to achieve at least a 50% IPv6 deployment rate. ➢ Support policies that attract investment by reducing legislative barriers to IPv6 implementation.	➢ Publish the IPv6 framework by 2026 ➢ Launch two IPv6 Enhanced innovation projects by 2027
Framework Compliance And IPv6 Deployment	➢ Build a monitoring system that incentivises compliance, offering rewards such as National IPv6 Industry Champions and Hall of Fame recognitions. ➢ Develop an internal IPv6 certification program that includes compatibility and interoperability tests. ➢ Implement the IPv6 Forum's "IPv6-Driven Digital Transformation & Digital Economy Framework" to suit Nigeria's local needs. ➢ Enact IPv6-supportive policies and legislation, such as linking national broadband funding and frequency allocation to IPv6. ➢ Set ambitious national broadband goals by 2027, aiming for gigabit broadband in urban and rural areas, including public institutions.	➢ The IPv6 traffic on Mobile and fixed networks will account for 60% and 20%, respectively, by 2027 ➢ **30%** of major websites and mobile applications should support IPv6 ➢ SRv6 node deployment should reach **40%** by 2027 ➢ **20%** of private lines IPv6-enabled by 2027 ➢ Fibre-to-the-station deployment should reach **40%** by 2027

Figure 12: Nigeria's government can accelerate IPv6 adoption

7.0 Conclusion

The Internet Protocol (IP) and its addresses are essential for the global internet. With the depletion of available IPv4 addresses, IPv6 is crucial for sustainable growth and universal connectivity.

Governments worldwide have implemented policies to accelerate the deployment of IPv6, resulting in significant increases in IPv6 adoption rates and the overall efficiency of digital societies. IPv6 represents the protocol innovation of the network, and Net5.5G brings the future vision of infrastructure innovations for the network.

The transition to IPv6 and Net5.5G in Nigeria is critical for advancing the country's Digital Public Infrastructure objectives. This report provides recommendations for optimising Nigeria's IPv6 migration strategy and presents a framework of IPv6-enhanced innovation metrics to evaluate operator performance and the nation's overall IPv6 and Net5.5G innovation proficiency. Collaborative efforts among stakeholders can help Nigeria achieve its IPv6 migration objectives and build a more interconnected and sustainable network infrastructure based on Net5.5G.

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