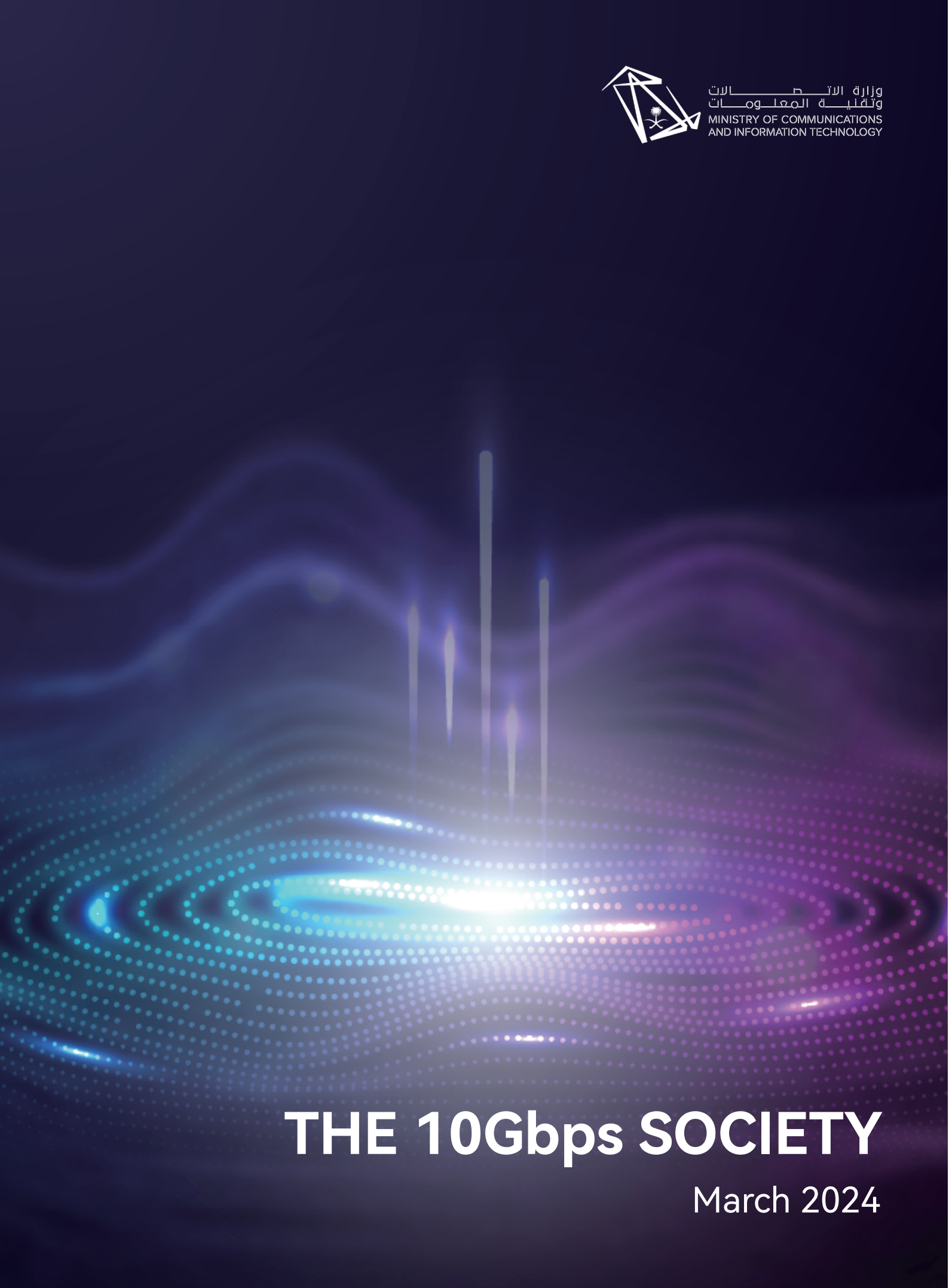
وزارة الاتصالات وتقنية المعلومات
MINISTRY OF COMMUNICATIONS AND INFORMATION TECHNOLOGY



THE 10Gbps SOCIETY

March 2024

CONTENTS

Executive Summary

Facilitating digital transformation throughout society is likely to be one of the key enablers for realising many of the goals of the Vision 2030 plan. But in order to achieve the best outcomes, it is crucial that the country first establishes a robust and superior digital infrastructure that accelerates the overall digital transformation of the Kingdom of Saudi Arabia (KSA) and lays the foundation for a Future Intelligent World.

The report opens by documenting recent global trends in digital economy planning and digital infrastructure roll-out. In recent years, the major economies have published detailed national digital transformation strategies, outlining how they will remain competitive across the 'digital decade'. The KSA has done well to date.

Looking forward in time, the Future Intelligent World is composed of intelligent education, intelligent entertainment, intelligent healthcare, intelligent cities and intelligent manufacturing. Leading to a society where everyone can enjoy a high-quality life – improved health and longevity, more attractive living environments with an enhanced digital and traditional economy.

As a helpful corollary, the 10Gbps Society creates such an intelligent and connected world, elevates ICT services and supports scenarios for connected individuals, connected homes, and connected enterprises. Therefore, it is necessary to evolve towards a 10Gbps Society to ensure the success of Vision 2030.

The 10Gbps Society is characterised as one that has at its foundation an advanced network infrastructure with 10 gigabits per second peak download speeds, low latency, wide coverage, and massive connectivity. A connected, digital and intelligent world with abundant modern application scenarios, covering all aspects of society.

In a highly dynamic and disruptive global digital economy, the 10Gbps Society would additionally empower the KSA with world-leading digital infrastructure. This could provide the foundation for a thriving domestic digital ecosystem and further foster national resilience. It would also help build a world-class digital hub to connect MENA, Asia and Europe. This would also improve the attractiveness of the nation to foreign direct investment (FDI) in the digital sector, furthering the national goal of raising the relative and absolute contribution of non-oil based GDP.

The report also outlines how the KSA can transition from where it is today to the 10Gbps Society by 2030 through gap analysis, and discusses the opportunities that could result from an upgrade of the Kingdom's digital capabilities to that of a 10Gbps Society – making the KSA a true global digital leader.

Achieving the 10Gbps Society will nonetheless require a multi-faceted strategy which encompasses policy development, stakeholder coordination and innovation. This aspiration begins with the introduction of a unique framework utilized to govern the policy-making process of the 10Gbps Society.

The 10Gbps Society will henceforth help illuminate a future where technology combines with progress and the KSA achieves its admirable aspirations for Vision 2030.

Abbreviations

AR
Augmented Reality

AOI
Automated Optical Inspection

CT
Computed Tomography

CST
Communications, Space & Technology Commission

FTTB
Fibre to the Business

FTTH
Fibre to the Home

FTTP
Fibre to the Premises

FTTR
Fibre to the Room

FWA
Fixed Wireless Access

GDP
Gross Domestic Product

GCC
Gulf Cooperation Council

ICT
Information and Communications Technology

IXP
Internet Exchange Point

IPv4
Internet Protocol version 4

IPv6
Internet Protocol version 6

MCIT
Ministry of Communications and Information Technology

MENA
Middle East and North Africa

MRI
Magnetic Resonance Imaging

NTP
National Transformation Program

PON
Passive Optical Network

VR
Virtual Reality

Wi-Fi
Wireless Fidelity

WLAN
Wireless Local Area Network

XR
Extended Reality

3D
Three Dimensional

3GPP
3rd generation partnership project, a collaborative project aimed at developing globally acceptable specifications for third- generation (3G) mobile systems

5G
Fifth generation mobile network

1. INTRODUCTION

We live in a time of global digital enhancement. Fast developing technological infrastructures, such as ultra-fast broadband and advanced cutting-edge digital technologies are transforming economies worldwide. We may well be on the cusp of a truly connected intelligent global society.

Within this new paradigm, the KSA is positioning itself as a global pioneer and regional leader for innovation and technology investment, largely through its ambitious Vision 2030 national plan. In this regard, the KSA has been actively supporting the roll-out of advanced digital architecture.

The fruits of these successful government and private sector collaborations have become ever more apparent in recent years. At the beginning of this decade for example, the KSA hit a notable milestone when the number of global content and service networks in the country reached twenty. This has greatly improved the domestic digital ecosystem of the country. As a consequence, these efforts have resulted in the KSA becoming the largest and arguably most advanced digital and technical market in the Middle East and North Africa (MENA) region.

While these focused efforts have clearly boosted the KSA's digital economy to date, they are also proving crucial in realizing the broader societal and economic aspirations of the nation's Vision 2030 plan. But with the decade moving along swiftly, an acceleration in digital technological development may well be warranted.

In order to move to a global leadership position and realize many of the economic and social goals of Vision 2030 the country will not just need an overhaul and upgrade of digital infrastructure. It may require a wholly new holistic descriptor of superior digital connectivity and a step-change in digital capabilities. A new ambition that is best described as the 10Gbps Society.

2. GLOBAL DIGITAL INFRASTRUCTURE OUTLOOK

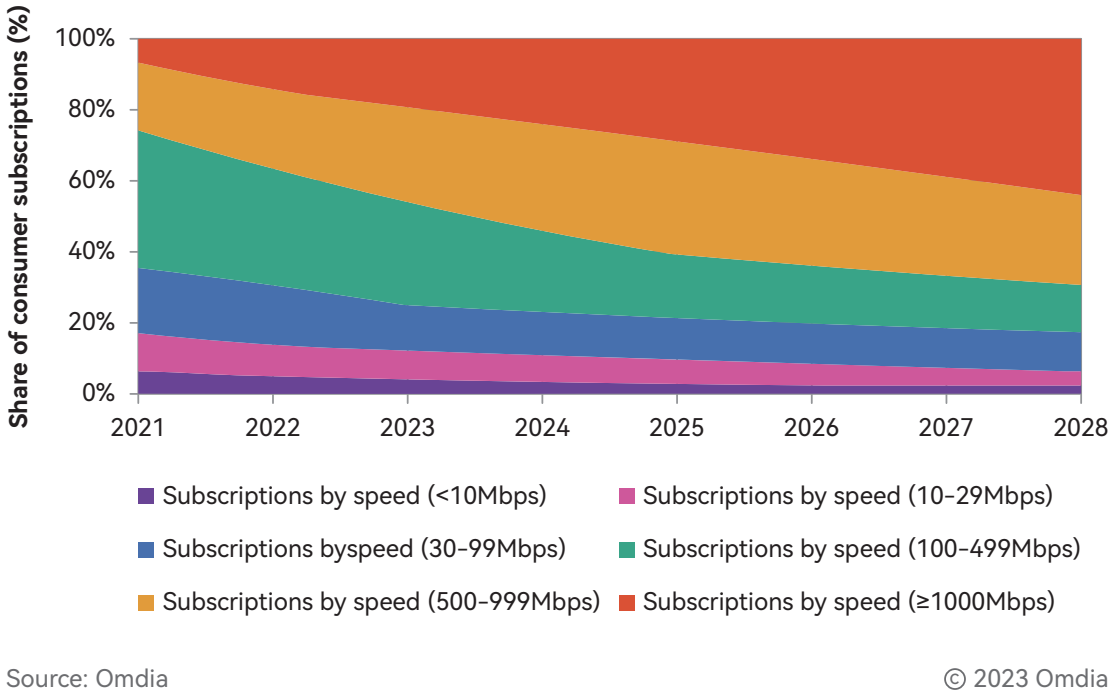
In recent years, the major economies have published their national digital transformation strategies, outlining how they will remain competitive across the 'digital decade'. The United States for example, has announced its Broadband Equity Access and Deployment (BEAD) Program as a component of the Infrastructure Investment and Jobs Act (Bipartisan Infrastructure Bill). This program includes policies and actions on how the government intends to improve internet and broadband infrastructure, with the aim to connect every citizen and small business to reliable, high-speed internet by 2030. Similarly, the European Commission in 2021 began implementing its Work Programme for the digital component of its Connecting Europe Facility (CEF Digital). This defines the scope and objectives of the EU-supported actions needed to improve Europe's digital connectivity infrastructures for three years, including Gigabit and 5G networks as well as digital backbone infrastructures. China has developed several action plans to promote 5G, Gigabit Broadband, Datacentres and Cloud Computing development at both the national and local levels. Germany launched the Federal Digital Strategy in 2022. Japan released its Master Plan 3.0 for the Regional Development of ICT Infrastructure plan in December 2020. And the United Kingdom published its 2022 Digital Strategy, which is an extensive update to its 2017 Digital Strategy.

According to the World Bank, the digital economy now contributes more than 15% to total global GDP[1]. The Digital Cooperation Organization (DCO) expects the digital economy to continue to grow strongly (and above that of the traditional economy) over the rest of this decade. By 2030, the digital economy is forecast to contribute around 30% to total global GDP and create 30 million new jobs[2]. In terms of growth, again according to the World Bank, the digital economy has grown 2.5 times faster over the previous ten years than the GDP contribution of the traditional economy[1].

2.1 Digital infrastructure development

According to data compiled by the Global Mobile Suppliers Association (GSA) that 578 operators in 173 countries and territories had committed substantially to investments in 5G networks (including trials, acquisition of licences, planning, network deployment and launches) as of September 2023. Furthermore, 290 operators in 113 countries and territories had launched 5G mobile services[3].

For fixed broadband, the global overall fixed broadband penetration rate is expected to be 70% by 2030. Around 52.3% of this will be full-fibre adoption as predicted by Point Topic[4]. According to Omdia[5], by the end of 2022 only 8% of global broadband subscriptions were at gigabit broadband speeds or above. This is expected to reach 32% of all subscriptions by 2027 and to then climb to over 40% by 2030, driven by an uptick in advanced digital home devices and surging requirements for higher bandwidth.



Source: Omdia

Figure 1: Take-up of gigabit speed broadband services is expected to accelerate

2.2 The characteristics of 10Gbps Society

The last few years have witnessed the rapid development of broadband networks, intelligent devices, cloud computing and now the nascent application of artificial intelligence. These digitally based technologies have greatly enriched humanity and become an indispensable part of our daily lives. Looking towards the future, information communication technologies (ICT) could provide even broader solutions and tools, leading to greater contributions. For example, wearable sensors and cloud computing that can better support the management of our overall health, provide timely preventive diagnosis and improved management of chronic diseases. Artificial Intelligence is already drastically cutting the duration of new drugs and vaccines development.

The Future Intelligent World is composed of intelligent education, intelligent entertainment, intelligent healthcare, intelligent cities, and intelligent manufacturing. Leading to a society where everyone could enjoy a high-quality life - improved health and longevity, more attractive living environments with an enhanced digital and traditional economy.

Within this future however, large volumes of data need to be transmitted. The network bandwidth needs to reach multi-Gbps to ensure a stable and reliable network. In scenarios such as autopilot, virtual reality teaching, glasses free 3D games and remote surgery, network latency must reach millisecond or even microseconds to ensure an acceptable user experience. As well as providing the best levels of cybersecurity.

Scenarios such as intelligent cities and intelligent manufacturing will also require superior connectivity. In order to connect a large number of IoT sensing machines and equipment, the network needs to have massive connectivity capabilities to achieve communication between people and machines, as well as between machines. Additionally, the development and application of generative AI technologies place even higher requirements for latency, data volume transmission and analysis.

It is predicted that by 2030 the 10Gbps Society will be defined by the following requirements:

- With the widespread application of the Metaverse and holograms among other technologies, the demand for bandwidth will increase from Gbps to 10Gbps level.
- With ultra-low latency applications such as factory automation and remote healthcare, the demand for latency will reduce from 100ms to the millisecond level.
- The interconnection of all things will become a reality. The subsequent required number of connections will increase at least tenfold from connecting just people to connecting (every) things. The demand for connection capacity will reach millions per square kilometre.
- With emergency remote rescue, key industrial production, intelligent transportation and other high reliability requirement scenarios, the acceptable annual downtime for networks will fall from minute level to the second level. The availability rate will need to increase from 99.999% to 99.9999%.

In summary, moving towards a 10Gbps Society is the only way we will be able to evolve to a Future Intelligent World. The construction of a 10Gbps Society is not only a technical task, but also a holistic national endeavour, involving many aspects of society. It would require clear planning and inclusive agreement. We will need to make clear plans, strengthen technological research and innovation, promote coordinated industrial development, and establish and improve relevant laws, regulations, and standard systems.

2.3 10Gbps Society will drive us to an intelligent future

The upcoming intelligent future will create a connected, digital and intelligent environment, providing abundant modern application scenarios, touching all aspects of society. Some tangible examples of these are outlined below.

Intelligent education

- Virtual laboratories
- Virtual reality scenarios
- Interactive learning
- Virtual tutors

Future classroom technologies are expected to provide students with much more immersive experiences. In virtual labs, you will be able to watch scientific experiments in action, animations that help you understand many abstract concepts and videos for virtual visiting trips. Tailored individual education programs supported by AI will greatly improve average educational attainment. Virtual simulations will also make it possible to train professionals, such as firefighters or engineers, in more interactive and safer conditions.

Network requirements:

Without real-time and stable data transmission, dizziness may be induced in VR applications or insensitive control, which greatly reduces the quality of teaching and the student experience.

Single terminal bandwidth requires more than 80Mbps. If 50+ concurrent requirements are achieved, the total bandwidth requirement exceeds 4Gbps, the network needs to be continuously upgraded to 10Gbps[6].

- Bandwidth: 4Gbps+
- Latency: <20ms

Intelligent entertainment

- Metaverse gaming
- 16k/32k definition for streamed content
- Glasses-Free 3D
- Holographic simulations for tourism

The Future Intelligent World is where digital entertainment gets a huge upgrade and new modes of experience. In the metaverse, you might soon be doing ultra-realistic gaming, watching movies in 16k/32k resolution and using glasses-free 3D. But the requirements for digital infrastructure are high in order to enable compelling, innovative and fully immersive experiences.

Network requirements:

In metaverse gaming, the network needs to have sufficient bandwidth and stability, otherwise there will be problems such as game lags, latency problems and even game disconnection and screen distortion.

Glassless-free 3D also requires the network to provide clear and smooth 3D image transmission, otherwise problems such as blurry images and distorted 3D effects may occur. 16k/32k video streaming needs for films, TV and sports/music events also require high bandwidth capabilities.

A single glasses-free 3D has a network bandwidth requirement of over 1Gbps and a latency requirement of 1-5ms[7]. For a household with multiple bandwidth sensitive devices to be connected to the internet, the bandwidth requirement is above 5Gbps.

- Bandwidth: 1Gbps+ (per glasses-free 3D user)
- Latency: <5ms

Intelligent healthcare

- Remote examination and monitoring
- Early diagnosis through sensitive biosensors
- Remote robotic surgery
- AI supported medical imaging

The future of healthcare includes remote medical consultations, advanced diagnostic methods using sensitive biosensors and even remote surgery. For these innovations to work well, they need a network that can handle large amounts of medical data quickly and reliably. 10Gbps Society capabilities would make sure healthcare professionals can rely on their digital networks to provide the best care, no matter where the patient is located.

Network requirements:

Remote medicine often requires real-time transmission of a large amount of medical data, including X-rays and MRIs. Poor network performance can cause file transmission delays, affecting doctors' accurate judgments and creates inefficiencies.

The download speed of online medical image data is required to be above 2Gbps, based on downloading one CT or MRI image (800MB) within 3 seconds. Upgrading to 3D imaging, with a significant increase in data volume (6-8 times), the download speed requirement will exceed 10 Gbps. Remote surgery requires the highest level of network reliability, typically requiring end-to-end delay control at the millisecond level and delay jitter control at the microsecond level[6].

- Bandwidth: 2Gbps+/ 10Gbps+
- Latency: <10ms

Intelligent City

- Intelligent parking
- Intelligent traffic management
- Energy conservation and environmental efficiencies
- Environment management
- Public safety management
- Intelligent buildings

Smart cities are an essential aspect of the Future Intelligent World. Featuring intelligent parking, smart traffic and energy saving intelligent buildings. This vision requires a network that seamlessly interconnects vehicles, infrastructure and cloud systems. Nonetheless, it would require network upgrade investments in order to enable these smart city solutions, making people’s lives in cities more efficient and enjoyable.

Network requirements:

Taking intelligent parking and intelligent transportation management as an example, it is necessary to meet the communication requirements between vehicles, infrastructure, and cloud systems. The bandwidth requirement for a single vehicle is usually between 10Mbps and 100Mbps. If multiple vehicle data are concurrent, the bandwidth requirement will reach 10Gbps with a latency of less than 20ms [8] .

- Bandwidth: 10-100Mbps+ (per vehicle)
- Latency: <20ms

Intelligent productivity

- Dark factory
- 3D AOI quality inspection
- Digital twin
- Flexible manufacturing

Technology such as digital twins and high-level quality inspection systems are going to be fundamentals for the fourth industrial revolution. But these technologies rely on the availability of a stable and high-speed network. Therefore, we are concentrating on ensuring that our networks are upgraded to support such innovations. This will in turn result in more efficient, sustainable and agile manufacturing.

Network requirements:

If there is a notable latency in the network, the control of equipment may malfunction or err, leading to an increase in equipment failure rates, impairing the production process.

Take 3D AOI as an example. Assuming 5-6 industrial cameras are used for detection, the single channel bandwidth requirement is 12 Gbps, the total bandwidth requirement is 60 Gbps-72 Gbps and the network transmission delay requirement should not be greater than 8ms[6].

- Bandwidth: 12Gbps (per channel)
- Latency: <8ms

3. SAUDI ARABIA DIGITAL INFRASTRUCTURE DEVELOPMENT

Facilitating digital transformation throughout society is likely to be one of the key enablers for realising many of the goals of the Vision 2030 plan. But in order to achieve the best outcomes, it is crucial that the country first establishes a robust and superior digital infrastructure that accelerates the overall digital transformation of the Kingdom and lays the foundation for a futuristic world. An advanced network infrastructure with high speed, low latency, wide coverage, and massive connectivity. A connected, digital and intelligent world with abundant modern application scenarios, covering all aspects of society. One which will stimulate economic diversification, foster greater national resilience and create a prosperous future for the people of the KSA. What could be best described as a Future Intelligent World. As a helpful corollary, the 10Gbps Society creates such an intelligent and connected world, elevates ICT services and supports scenarios for connected individuals, connected homes, and connected enterprises. Therefore, it is necessary to evolve towards a 10Gbps Society to ensure the success of Vision 2030.

More recently in the KSA, there has been a shift towards fixed broadband networks, with the granting of unified licences, government-subsidised fibre deployment and an increasing commercial and government push to expand the take-up of FTTH services. When one considers the distinct advantages of FTTH and FWA technologies, both access technologies are expected to be utilised for home broadband in the long term.

3.1 Mobile broadband development

According to the latest report from CST[9], the KSA's 4G network population coverage is an impressive 98%. 5G network population coverage has already exceeded the half-way point at around 53%, with an average 327Mbps downlink speed. But in certain urban areas such as in Riyadh, 5G network coverage is at 94%. In 2023, the number of 5G towers had increased to more than 16,000, based on the number of 5G towers announced by the operators [10] [11], which means that the number of 5G towers per 10,000 people had reached nearly 4.4. This number is set to increase as the allocation of new spectrum aligns with the growing appetite for high-speed mobile internet services. Mobile subscriptions in the KSA keeps increasing with the 5G user penetration rate at around 30%. Mobile broadband remains the primary mode to access the internet in the KSA. By Q3 2023, the KSA has over 48.2 million mobile broadband subscribers, with a penetration rate of 132.3%[12].

3.2 Fixed broadband development

The FTTH network has undergone a substantial expansion, resulting in an impressive total of 3.7 million homes across the Kingdom now having access to fibre coverage[13]. According to data from Omdia, the FTTB penetration was 82% by the end of 2022[5].

The kingdom is keenly aware of the crucial role that high-speed fixed broadband plays in the digital lives and work of its citizens. Consequently, it has implemented a series of measures to boost network speeds. A notable initiative is the introduction of the 300Mbps entry package. In response, major operators such as STC, Zain, Mobily, and Salam have rolled out subscription plans that guarantee a minimum speed of 300Mbps. Furthermore, STC, Mobily, and Salam have gone a step further by offering a 1Gbps subscription plan. Additionally, STC, Zain, and Salam have introduced the advanced FTTR (Fibre to the Room) service. These proactive steps by the operators are set to significantly enhance the broadband experience and elevate the kingdom's position in global internet speed rankings.

3.3 Building the regional digital hub

The KSA aims to place the country as a leading global connectivity and computing nation but also as a regional digital hub by 2030[14]. This includes positioning the KSA as a connectivity hub and a computing hub. Relevant national level initiatives and achievements are as follows:

The KSA's Internet Exchange Point (IXP). Till November 2023, the SAIX has 23 connected members, 65 connected ports, 177 total ASNs, more than 17,000 IPv4 prefixes and 7,000 IPv6 prefixes. Peak and average traffic of IXP reached 361.04Gbps and 140.2Gbps respectively[15].

IPv6 adoption. Since 2018, the KSA has actively promoted IPv6 deployment by forming a national action team, developing a clear strategy and setting up KPIs for operators[16]. In 2023, the KSA has achieved a 60% IPv6 adoption rate, placing the nation 8th globally.

Data centres. MCIT has actively supported investors in developing appropriate operating models and assisting with the issuing of building permits and licenses. Data Center capacity in the KSA has consequently increased from 90 MW in 2021 to 122.4 MW in 2022[17].

4. THE PATH TO A 10Gbps SOCIETY

Despite the immense progress made in the 5G era so far with regard to the build-out of digital infrastructure, much more development still needs to take place to realise the capabilities of the 10Gbps society. Within this future, large volumes of data need to be transmitted.

To better define the requirements and metrics for the 10Gbps Society, an updated set of technical targets and supporting determinants are outlined below for reference to all stakeholders.

For mobile broadband networks, 5G carrier aggregation and mmWave are expected to support an acceleration in data transmission speeds. 5G will become the dominant mobile access technology subscription type by 2028. It is projected that North America and the GCC countries will have the highest 5G penetration in 2029 at 92%[17]. Aiming to support the throughput and capacity needed, the 5G second carrier are expected to be made available to a minimum of 80% of telecom towers. The mmWave deployment could be deployed on-demand through hotspots in dense urban areas. According to the report about Indoor 5G Scenario Oriented White Paper[18], It was predicted that 80% of data traffic will occur indoors in 5G era. In China, one of the criteria for Giga City is that the 5G indoor coverage in key places reaches 80%. Refer to China's MIIT defined "Giga City" criteria in 2021[19], the 5G coverage rate in key areas is required to reach 80% to support a wide range of applications and services, further more all those benchmark reference could be applied to the criteria of 10Gbps society.

For fixed broadband networks, the FTTP gigabit and higher subscription plan will need to be highly inclusive, with FTTP being made available to more than 95% of households. Fibre access technology will need upgrading from GPON to 10GPON/50GPON. As forecasted by Omdia[20], ninety-eight percent of ports shipped will be 10G or higher by 2027 in North America. In a move to position itself as a global benchmark in the digital economy, Beijing, China, has unveiled the ambitious 10Gbps City Action Plan for 2025[21]. This comprehensive plan sets key performance indicators (KPIs) for digital infrastructure development, including achieving 80% Optical Transport Network (OTN) coverage in crucial areas, ensuring that 80% of ports are equipped with 10G PON technology, and aiming for 20% of subscribers to adopt Fiber to the Room (FTTR) services by 2025. To cater to the growing demand for gigabit services and ensure the best user experience, the deployment of 10G PON and 50G PON technologies is expected to accelerate. Concurrently, enhancing the backhaul network is crucial, this includes ensuring that 80% of 5G base stations and central office hubs are connected via fibre, laying a solid backhaul foundation.

For enterprise access networks, the Wi-Fi 7 will begin deployment from 2023. The Wi-Fi 8 standard is expected to be ready from 2028. As a key infrastructure asset for business and public internet access alike, Wi-Fi 7 adoption is expected to grow significantly over the next few years and will represent 45% of the Indoor APs shipped in 2027[22].

For the bearer and data centre networks scenario, the massive deployment of 400/800Gbps Ethernet (GE) will commence from 2024 and reach 40% penetration by 2027 in terms of port volume[23]. Furthermore, it's essential for all networks to embrace IPv6 advanced technologies, including Segment Routing over IPv6 (SRv6), network slicing, and digital mapping, to ensure enhanced efficiency, security, and scalability.

The 10Gbps Society requires key digital infrastructure that will be critical to implementing national digital strategies while also boosting the development of the digital economy. The transition to the 10Gbps Society involves

delivering 10Gbps to individuals, homes and enterprises. It also involves 400GE/800GE converged bearer networks and AI data centre networks related to the preceding three 10Gbps access scenarios.

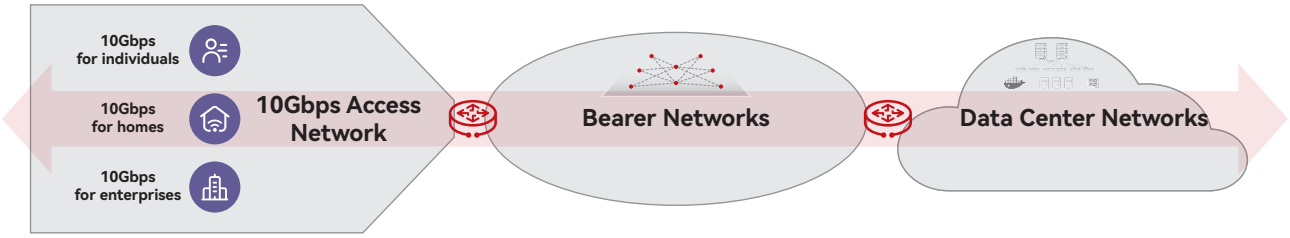


Figure 2: 10Gbps society end-to-end infrastructure

4.1 10Gbps for mobile broadband

Wireless technology has become an indispensable part of modern life, empowering individuals with the freedom to communicate, work, and access information wirelessly, irrespective of their physical location. The ubiquity and versatility of wireless connectivity has profoundly transformed the way individuals interact with the digital world. In order to accelerate the implementation of next generation technologies, the following planning and actions are suggested.

5G-Advanced is the technology bridge to 6G. The freeze of 3GPP Release-18 is expected by June 2024, marking the initial phase toward 5G-Advanced. This aims to enhance speed, coverage, mobility, power efficiency, and the expansion of mobile connectivity across all devices and use cases. It also guides the development of future 6G. In June 2023, ITU released the 6G Vision, furthering the evolution of 5G-Advanced. Saudi Telecom Company (stc) announced the success of advanced trials of 5G-Advanced technology with speeds exceeding 10Gbps at the end of July[24]. Other news reported that Zain KAS had successfully tested 5G-Advanced use cases, such as ambient-powered Passive IoT[25]. By 2024, significant progress in the deployment of 5G-Advanced is expected.

Allocate sufficient spectrum for mobile broadband or IMT services in advance. In 2023, Saudi CST planned the 5th spectrum auction for IMT networks in the frequency bands (600, 700, 3800) MHz[26]. Anticipating the demands of the 10Gbps Society, mmWave high bands are expected to be needed and released. Based on likely network coverage and capacity needs, the utilization strategy for multiple spectrum bands balance could be planned as follows:

- The "Coverage Layer" exploits spectrum below 1 GHz (low-band such as 700 MHz,600MHz) providing wide-area and in-depth coverage.
- The "Coverage and Capacity Layer" is a mid-band spectrum, such as C-band, 2.3GHz, 2.6GHz, which delivers the balanced capability between capacity and coverage.

- The "Super Capacity Layer" is spectrum of mmWave (high band such as 24.25–29.5 GHz), used to address specific use cases requiring extremely high data transfer rates.

Promote all band spectrum evolution to 5G. 4G/5G networks offer higher spectral efficiency, improved user experience and energy-saving benefits compared to older generation network technologies. A timely sunset of 2G and 3G services and repurposing of spectrum for 5G is suggested.

Accelerate the commercialization and coverage of 5G-Advanced technology. To be truly inclusive in terms of providing pervasive 10Gbps capabilities, we suggest the extension of 5G coverage at all levels, including national, provincial and local. Even to remote currently under-served areas of the country. 5G-Advanced as the key technology for achieving 10Gbps mobile connectivity should be commercially deployed as the obvious evolution of the current 5G network.

Enhance the policy of passive infrastructure sharing. Policymakers and regulators should encourage better physical infrastructure sharing by operators by opening-up more public facilities such as rooftops, bus stations and smart poles for the sector. This would incentivise operators to build base stations and better share resources like optical fibres, equipment rooms, pipelines and installation locations.

4.2 10Gbps for fixed broadband

The Future Intelligent Home is one of the cornerstones of the digital economy. It will be increasingly used as a remote workspace, but also as our entertainment hubs for cloud gaming and streaming video. In September 2022, ETSI released the Fixed 5th Generation Advanced and Beyond white paper[27]. This defined the core capabilities of F5G-Advanced, which will enable the user experience to reach 10Gbps through next-generation technologies such as FTTR, Wi-Fi 7, 50G PON and 800G. STC accomplished the 1st 50G PON live trial in the Middle East[28].

Comprehensive planning is needed to formulate a new national broadband plan. This will provide clear and ambitious goals for the 10Gbps Society and milestones for improved fixed broadband roll-out. By Nov of 2023, Mobily announced its unwavering commitment to accelerate the realization of Fixed 5th Generation Advanced (F5G-A), upgrading its Fiber-to-the-Home (FTTH) network from GPON to 10GPON technology, and the network capability of seamless upgrade to 50G PON, together with ultra long-haul 400G transmission[29].

Fibre pre-deployment policy for cost savings and avoid duplicated construction. We suggest that policymakers carefully assess the relevant fibre pre-deployment regulations and standards required. And make them mandatory (with checks and enforcement where necessary). Promoting the implementation of pre-deployment in new-build will undoubtedly save costs in aggregate and accelerate the time-to-market of the 10Gbps Society.

Ensure fair competition and coverage obligations. A 'Dig Once Policy' advocates that telecom infrastructure should be planned together with road, pipeline and power supply infrastructure construction thus avoiding unnecessary duplicated construction. We also suggest a simplification of the approval process, reduce RoW (Right of Way) costs, set new construction standards and finally, provide free access to public facilities.

4.3 10Gbps for enterprise network

For the enterprise scenario, providing a 10Gbps capability infrastructure will be paramount in order for businesses to best utilize cloud computing and AI solutions.

Enhance the enterprise digital infrastructure. The government, enterprise and public networks are encouraged to upgrade and evolve based on technologies such as Wi-Fi 7 and enterprise private line for 10Gbps enterprise. For new campuses, industry parks, public buildings and transport centers, it is suggested that they deploy Wi-Fi 7 at large scale.

Establish benchmark projects. The candidate pilot model applications would be advanced e-government initiatives, intelligent finance, scientific research, higher education and intelligent manufacturing. In line with Industry 4.0, factories will need to implement a wide range of IoT sensors and devices to enable data analytics, AI and machine-learning applications. Another possible action is building a number of innovative and high-quality 10Gbps campus infrastructure models to effectively support technological innovation, system tests and industry promotion.

4.4 Bearer and data center networks

This will require end-to-end architecture readiness with an ultra-low latency circle of 1ms within the city, 5ms within the country and 20ms across the region.

400GE/800GE Bearer Network. The bearer network will need to maintain fixed mobile converged (FMC) which enables ultra-reliable low-latency communications. According to the "Next-Generation Broadband Roadmap 2023 to 2030" released by WBBA[30], the IP bearer network needs to be gradually upgraded to 400GE/800GE technologies.

Accelerate IPv6 and IPv6 enhanced adoption. To further accelerate the IPv6 deployment, it is suggested that newly built networks should have IPv6 capability and encourage IPv6 Enhanced deployment such as SRv6, network slicing and digital map.

Optimize the capability of data center interconnections for the AI infrastructure. We finally suggest the enhancement of inter-data center connections and connections to enterprises through a high-bandwidth 400GE/800GE backbone solution.

5. ENABLERS TO ENSURE THE SUCCESSFUL IMPLEMENTATION OF THE 10Gbps SOCIETY

Achieving the 10Gbps Society will require multi-faceted regulation, coordination and innovation.

Regulatory excellence. Regulations are indispensable to the proper functioning of economies and societies. They underpin markets, protect the rights and safety of consumers as well as providing assurances to businesses while encouraging healthy competition. The quality of the regulatory environment has also been specifically proven to boost investment and development in ICT sector infrastructure roll-out.

Stakeholder engagement and coordination. Successful implementation necessitates the formation of a collaborative network comprising key entities such as the MCIT, CST, service providers and other relevant stakeholder groups. The overarching goal here is to ensure that all objectives are sufficiently communicated and that the required resources are integrated and aligned across all stakeholders.

R&D and innovation incubation. Enhancing R&D efforts are also crucial. To do this requires more government and private-sector investment, cultivation of human resources, the creation of innovation centers and the safeguarding of intellectual property so as to spur the technological breakthroughs that will underpin the 10Gbps Society.

International collaboration while increasing local content generation. Achieving the 10Gbps Society initiative will require global engagement and openness, especially in standardization and cross-border connectivity. Meanwhile, keep increasing the local content ratio and flavor. Boost the native digital ecosystem. Engaging in international bodies actively and attracting the best international partners will provide much-needed impetus and expertise.

Industry ecosystem development. Driving technological and application development in the 10Gbps commercial ecosystem will require extensive collaboration among different sectors and agents. Such as the formation of joint innovation labs by companies, universities and research institutes to explore commercial opportunities and go-to-market activities.

Talent cultivation. It is crucial that we prioritize the development of human capital, particularly in technological evolution, isolating useful data and change casting. Development of this talent will however be underpinned by investment in education and training programs.

Monitoring and evaluation. There must be a sound monitoring and evaluation system, with elaborate broadband development reports and user experience assessment instruments. This facilitates good decision making and will help keep the initiative on track.

Therefore, the 10Gbps Society requires effective policy making, integrated stakeholder management, R&D and innovation, industry ecosystem, international collaborations and talent development measures for successful implementation.

6. THE VALUE OF THE 10Gbps SOCIETY

The 10Gbps Society is expected to deliver significant economic, environmental and business value. The 10Gbps Society would greatly facilitate the implementation of Vision 2030 and national transformation, directly contribute to economic growth and job creation, and enhance the KSA's national economic competitiveness. Details on how follow.

6.1 Strategic value

The technical requirements for the 10Gbps Society would greatly improve national digital infrastructure capabilities. It would also provide a solid foundation to Vision 2030 which aims to build a vibrant society, a thriving economy and an ambitious nation[31]

In a highly dynamic and disruptive global digital economy, the 10Gbps Society would additionally empower the KSA with world-leading digital infrastructure. This could provide the foundation for a thriving domestic digital ecosystem and further foster national resilience. It would also help to build a world-class digital hub to connect MENA, Asia and Europe. This would also improve the attractiveness of the nation for foreign direct investment (FDI) in the digital sector, furthering the national goal of raising the relative and absolute contribution of non-oil based GDP.

6.2 Economic value

Academic research has reached the strong consensus that wider diffusion of digital infrastructure and increased speeds provide multiple beneficial economic impacts. See Information Telecommunications (2021) and bibliography for example.[32]

The 10Gbps Society would likely have a positive economic impact through multiple channels. The first would be through the direct impact stimulus of increased investment and consumption of ICT services. The second would be through the 10Gbps Society's ability to create wholly new business models, new digital products and services. Finally, productivity improvements stem from the proven beneficial impacts digital applications and solutions have by creating new efficiencies across all economic sectors. Meaning we can do more with less.

Direct channel. The dawn of the 10Gbps Society would drive an upsurge in investment and expenditure on cutting-edge ICT products and services, consequently bolstering the revenue of technology companies and thereby contributing to a direct increase in GDP. Based on the current trajectory and ongoing expansion plans within the telecommunications sector, it is projected that ICT's contribution to the KSA's GDP will witness a year-on-year growth rate of 6%,

reaching SAR 247 billion by 2030. Furthermore, with the emergence of the 10Gbps society, ICT's contribution to GDP is anticipated to rise by an additional 1%, equivalent to SAR 51 billion by 2030. The cumulative impact is estimated to be SAR 358 billion to 2030.

New business models' channel. It is widely agreed that the digital economy transitions through three phases and archetypes as it develops in maturity. We are most familiar with the initial 'Core' phase – this involves the traditional ICT sectors such as hardware manufacturing and software services. But as digitization leads to digitalization, a country's digital economy expands to the 'Narrow' phase. High-quality broadband networks can provide better online experiences, which has led to new internet businesses focussed around e-commerce, e-gaming, streaming videos and other online activities. This creates the many new business models we are familiar with today. But the intelligent scenarios as outlined in the 10Gbps Society takes us from digitalisation to full digital transformation of our economy and society. The so-called 'Broad' and final phase. This will lead us to wholly new business models centred around precision agriculture, intelligent healthcare, intelligent manufacturing, intelligent education, automated transportation and so on. All undergirded by superior digital networks, cloud computing, IoT, robotics and artificial intelligence.

Productivity improvement channel. The implementation of faster broadband speeds, driven by the 10Gbps Society, is expected to improve productivity rates and drive the transformation of businesses in various sectors across the KSA. Such digital adoption and the development of digital skills in the workplace, have already exhibited positive impacts on productivity in other countries. Academic research indicates that technology hardware investments and improved digital skills among employees can lead to significant productivity gains. Furthermore, investments in digital adoption platforms, automated learning technologies and robotics are projected to substantially boost productivity globally. The adoption of advanced technologies is also predicted to significantly contribute to economy-wide productivity, with the digital economy's current contribution to global GDP expected to reach 30% by 2030[33]. The KSA's digital transformation is projected to increase labour productivity and potentially reduce unemployment in the long term.[34]

Job creation. Digital transformation and adoption of new technologies will create jobs in the ICT sector and other industries. As a result of the 10Gbps Society initiative approximately 56,000 new jobs are expected to be created in the KSA by 2030. While automation may lead to some job displacement, a majority of experts anticipate that digital transformation in aggregate will actually generate a net-positive amount of employment opportunities.

6.3 Commercial value

The KSA's ICT sector is projected to reach $53 billion by 2025[35], driven by mega-projects, smart cities, healthcare, education, and tourism. Enhanced mobile and fixed broadband networks could facilitate hyper-connected communities and digital societies, offering new opportunities for operators and promote a myriad of intelligent lifestyle experiences.

New use cases like intelligent manufacturing and intelligent city applications are already emerging, improving enterprise efficiency and productivity through massively enhanced real-time communication. These various applications could support telecom operators by encouraging greater customer loyalty while also generating new revenue streams.

6.4 Environmental value

As part of the KSA's commitment to better global environmental sustainability, the KSA aspires to provide energy-neutral, zero-carbon, and zero-waste governance processes. The 10Gbps Society initiative facilitates improved environmental sustainability, promoting energy savings and reduced carbon emissions. For example, an optical fibre network is notably eco-friendlier, using 60-75% less energy than copper line[36].

The 10Gbps network employs AI intelligence and 5G-Advanced to optimize energy usage, while green data centers utilizing renewable energy sources further reduce carbon emissions. Moreover, the 10Gbps Society would provide greater flexibility to the way people live and work, and could thus have an impact on the average individual's carbon footprint. The pervasive application of remote working in the 10Gbps society will negate the need for energy intensive commutes which would decrease carbon emissions. In a report published by Ericsson, only the use of IoT has the potential of reducing emissions by as much as 63.5 gigatons by the year 2030 from global perspective[37].

7. CONCLUSION

In essence, a transition to the 10Gbps Society would place the KSA at the vanguard of leading countries fully exploring and benefiting from the digital decade. It is not just a technological leap, but a strategic move that profoundly enables the country as an early adopter of advanced digital infrastructure. Through the transformative power of the 10Gbps Society, the KSA seeks to stimulate a widespread digital revolution across both the public and the private sectors. This revolution is more than just making connections better; it is about changing the character of our economy, where the digital economy becomes a significant catalyst for our potential economic growth. In addition, it reflects the will to enhance the quality of life of its people through much greater digital inclusion, enhanced digital skills and a more vibrant economy. All realized in improved real-world daily experiences.

The 10Gbps Society will henceforth help illuminate a future where technology combines with progress and the KSA achieves its admirable aspirations for Vision 2030.

REFERENCES

[1] 'Digital Transition Framework: An action plan for public-private collaboration', World Economic Forum. Accessed: Dec. 24, 2023. [Online]. Available: https://www.weforum.org/publications/digital-transition-framework-an-action-plan-for-public-private-collaboration/

[2] Arya Devi, 'Digital economy to contribute 30% of global GDP and create 30 million jobs by 2030 - Edge Middle East'. Accessed: Dec. 24, 2023. [Online]. Available: https://www.edgemiddleeast.com/business/dco-2030-digital-economy-to-contribute-30-of-global-gdp-and-create-30-million-jobs-by-2030

[3] '5G-Market Snapshot November 2023', GSA. Accessed: Dec. 24, 2023. [Online]. Available: https://gsacom.com/paper/5g-market-snapshot-november-2023/

[4] J. Stanke, 'Global Fixed Broadband Take-up Forecasts by Technology for up to 2030', Point Topic. Accessed: Dec. 24, 2023. [Online]. Available: https://www.point-topic.com/post/global-fixed-broadband-2030

[5] 'Fiber Development Index: 2023 Omdia'. Accessed: Dec. 24, 2023. [Online]. Available: https://omdia.tech.informa.com/OM032629/Fiber-Development-Index-2023

[6] 'White Paper on Commercial Application Scenarios of 10 Gbps Broadband Network', Broadband Development Alliance, 2023.

[7] 'Intelligent World 2030', HUAWEI, 2021.

[8] 'White Paper on 5G-V2X Technology and Requirements', China Mobile, 2021.

[9] 'As The Largest and Fastest Growing Market in the Region.. CST Announced that the ICT Market in the Kingdom has reached 154 Billion SAR'. Accessed: Dec. 24, 2023. [Online]. Available: https://www.cst.gov.sa/en/mediacenter/pressreleases/Pages/2023030801.aspx

[10] 'Zain KSA Launches the Kingdom's First 5G Stand-Alone Network'. [Online]. Available: https://sa.zain.com/en/all-news/news-01-02-22

[11] 'STC Annual Report 2022', STC, 2023. [Online]. Available: https://www.stc.com.sa/content/stcgroupwebsite/sa/en/investors/financial-reports/reports/annual-reports.html

[12] 'GSMA Intelligence'. Dec. 24, 2023. Accessed: Dec. 24, 2023. [Online]. Available: https://data.gsmaintelligence.com/signin?returnPath=%2Fdata%2Foperator-metrics

[13] 'ICT Indicators Forum Reveals Saudi ICT Market as Largest in the MENA R', Telecom Review. Accessed: Dec. 25, 2023. [Online]. Available: https://www.telecomreview.com/articles/reports-and-coverage/6900-ict-indicators-forum-reveals-saudi-ict-market-as-largest-in-the-mena-region

[14] 'Saudi Arabia: A Tech-Powered Economy and Digital Hub - Telecom Review'. Accessed: Dec. 24, 2023. [Online]. Available: https://www.telecomreview.com/articles/reports-and-coverage/6228-saudi-arabia-a-tech-powered-economy-and-digital-hub

[15] 'Statistics - Saudi Arabian Internet Exchange'. Accessed: Dec. 24, 2023. [Online]. Available: https://www.saix.sa/en/services/statistics/

[16] 'CITC Annual Report 2021', CITC, 2022.

[17] 'MCIT Annual Report 2022', MCIT, 2022.

[18] 'Indoor 5G scenario Oriented White Paper', HKT, GSA, Huawei. [Online]. Available: https://carrier.huawei.com/~/media/CNBGV2/download/products/servies/Indoor-5G-Scenario-Oriented-White-Paper-en.pdf

[19] MIIT of China, 'The number of Giga City reaches 110'. Accessed: Dec. 26, 2023. [Online]. Available: http://www.news.cn/politics/2022-12/21/c_1129224609.htm

[20] JAIMIE LENDERMAN, JULIE KUNSTLER, 'How gigabit became the broadband standard Omdia'. Accessed: Dec. 26, 2023. [Online]. Available: https://omdia.tech.informa.com/OM024143/How-gigabit-became-the-broadband-standard

[21] 'Beijing 10Gbps City Action Plan 2023-2025'. Accessed: Dec. 26, 2023. [Online]. Available: http://www.ccidcom.com/guangchengzai/20230920/Q5fDdWdpBY3UsKXuW1ad64uk5keso.html

[22] DELL'ORO Group INC, 'Enterprise Class Wireless LAN—The Market Will Shift in 2024'. [Online]. Available: https://www.delloro.com/enterprise-class-wireless-lan-the-market-will-shift-in-2024

[23] DELL'ORO Group INC, 'Exploring the Data Center Switch and AI Networks Markets Landscape in 2024'. [Online]. Available: https://www.delloro.com/exploring-the-data-center-switch-and-ai-networks-markets-landscape-in-2024

[24] 'stc group announces success advanced trials fifth generation mmwave technology'. Accessed: Dec. 26, 2023. [Online]. Available: https://www.stc.com.sa/content/stcgroupwebsite/sa/ar/media-center/press-release/press-release-detail.html?id=stcgroup-announces-success-advanced-trials-fifth-generation-mmwave-technology

[25] Zain, 'New technological breakthrough unlocking new 5G capabilities'. [Online]. Available: https://sa.zain.com/en/all-news/news-22-6-2023

[26] 'CST announces the 5th Spectrum Auction for IMT Networks on the 16th of October 2023'. Accessed: Dec. 24, 2023. [Online]. Available: https://www.cst.gov.sa/en/mediacenter/pressreleases/Pages/2023091602.aspx

[27] 'ETSI - F5G - Fifth Generation Fixed Networks'. Accessed: Dec. 24, 2023. [Online]. Available: https://www.etsi.org/technologies/fifth-generation-fixed-network-f5g

[28] 'stc and Huawei accomplish the first 50G PON live trial in the Middle East', huawei. Accessed: Dec. 24, 2023. [Online]. Available: https://www.huawei.com/en/news/2023/2/first-50gpon-live-trail

[29] 'Mobily Paves the Way to Saudi Digital Society with Fixed 5th Generation Advanced (F5G-A)'. Accessed: Dec. 24, 2023. [Online]. Available: https://www.telecoms.com/fixed-networks/mobily-paves-the-way-to-saudi-digital-society-with-fixed-5th-generation-advanced-f5g-a-

[30] 'Next-Generation Broadband Roadmap 2023 to 2030', World Broadband Association: Broadband Industry | Global Telecom. Accessed: Dec. 24, 2023. [Online]. Available: https://worldbroadbandassociation.com/resources-videos/next-generation-broadband-roadmap-2023-to-2030/

[31] 'Saudi Vision 2030'. Accessed: Dec. 24, 2023. [Online]. Available: http://www.vision2030.gov.sa/en/

[32] R. Katz and J. J, The Economic Impact of Broadband and Digitization through the COVID-19 Pandemic,". International Telecommunications Union, 2021.

[33] Katz, R, 'Digital trust: How to unleash the trillion-dollar opportunity for our global economy', Ashewa Technology Solution (ATS) S.C. Accessed: Dec. 24, 2023. [Online]. Available: https://www.ashewatechnology.com/news-or-blog-detail?title=Digital-trust:-How-to-unleash-the-trillion-dollar-opportunity-for-our-global-economy&id=75

[34] M. Sarabdeen and H. Alofaysan, 'Investigating the Impact of Digital Transformation on the Labor Market in the Era of Changing Digital Transformation Dynamics in Saudi Arabia', Economies, vol. 11, no. 1, Art. no. 1, Jan. 2023, doi: 10.3390/economies11010012.

[35] 'The ICT sector in Saudi may reach $53 bln in 2025 - Economy Middle East'. Accessed: Dec. 24, 2023. [Online]. Available: https://economymiddleeast.com/news/the-ict-sector-in-saudi-may-reach-53-bln-in-2025/

[36] Kyra Mi, 'Connecting to a Green Future with Optical Networks', Huawei BLOG. Accessed: Dec. 24, 2023. [Online]. Available: //blog.huawei.com/en/post/2020/07/01/connecting-to-a-green-future-with-optical-networks

[37] Ericsson, 'ICT's potential to reduce greenhouse gas emissions in 2030'. Accessed: Dec. 24, 2023. [Online]. Available: https://www.ericsson.com/en/reports-and-papers/research-papers/exploring-the-effects-of-ict-solutions-on-ghg-emissions-in-2030

وزارة الاتصالات
وتقنية المعلومات
MINISTRY OF COMMUNICATIONS
AND INFORMATION TECHNOLOGY