# Final Report

## National Research and Education Network of Guinea-Bissau (RNEP-GB)


## West Africa Regional Digital Integration Program Guinea-Bissau

**July 2024**

# Contents

# Abbreviations

| Term | Description |
|---|---|
| **ACE** | Africa Coast to Europe (submarine fibre cable system) |
| **ARN-TIC** | Autoridade Reguladora Nacional (Telecom and ICT Regulator) |
| **ECOWAS** | Economic Community of West African States |
| **EMIS** | Education Management Information System |
| **GNI** | Gross National Income |
| **HEI** | Higher Education Institution |
| **ICT** | Information and Communications Technology |
| **IGE** | General Inspection of Education |
| **ITMA** | Instituto Tecnológico para Modernização Administrativa |
| **ITU** | International Telecommunications Union |
| **IXP** | Internet Exchange Point |
| **KCL** | Knowledge Consulting Ltd. |
| **LBSE** | Basic Education Law of Guinea-Bissau |
| **NREN** | National Research and Education Network |
| **MENESIC** | Ministério da Educação Nacional, Ensino Superior e Investigação Científica |
| **MTTED** | Ministry of Transport, Telecommunications and Digital Economy |
| **OMVG** | Gambia River Basin Development Organisation |
| **PEESIC** | Plan for Higher Education and Scientific Research |
| **PESTEL** | Political, Economic, Sociocultural, Technological, Environmental and Legal/Regulatory |
| **RNEP-GB** | Rede Nacional de Educação e Pesquisa da Guiné-Bissau |
| **SCGB** | Sociedade de Cabo da Guiné-Bissau |
| **TOR** | Terms of Reference |
| **UAF** | Universal Access Fund |
| **UEMOA** | West African Economic and Monetary Union |
| **USD** | United States Dollar |
| **WACREN** | West and Central African Research and Education Network |
| **WARDIP** | West African Regional Digital Integration Programme |

# Executive Summary

The Government of Guinea-Bissau is committed to improving the social and economic development of its people and has identified education as a key priority for progress, particularly in higher education. With a young and growing population expected to reach 2.5 million by 2030, the country's education system extends from pre-school to tertiary level under the Ministry of National Education, Higher Education and Scientific Research (MENESIC). The strategic plan, Terra Ranka, aims to combat poverty and inequality by improving access to basic services and achieving sustainable development goals by 2030.

Higher education institutions (HEIs) in Guinea-Bissau, including public and private universities and colleges mainly located in the capital, Bissau, lack comprehensive data on institutions and the use of digital technologies. The country has the lowest tertiary enrolment rate compared to the African average, highlighting the need for investment in infrastructure, qualified teachers and digital literacy in higher education.

The Ministry of Transport, Telecommunications and Digital Economy (MTTED) is leading Guinea-Bissau's digital transformation and broadband efforts. Despite the recent connection of the Africa Coast to Europe (ACE) submarine fibre-optic cable, challenges remain in deploying a national fibre-optic backbone to improve connectivity. With low 4G population coverage and unreliable access to electricity hampering the use of ICT in education, the ICT sector faces hurdles such as inadequate infrastructure, limited access to electricity and a shortage of skilled ICT professionals.

KCL's research sheds light on the educational landscape, revealing varying levels of internet access across higher education institutions and disparities in student-to-computer ratios. While some students have used computers and the internet in the last three months, ownership of digital tools such as smartphones, laptops and desktop computers remains limited. Teachers report inadequate support for ICT infrastructure, highlighting the need for training and investment in digital skills.

The establishment of the Rede Nacional de Educação e Pesquisa da Guiné-Bissau (RNEP-GB) is a key initiative to connect higher education institutions and strengthen governance and network management capacities for improved teaching, research and learning outcomes. RNEP-GB's goals include achieving global educational standards through broadband connectivity, fostering

collaboration, and providing essential services to promote national development impact.

RNEP-GB's priorities include building an advanced data network, providing educational applications and services, establishing governance structures and enhancing member capacity. The provision of high-speed connectivity and advanced services such as videoconferencing and high performance computing will benefit 32 higher education institutions across Guinea-Bissau. Joining the West and Central African Research and Education Network (WACREN) and securing the necessary resources and funding are essential for sustainable operations.

Capacity building is crucial to the success of RNEP-GB, with a focus on training programmes for technical and management staff to improve the efficiency of the network. Collaboration with regional bodies and twinning partnerships with established NRENs will facilitate knowledge sharing and the development of technical expertise. Sustainable funding through membership fees and service charges, together with effective communication and marketing strategies, will ensure the long-term success of RNEP-GB in strengthening higher education in Guinea-Bissau.

The proposed roadmap and action plan detail the phased approach to establishing RNEP-GB, focusing forming a legal entity, expanding the network and sustainable operations to achieve national coverage. With a clear vision and strategic priorities to guide its initiatives, RNEP-GB aims to revolutionise higher education in Guinea-Bissau through connectivity and capacity building.

# 1 Introduction

## 1.1 Background

Guinea-Bissau is one of the countries benefiting from the World Bank-funded West African Regional Digital Integration Programme (WARDIP). The project aims to help Guinea-Bissau create an enabling environment for digital transformation by promoting innovation and competitiveness in the regional digital single market.

> *"Digital skills are the bedrock of a digital economy and are poised to increase in importance (World Bank, 2019b). …., a digitally literate population is a prerequisite for the development and growth of a country's digital economy. To function effectively, however, digital literacy requires an enabling infrastructure—i.e., stable electricity, reliable broadband internet connectivity, and technology devices—particularly across the education sector, as well as an enabling policy environment with a unifying digital skills strategy as part of the broad education sector strategy plan.*[1]

To contribute to the achievement of the high-level objectives, WARDIP has contracted Knowledge Consulting Limited (KCL) to assist the Government of Guinea-Bissau in carrying out feasibility and technical studies for the establishment of a National Research and Education Network (NREN). The project includes an assessment of the capacities required for the NREN, its connectivity to regional networks such as WACREN, and its uses. NRENs have been shown elsewhere to be key contributors to the sustainable digitisation of Higher Education Institutions (HEIs).[2,3,4] They address national, regional, and global connectivity needs for access to online educational and research resources and applications. NRENs facilitate national, regional, and global research collaboration.

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[1] World Bank, 2019, Digital Economy Diagnostics: Guinea Bissau, https://documents1.worldbank.org/curated/en/099745006262216743/pdf/P177016084979202b08dd501a5690c82506.pdf

[2] See e.g. https://casefornrens.org,

[3] https://kcl.co.ug/breaking-the-final-connectivity-barriers-for-higher-education-institutions-in-africa-the-next-steps-and-a-call-to-action/

[4] https://kcl.co.ug/broadband-connectivity-a-critical-enabler-for-modernizing-higher-education-institutions-in-africa/

## 1.2 Approach

The contract included a number of key activities, including an assessment of the connectivity needs of higher education institutions in Guinea-Bissau, the organisation of study tours and training for selected individuals in Togo and Mozambique to understand management and ownership options/business models, the development of a proposal for the establishment of a NREN in Guinea-Bissau, the development of a roadmap and action plan for the establishment of the proposed NREN, and the organisation of various stakeholder consultations and validation activities in Guinea-Bissau. The consultancy produced a number of reports, including:

i. An inception report
ii. A study tour report
iii. An assessment of higher education connectivity needs and cost options
iv. A proposal for the establishment of a NREN in Guinea-Bissau
v. A roadmap and action plan for the proposed NREN

This final Report integrates and summarises all the previous reports into one document.

## 1.3 Report Layout

This final report is divided into six chapters, including this introduction.

Section 2 discusses the social and economic environment of Guinea-Bissau that underpins the development of a National Research and Education Network (NREN). This covers the education sector in general and the tertiary education sub-sector in particular. It considers the status of various components that underpin broadband connectivity, including infrastructure, access, skills and utility, which are relevant to NREN development in Guinea-Bissau.

Section 3 presents the results of two surveys conducted by KCL to understand the needs of students and staff at different higher education institutions in Guinea-Bissau and the institutional readiness to use ICT for teaching and learning.

Section 4 summarises the training workshops and study tours to Togo and Mozambique, which have helped to raise awareness of NREN opportunities and challenges among a wide range of stakeholders in Guinea-Bissau. They have also helped to create a critical mass of stakeholders in Guinea-Bissau who appreciate the potential benefits of establishing an NREN, understand potential management and ownership options/business models, and have insight into the technical set-up and operation of an NREN.

Section 5 summarises the proposal for the establishment of RNEP-GB, including the vision, mission and objective for the networking of higher education and research institutions in Guinea-Bissau. It then explores how the objective will be achieved through the pursuit of five strategic priorities, which include establishing the institutional framework, deploying a scalable data network, providing applications and services, building the capacity of RNEP-GB members and staff, and promoting the sustainable operation of RNEP-GB.

Section 6 details the Roadmap and Action Plan, which sequentially outlines what needs to be done and when, along with timelines and costs for each of the strategic priorities discussed in the previous section.

Section 7 concludes the report.

# 2 Context and Connectivity Gaps in Higher Education

The Government of Guinea-Bissau is committed to social and economic development and improving citizens' quality of life. Education is one of the government's key priorities in achieving social and economic transformation. The Government has adopted several strategies to enhance connectivity and development in the education sector, especially higher education.

## 2.1 National Context

Guinea-Bissau is a coastal state in West Africa, covering an area of approximately 36,125 square kilometres. It is bordered by Senegal to the north, Guinea to the south and east, and the Atlantic Ocean to the west.

*Source: UN Department of Field Support*


*Figure 1: Administrative Map of Guinea-Bissau*

For administrative purposes, the country is divided into eight regions and one autonomous sector, which in turn are subdivided into 37 sectors. According to United Nations projections, Guinea-Bissau's population was 2.1 million in 2022 and is expected to grow to 2.5 million by 2030.[5]

The population of Guinea-Bissau is predominantly young, with 50.3% of the population aged 19 years and under. 46.5% of the population falls between 20 and 64 years, and the rest are 65 years and above. There are approximately 974 men per 1000 women, indicating a slightly higher number of women in the country.[6]

About 45% of the population lives in urban areas[7], and mainly coastal cities, with the capital, Bissau, home to around a fifth of the total population. Other coastal cities such as Bafatá and Gabú also have significant populations, partly due to their role as administrative centres and access to trade routes. 54.8% of HEIs are also located in the Bissau region.[8] This urban concentration of HEIs makes reaching each with high-speed broadband easier.

Guinea-Bissau's Strategic and Operational Plan for 2015-2025 "Terra Ranka,"[9] is the country's overarching guide to sustainable development. The operational plan aims to reduce poverty and inequalities throughout the country by improving access to basic services and to achieve the Sustainable Development Goals by 2030 through targeted interventions and strategic investments in key sectors of the economy. The plan defines five strategic axes for the development of Guinea-Bissau - peace and governance, biodiversity and natural capital, infrastructure (which includes improving ICT infrastructure and access to electricity) and urban development, human development and the business framework.

Two of the plan's priority areas of intervention are infrastructure development—including digital infrastructure to improve connectivity within the country and with neighbouring regions, and education—improving access to quality education, particularly in rural areas where access is limited. Investment in telecommunications infrastructure (along with other infrastructure such as roads, electricity, schools, etc.) is seen as essential to facilitate access to information, promote digital inclusion, and stimulate innovation and economic growth.

[5] https://population.un.org/wpp/

[6] https://population.un.org/dataportal/

[7] https://futures.issafrica.org/geographic/countries/guinea-bissau

[8] https://www.fecongd.org/wp-content/uploads/2022/12/ESIC_2022_web.pdf

[9] https://one.oecd.org/document/DCD/DAC/RD(2015)15/RD2/En/pdf

Investment in education is seen as important to empower individuals, build human capital, and lay the foundations for sustainable economic growth and social progress.

## 2.2 Higher Education in Guinea-Bissau

Education in Guinea-Bissau comprises pre-primary, primary, secondary and tertiary levels. The Ministry of National Education, Higher Education and Scientific Research (MENESIC) oversees and regulates the education sector. MENESIC formulates policies and strategies to develop the education sector, regulates the operation of educational institutions, including HEIs, promotes and supports scientific research activities as well as allocates and manages resources for the education sector. MENESIC has great interest in the establishment of an NREN in Guinea-Bissau.

The main education sector laws that impact higher education include the Basic Education Law of Guinea-Bissau (LBSE) (Law 4/2011)[10] and the Higher Education and Scientific Research Law (Law No. 3/2011). The LBSE defines the organisation, management and operation of the education system and addresses issues related to curriculum development, teacher training, school infrastructure, educational standards and quality assurance while the Higher Education and Scientific Research Law outlines the principles, objectives, and regulations governing higher education and scientific research in Guinea-Bissau. Additionally, the LBSE recognizes ICT as a crucial educational resource (Article 54) and highlights its potential to facilitate distance learning at all education levels (Article 36).

Higher Education Institutions (HEIs) are the main beneficiaries of the establishment of a NREN. Success requires that their needs are quantified and that their priorities, preferences and aspirations are central to the process. HEIs in Guinea-Bissau include universities and colleges, comprising public and private institutions, all of which currently offer undergraduate education only. Most institutions are located in Bissau, the capital, and only twelve of the thirty-two HEIs (37.5%) are public institutions, as shown in Table 1. Data collected in 2024 shows that there were 19,369 students and 1,859 staff in higher education institutions in Guinea-Bissau.

10 https://www.unesco.org/education/edurights/media/docs/66ed11bae55d3ab337a6c6d2f0b8a69be4fe5638.pdf

*Table 1: Location, ownership, enrolment and staffing of targeted higher education institutions*

| | Institution | Region | Sector | Ownership | Students | Staff | Total |
|---|---|---|---|---|---|---|---|
| **1** | Bimantecs | Bissau | Bissau | Private | 836 | 75 | 911 |
| **2** | Centro de Formação de Professores | Oio | Mansoa | Private | 560 | 15 | 575 |
| **3** | Centro de Formação de Professores "O Pedagogo" | Gabú | Gabú | Private | 466 | 28 | 494 |
| **4** | Centro de Formação Domingos Ramos | Bafata | Bafatá | Public | 510 | 55 | 565 |
| **5** | Escola de Formação Amílcar Cabral (ESE) | Bolama | Bolama | Public | 1,141 | 37 | 1,178 |
| **6** | Escola de Formação Serifo Fall Camara (ESE – Unidade Buba) | Quinara | Buba | Public | 865 | 51 | 916 |
| **7** | Escola de Formação Superior "DNS" | Cacheu | Cacheu | Private | 47 | 12 | 59 |
| **8** | Escola Formação de Professores Domingos Mendonça (ESE – Unidade Cacheu) | Cacheu | Cacheu | Public | 909 | 99 | 1,008 |
| **9** | Escola Nacional da Educação Física e Desportos | Bissau | Zona-V | Public | 374 | 53 | 427 |
| **10** | Escola Nacional de Administração (ENA) | Bissau | Bissau | Public | 3,200 | 207 | 3,407 |
| **11** | Escola Nacional de Saúde | Biombo | Prábis | Public | 780 | 89 | 869 |
| **12** | Escola Normal 17 de Fevereiro | Bissau | Zona-V | Public | 558 | 61 | 619 |
| **13** | Escola Normal Superior Tchico Té | Bissau | Zona-V | Public | 2,040 | 122 | 2,162 |
| **14** | Escola Superior de Informática | Bissau | Zona-V | Private | 204 | 22 | 226 |
| **15** | Faculdade de Direito de Bissau | Bissau | Zona-V | Public | 280 | 15 | 35 |
| **16** | Faculdade de Medicina | Bissau | Bissau | Public | 492 | 42 | 534 |
| **17** | Instituto de Formação Superior (Bissorã) | Oio | Bissorã | Private | 213 | 27 | 240 |
| **18** | Instituto de Formação Superior (Farim) | Oio | Farim | Private | 169 | 16 | 185 |
| **19** | Instituto Nacional de Pedagogia e Administração Educacional | Bissau | Zona-I | Private | 127 | 15 | 142 |
| **20** | Instituto S. Politécnico São Francisco de Assis | Bissau | Bissau | Private | 234 | 44 | 278 |
| **21** | Instituto Superior de Formação Mompó | Bissau | Bissau | Private | 43 | 4 | 47 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **22** | Instituto Superior de Gestão (ISG) | Bissau | Zona-V | Private | 204 | 23 | 227 |
| **23** | Instituto Superior Horizonte | Bissau | Bissau | Private | 400 | 57 | 457 |
| **24** | Instituto Superior Nova Esperança (IP9) | Bissau | Zona-I | Private | 538 | 101 | 639 |
| **25** | Universidade Amílcar Cabral | Bissau | Bissau | Public | 831 | 54 | 885 |
| **26** | Universidade Católica da Guiné-Bissau (UCGB) | Biombo | Prábis | Private | 221 | 58 | 279 |
| **27** | Universidade Colinas de Boé | Biombo | Safim | Private | 783 | 63 | 846 |
| **28** | Universidade Jean Piaget | Bissau | Bissau | Private | 1,120 | 125 | 1,245 |
| **29** | Universidade Livre de Bissau | Biombo | Safim | Private | 371 | 44 | 415 |
| **30** | Universidade Lusófona da Guiné | Bissau | Bissau | Private | 1,500 | 201 | 1,701 |
| **31** | Universidade Nova da Guiné | Bissau | Bissau | Private | 223 | 10 | 233 |
| **32** | Universidade Virtual Africana na Guiné-Bissau (UVAGB) | Bissau | Bissau | Private | 250 | 34 | 284 |

*Source: Institutional Survey of Higher Education Institutions (white rows)*

*Source: FEC, Diagnostic Study of Higher Education and Scientific Research: Opportunities and Recommendations (grey rows)*

There is a lack of data on higher education institutions in general and on the use of digital technology in particular in Guinea-Bissau. There is a lack of data on the most basic statistics, such as the number and location of schools, teachers, students, etc. The last reliable data on education dates from 2014-2015. Guinea-Bissau has the lowest tertiary enrolment rate compared to the African average. Data show that the enrolment rate in the 2020s was 2.6%, well below the African average of 9.4%.[11]

From an education sector perspective, several challenges hinder the use of ICT in higher education:

i. Low access to education and poor quality, especially in rural areas, due to inadequate government funding (only 2.7% instead of the 20% as envisaged in the education plan)[12,13]
ii. Lack of qualified teachers with digital literacy skills to promote the use of ICT in institutions and lack of ICT professionals to support campus networks and institutional systems.
iii. Brain drain as professionals leave for postgraduate education abroad, affecting the availability of teachers and ICT professionals.[14]
iv. Inadequate digital infrastructure in higher education institutions, with most operations still manual and paper-based.
v. Lack of a functional Education Management Information System (EMIS) within MENESIC, leading to data challenges for effective planning and monitoring. The most recent publicly available administrative data is the 2014/2015 school yearbook, published with support from UNESCO.

Investment in infrastructure such as computers and broadband services is crucial. Government and the private sector should work together to improve access to equipment and internet services in the education sector. These challenges need to be addressed to increase the use of ICTs and improve the quality of education in higher education institutions in Guinea-Bissau.

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[11] World Bank, Sub Sharan Tertiary Education, https://thedocs.worldbank.org/en/doc/908af3404023a2c31ef34853bba4fe60-0200022022/original/One-Africa-TE-and-COVID-19-11102021.pdf

[12] https://data.worldbank.org/indicator/SE.XPD.TOTL.GD.ZS?locations=GW

[13] Programme sectoriel de l'éducation de la Guiné-Bissau pour 2017-2025, https://www.globalpartnership.org/fr/node/document/download?file=document/file/2018-10-guinea-bissau-esp-2017-2025.pdf

[14] https://rtpafrica.rtp.pt/noticias/guine-bissau-ministerio-da-educacao-precisa-contratar-cerca-de-tres-mil-professores/

## 2.3 Broadband Connectivity in Guinea-Bissau

The Ministry of Transport, Telecommunications, and Digital Economy (MTTED) oversees transport, telecommunications, and digital economy sectors in Guinea-Bissau. Leading the country's digital transformation through the Terra Ranka strategy, MTTED sets policies, regulations, and standards for ICT, providing crucial support for establishing an NREN in the country. Other key institutions include the National Regulatory Authority that oversees the ICT sector, Autoridade Reguladora Nacional (ARN)[15] and the nascent Instituto Tecnológico para a Modernização Administrativa (ITMA)[16] that oversees e-government applications and services.

The main regulation that governs the ICT sector in Guinea-Bissau is Law No. 5/2010, known as the Fundamental Law of Information and Communication Technologies (ICT).[17] The law defines ICT as "the technology used to collect, store, use and transmit information, including technologies that use computers and communication systems," with provisions for universal access and affordability. It also outlines stakeholder roles and responsibilities. Following the promulgation of Fundamental Law of Information and Communication Technologies (ICT), a number of decrees have been issued to guide and regulate the ICT sector.[18]

The telecommunications market in Guinea-Bissau is dominated by two licensed operators, Orange Guinea-Bissau and MTN Guinea-Bissau, both of whom provide mobile services and fixed broadband services.

Guinea-Bissau recently connected to the ACE submarine fibre-optic cable through the WARDIP project,[19] although activation is pending due to technical issues. As shown in Figure 2, the ACE lands in the town of Suro, with a 33 km connection to the Antula power plant on the outskirts of Bissau, the same landing point for the fibre-optic cable on the power transmission line of the Gambia River Basin Development Organisation (OMVG) energy project.[20] The submarine landing station is owned and operated by Sociedade de Cabo da Guiné-Bissau (SCGB), a partnership between the government (49%) and licensed private operators Orange and MTN (51%).[20] Guinea-Bissau has also joined six ECOWAS members in a bid to build the Amilcar Cabral submarine cable from Cape Verde to Guinea

[15] https://arn.gw/

[16] https://www.itma.gw/

[17] https://arn.gw/activeapp/wp-content/uploads/2015/03/3.-%C2%A6SUP.-B.-O.-N.-%C2%A6-21-2010.pdf

[18] Guinea-Bissau – Digital Economy Diagnostic (English). Washington, D.C.: World Bank Group

[19] https://ace-submarinecable.com/en/guinea-bissau-connects-to-ace-submarine-cable/

[20] Guinea-Bissau – Digital Economy Diagnostic (English). Washington, D.C.: World Bank Group

Conakry.[21] The region's use of international bandwidth lags behind the African and world average, suggesting growth opportunities.

*Source: Hamilton Research*

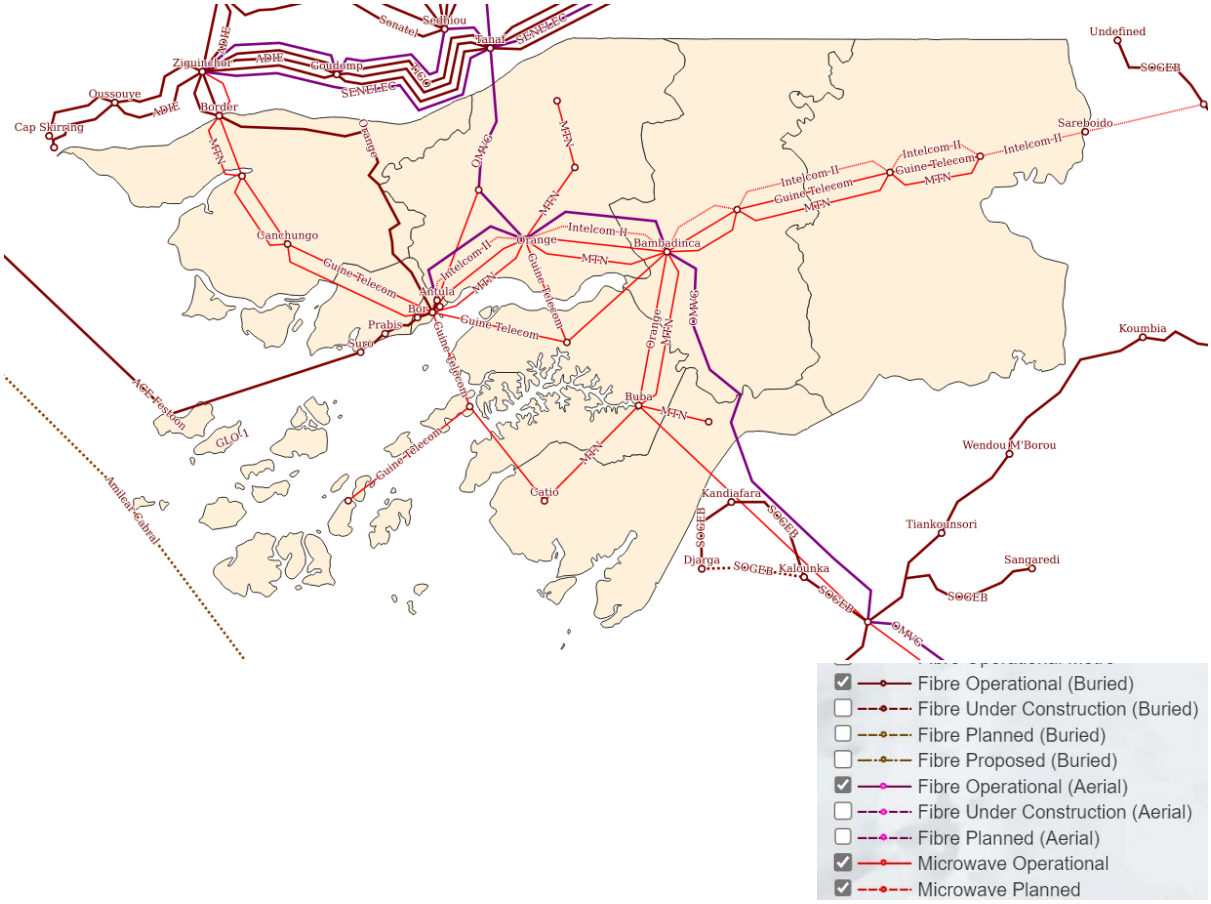


*Figure 2: International fibre cables and internal networks*

Guinea-Bissau still lacks a national fibre backbone that provides backhaul across the country, critical for digital connectivity and inclusion. Most of the country is still largely served by microwave links and lags far behind the rest of its UEMOA peers (see Table 2). Investment in fibre infrastructure is crucial for future broadband development.

*Table 2: National fibre network lengths*

| Country | Population (millions) | Area (1,000 sqkm) | Operational fibre routes | | Population within reach of a fibre node | | |
|---|---|---|---|---|---|---|---|
| | | | Km | Per 1,000 sqkm | % within 10-km | % within 25-km | % within 50-km |

[21] https://www.au-pida.org/project/construction-of-amilcar-cabral-submarine-cable-system/

| **Guinea-Bissau** | **2.1** | **36.1** | **112** | **3.1** | **22.4** | **29.5** | **54.8** |
|---|---|---|---|---|---|---|---|
| Benin | 13.4 | 112.7 | 5,146 | 45.7 | 71.6 | 86 | 99.4 |
| Burkina Faso | 22.7 | 273.6 | 5,342 | 19.5 | 29.4 | 69.7 | 86.3 |
| Ivory Coast | 28.2 | 318 | 27,109 | 85.2 | 40 | 67.9 | 95.3 |
| Mali | 22.6 | 1,220.2 | 6,872 | 5.6 | 23.3 | 39.2 | 61.8 |
| Niger | 26.2 | 1,226.7 | 4,008 | 3.3 | 20.6 | 46.5 | 78 |
| Senegal | 17.3 | 192.5 | 11,957 | 62.1 | 59.8 | 86.5 | 97.7 |
| Togo | 8.8 | 54.4 | 2,467 | 45.3 | 39.1 | 76 | 97.8 |

*Source: World Development Indicators (2022), Africa Bandwidth Maps (2023)*

4G population coverage in Guinea-Bissau was 31% in 2022, which is low compared to other UEMOA peers, some of which, such as Togo (96%), Senegal (95%) and Côte d'Ivoire (91%), are on track to achieve universal coverage.

Access to reliable electricity is still a major challenge in Guinea-Bissau. Electricity availability is largely confined to Bissau and other urban areas, demand far exceeds supply, and reliability is also an issue due to low generation capacity.[22,23]

The country's electrification rate is below the SSA average at all levels, which will have a major impact on the use of ICT for teaching and learning throughout the country. On the positive side, the government has invested in power plants to increase generation capacity, and the construction of the OMVG regional power line is in its final stages, which will allow Guinea-Bissau to import more electricity from its neighbours at a lower cost.

In sum, the ICT sector in Guinea-Bissau faces several challenges that hinder the use of ICT in higher education:

i. Inadequate development and deployment of ICT infrastructure, particularly in rural and remote areas of the country, which limits access to Internet services. This is exacerbated by duplication of infrastructure, lack of coordination and real sharing of infrastructure.[24]

ii. Limited access to electricity in non-urban areas, making it difficult and expensive to establish and maintain Internet connectivity.

[22] https://africa-energy-portal.org/aep/country/guinea-bissau

[23] https://www.reuters.com/world/africa/bissau-darkness-after-turkish-power-firm-cuts-off-supply-2023-10-17/

[24] https://arn.gw/activeapp/wp-content/uploads/2019/10/BOLETIM-2%C2%BA-sup-n%C2%BA45-Partilha-de-Infraestrutura.pdf

iii. Shortage of skilled ICT professionals, with few competent staff in higher education institutions to support the use of ICT in teaching and learning.

iv. The high cost of ICT equipment and Internet services relative to income levels hinders the widespread use of ICT.

v. Inefficient coordination of ICT initiatives across government ministries and departments, leading to duplication of effort and waste of resources.

vi. Lack of a clear digital governance framework to address key issues such as privacy, data protection, and cybersecurity, and to ensure better coordination between key agencies such as ARN and ITMA.

Addressing these challenges is critical for Guinea-Bissau to foster a thriving digital environment for individuals and institutions in the country, which is necessary for digital transformation and development.

# 3 Survey of Students and Staff

Due to the lack of educational data, KCL conducted two surveys to better understand the needs of students and staff at different institutions and the institutional readiness to use ICT for teaching and learning. For the institutional survey, KCL received a response from 10 higher education institutions, while for the student and staff survey, KCL received a total of 175 responses, of which 63% were from students and 37% from staff.

The survey results indicate a low level of ICT use by students and staff in higher education, due to limited device ownership and a lack of digital infrastructure in institutions. The results are summarised in the following sections.

## 3.1 Access to Computers and the Internet

In the institutional survey, seven out of ten responding institutions reported having access to the Internet. Six of them used GSM modems (4G) as the connection method and one had a microwave connection, as shown in Table 3. In terms of access to computers, the ratio of students per computer varies widely between institutions, from a low of one computer per 78 students to a high of one computer per 10 students.

*Table 3: Internet access and type of Internet connection among institutional survey respondents*

| Institution | Internet Access | Connection Type |
|---|---|---|
| **Bimantecs** | Yes | Microwave connection |
| **Centro de Formação de Professores** | Yes | GSM modem (4G) |
| **Centro de Formação Domingos Ramos** | Yes | GSM modem (4G) |
| **Escola de Formação Serifo Fall Camara (ESE)** | None | |
| **Escola Formação de Professores Domingos Mendonça (ESE)** | None | |
| **Escola Nacional de Administração (ENA)** | None | |
| **Faculdade de Direito de Bissau** | Yes | GSM modem (4G) |
| **Universidade Amílcar Cabral** | Yes | GSM modem (4G) |
| **Universidade Lusófona da Guiné** | Yes | GSM modem (4G) |
| **Universidade Virtual Africana na Guiné-Bissau (UVAGB)** | Yes | GSM modem (4G) |

*Source: Institutional Survey of Higher Education Institutions*

The individual survey collected data on students' and staff's use of computers and the Internet in the past three months and on the type of computer equipment they owned, if any. Overall, as shown in Figure 3, 45.7% of students had used a computer, and 39.4% had used the Internet at their institution in the previous

three months. The expectation for a modern higher education institution should be 100% use of computers and the Internet, and indeed use should be on a daily basis.

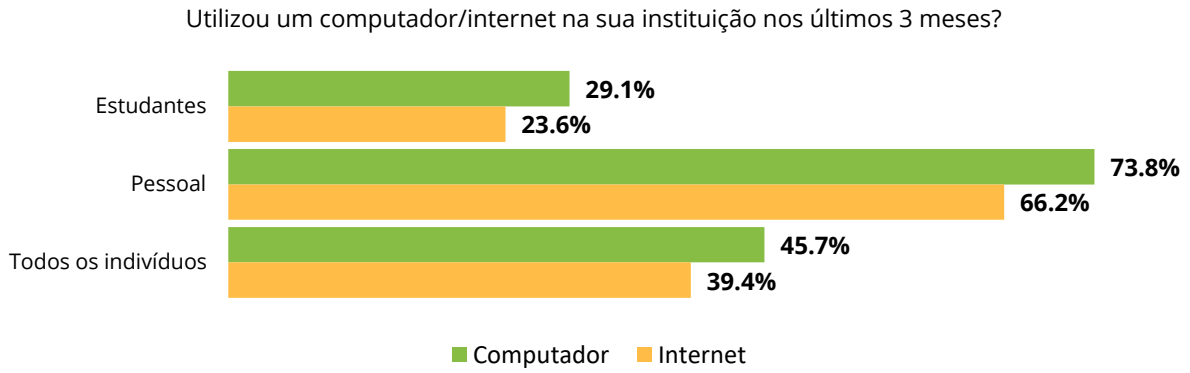


***Figure 3: Proportion of staff and students that had used a computer/internet at their institution in the previous three months***

Among students and staff who had not used a computer at their institution, 28% had used a computer outside their institution (e.g., at home, with friends or family members' homes, in an Internet café, etc.). For Internet access, this proportion was much higher at 46.3%.

Overall, one in two students/staff (56%) owned a smartphone, as shown in Figure 4, which is comparable to the Sub-Saharan African average of 51% in 2022.[25] This was followed by laptops (40%) and desktop computers (17.7%). This suggests that basic tools such as smartphones are not readily available to students.

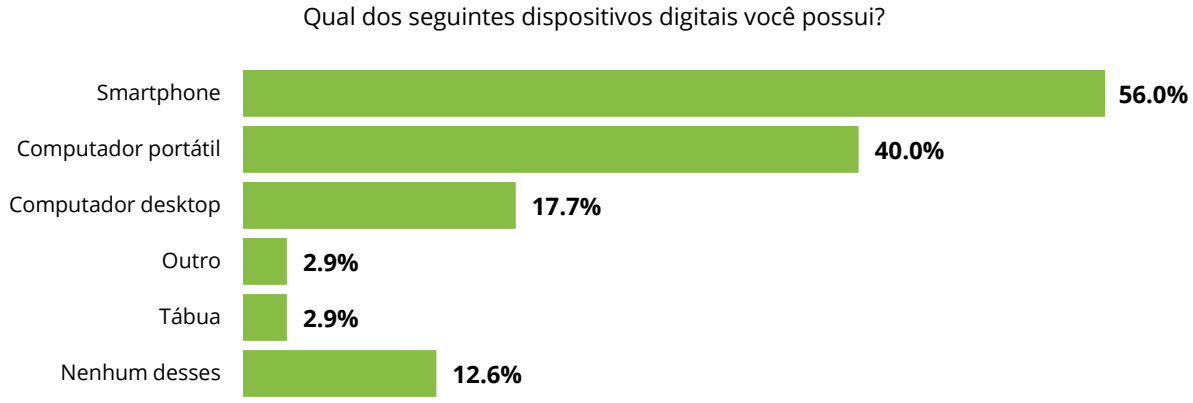


***Figure 4: Proportion of students and staff that owned different types of digital devices***

[25] GSMA, The Mobile Economy in Sub-Saharan Africa, 2023, https://www.gsma.com/solutions-and-impact/connectivity-for-good/mobile-economy/wp-content/uploads/2023/10/20231017-GSMA-Mobile-Economy-Sub-Saharan-Africa-report.pdf

All teachers reported that their institution had not provided them with a computer for their own use in the last two years. These findings highlight the limited extent to which higher education institutions are currently investing in their ICT infrastructure and resources, and the low level of digitisation in most higher education institutions in Guinea-Bissau. Public and private higher education institutions will need to invest heavily to ensure that they have the appropriate ICT infrastructure and resources to support the use of ICT for teaching, learning and research.

## 3.2 ICT Applications

In the individual survey, students were asked about their use of digital resources for learning. Most students (55%) used their smartphone every day or almost every day for some activity related to learning at their institution. Two in five students (43%) said they never or rarely used a computer. One in five students (22%) reported the same for the Internet, as shown in Figure 5.

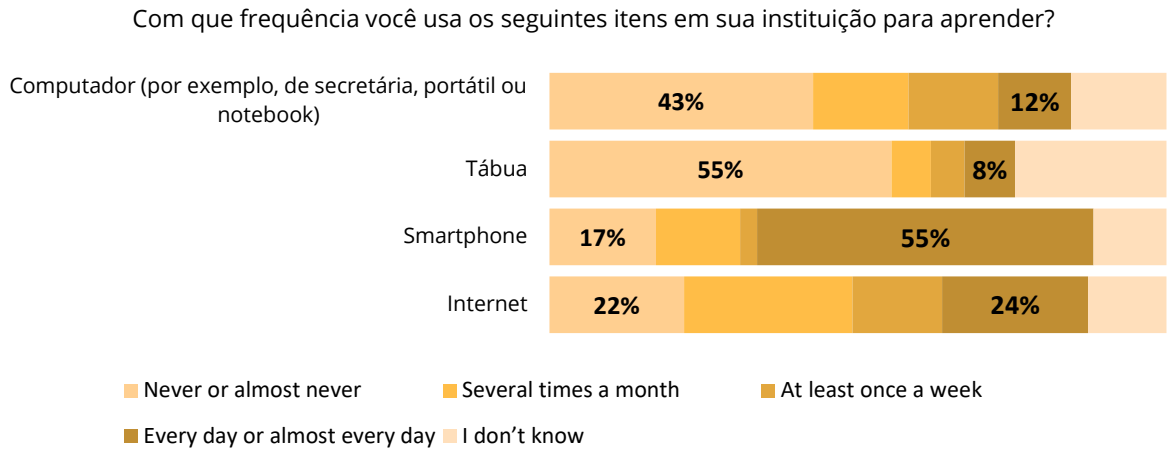


*Figure 5 Use of devices for learning*

As shown in Figure 6, most students (76.4%) ranked digital books/textbooks first among the tools/resources that could enrich their learning experience. This was followed by smartphone learning applications (30.9%) and text editing tools (23.6%).

In terms of learning activities that can be supported by digital technology, students ranked searching the Internet to gather information (77.3%) highest. This was followed by using productivity applications such as word processing, spreadsheets or presentation software (24.5%) and computers to carry out experiments, including coding (23.6%), as shown in Figure 7.

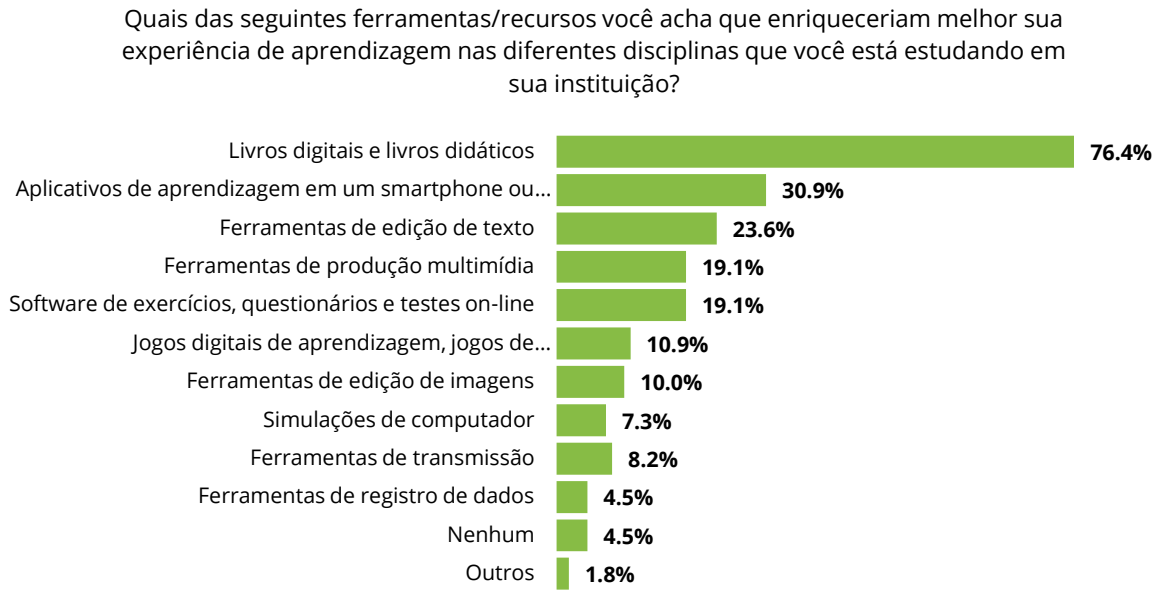


*Figure 6: Resources Used by Learners*

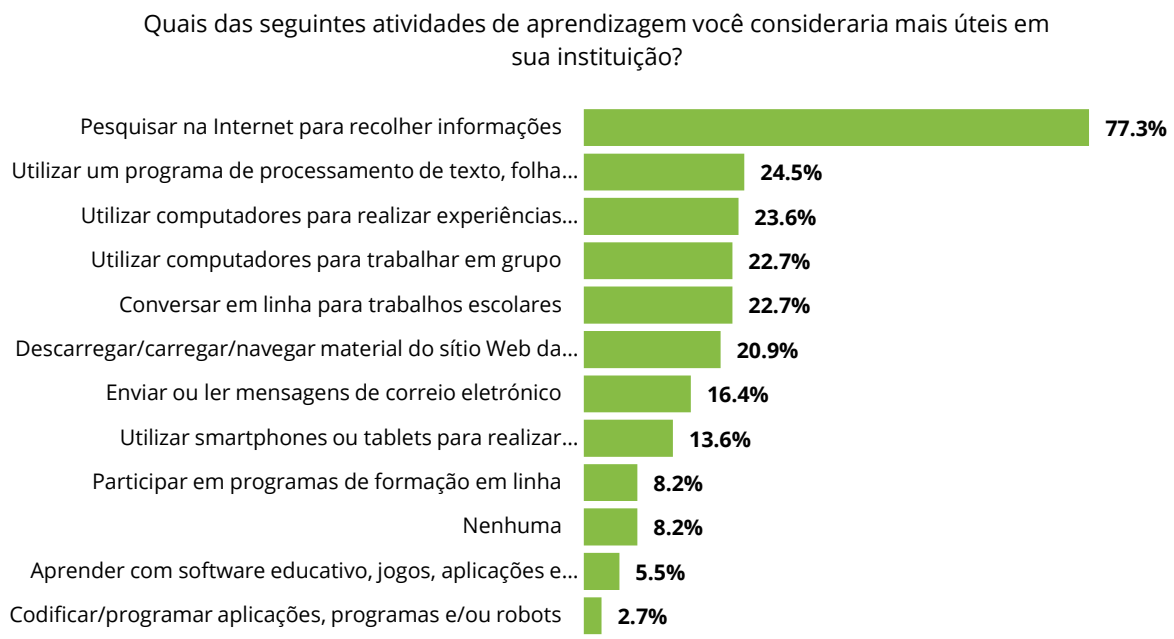


*Figure 7 Digital tools and applications that students prefer to enhance their learning*

Among teachers, one in two (50%) reported using computers and the Internet to prepare lessons, to create/modify digital content (e.g., video file, audio file, text file, PowerPoint presentation) and to provide feedback and support to students, as shown in Figure 8.

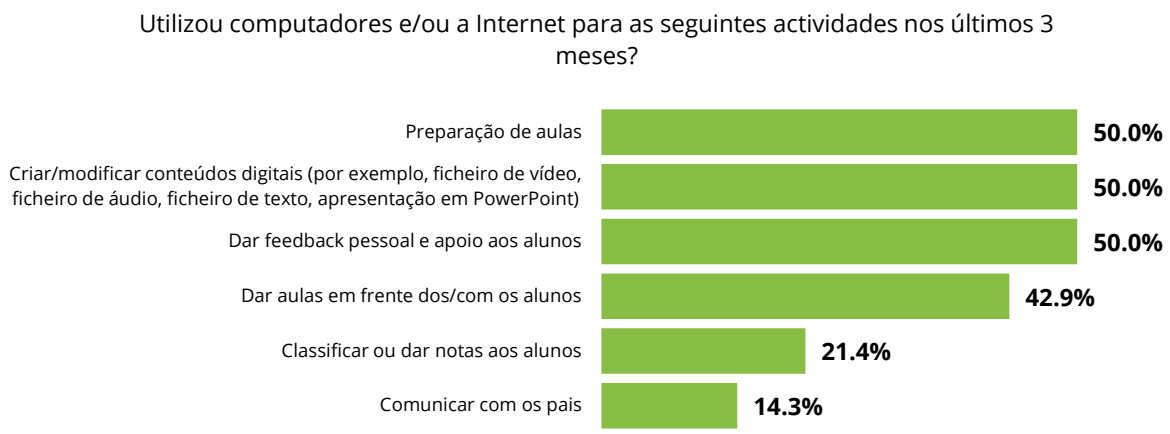


*Figure 8: Activities that teachers had used computers/internet in the previous three months*

Among administrators, the most commonly used applications are searching for information, communicating with teachers, making presentations and communicating with education authorities.

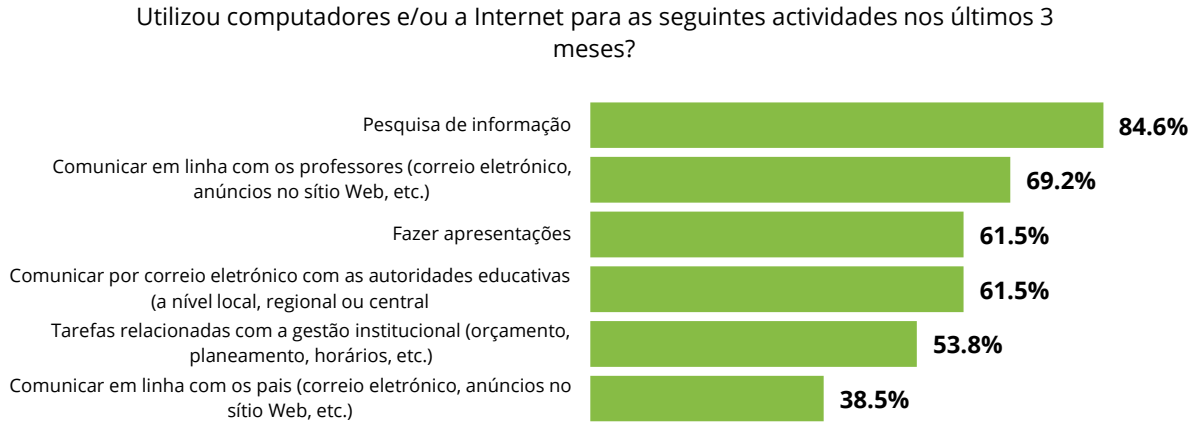


*Figure 9: Activities that administrative staff had used computers/internet in the previous three months*

Figures 6 and 7 highlight fast and reliable Internet connectivity and access to digital libraries and online educational resources as the main applications and services that a new NREN should prioritise at the outset.

## 3.3 Digital Literacy Skills

The survey asked students to rate their confidence in various digital tasks as a proxy for assessing their digital literacy levels. At the high end of the spectrum, most students (62%) said they were confident in using mobile applications on a smartphone. At the other end of the spectrum, few students (6%) said they were confident in coding/programming, as shown in Figure 10. This highlights the need for training in advanced areas such as coding in order to equip students with the

advanced skills needed to use digital technologies for learning and to be employed in jobs in the information economy jobs.

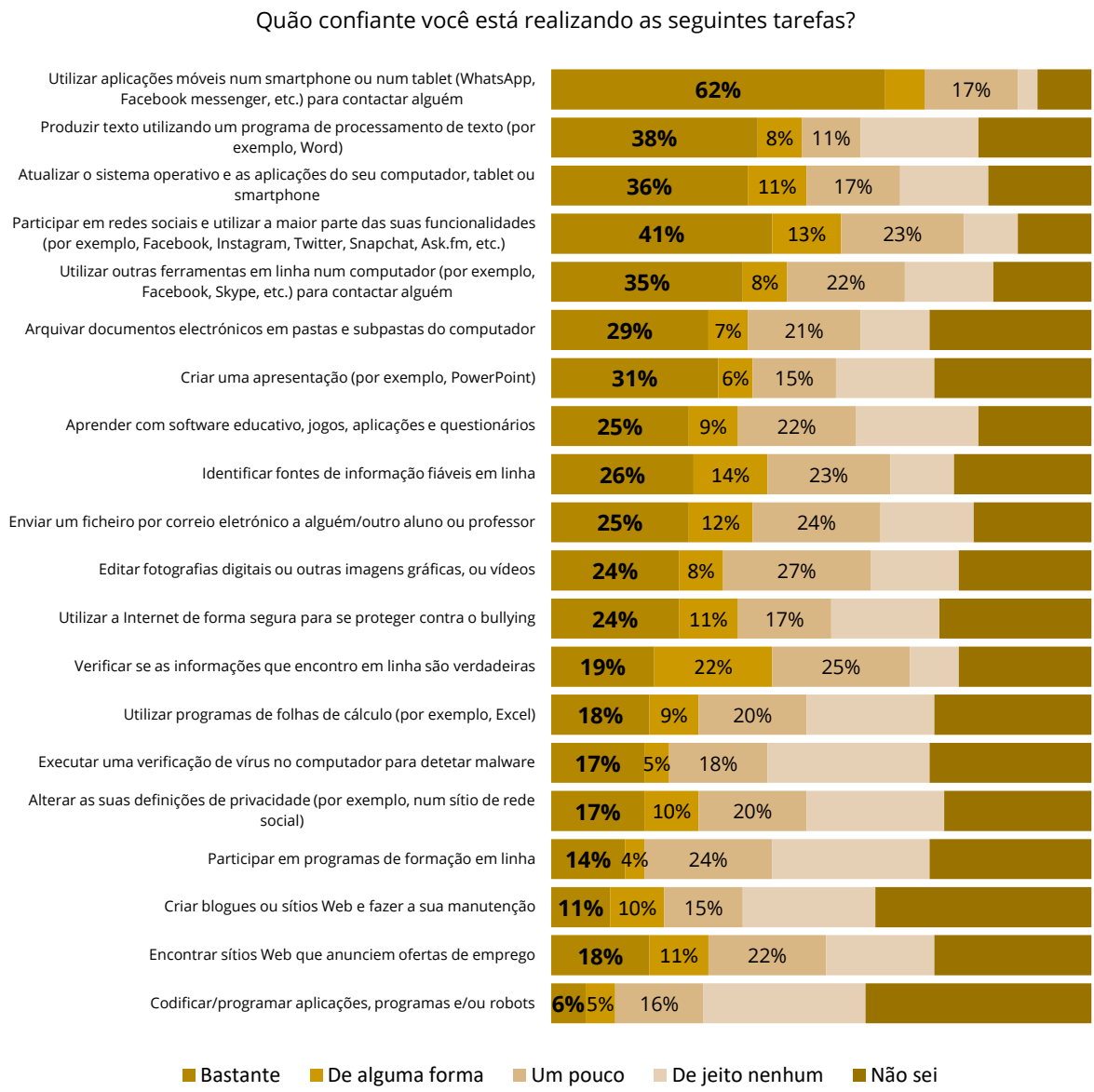


*Figure 10 Students Skills in using different digital tools and applications*

A key competence for teachers in a digital learning environment is the use of ICT in teaching and learning (including content development, learning mediation and assessment). The fact that only one in four teachers (23.1%) had received professional development in the use of ICT for teaching in the last two academic years indicates limitations in teachers' digital skills. Building the digital competence of academic staff, based on globally adopted digital competency frameworks such as the UNESCO ICT Competency Framework for Teachers[26] or

[26] https://unesdoc.unesco.org/ark:/48223/pf0000265721

the European Union Digital Competency Framework for Educators,[27] should therefore be given a high priority.

## 3.4 Challenges and Perceptions

Students and teachers were asked about the challenges that they perceive as hindering their use of digital technologies for teaching, learning, research and collaboration. The results show that access to ICT equipment (computers and laptops) and limited and slow internet connectivity are the main challenges. The establishment of RNEP-GB can help to address connectivity issues and provide a platform to improve collaboration between higher education institutions.

Students and teachers were also asked to rate their institutions on a range of measures that can affect the use of ICT for teaching and learning. At the high end of the spectrum, three out of four respondents (74%) strongly agree or agree that it is important for higher education institutions in Guinea-Bissau to network and share learning resources, reinforcing the need for the RNEP-GB. On the other hand, 16% of respondents strongly agree or agree that their institution provides ICT user training to students and staff on a regular basis, as summarised. Figure 11 highlights the need for investment in user training if higher education institutions in Guinea-Bissau are to be able to use ICT effectively for teaching and learning.

[27] https://joint-research-centre.ec.europa.eu/digcompedu_en

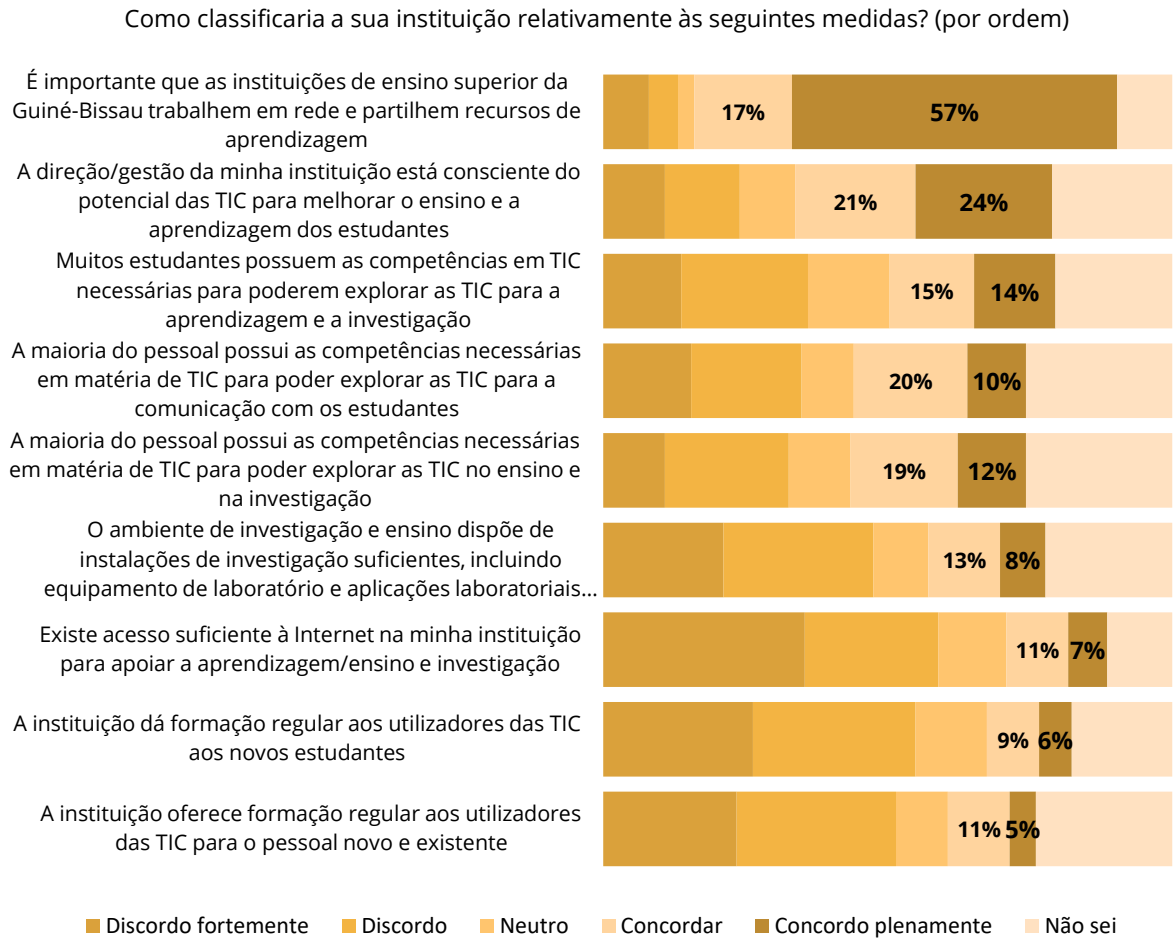


*Figure 11: Perceptions of respondents about their institutions on different measures of ICT*

# 4 Study Tours and Training

KCL organised study tours for selected individuals from Guinea-Bissau to National Research and Education Networks (NRENs) in Togo and Mozambique. The two countries were chosen because they have a similar socio-economic context to Guinea-Bissau. They also offer the possibility of future collaboration with the new NREN to be established in Guinea-Bissau.

The study tours were organised to provide learning opportunities for key stakeholders in the government and public and private higher education institutions so that they could better understand the different governance and management options and the business models that can be implemented for the new NREN to be established in Guinea-Bissau.

## 4.1 Study Tour to Togo

A team of five stakeholders from the Ministério da Educação Nacional, Ensino Superior e Investigação Científica (MENESIC) and higher education institutions travelled to Togo to learn from the experience of the Rede Nacional de Pesquisa e Educação do Togo (TogoRER)[28]. The study tour took place in Lome, Togo, from 8th to 12th April 2024. The study tour team consisted of the following participants:

i. Mr. Edualdo Maurício Porfírio da Costa – Ministério da Educação Nacional, Ensino Superior e Investigação Científica (MENESIC) – Chefe de Missão
ii. Mr. William Gomes Ferreira – Pro-Reitor da Universidade Jean Piaget (UNIPIAGET)
iii. Mr. Bande Sane – Docente da Universidade Amílcar Cabral (UAC)
iv. Mr. Sartawe Luciano Gomes – Docente da ESE – UE Cacheu
v. Ms. Cadijatu Iassim Djalo – Docente da ESE – UE Buba

The study tour team was supported on the ground in Lome by Mr. Omo Oaiya, the Chief Strategy Officer of the West and Central African Research and Education Network (WACREN), based in Accra, Ghana, and Mr. Ali Ndiwalana of KCL, based in Kampala, Uganda.

[28] https://www.togorer.tg/


***Figure 12: Study team to TogoRER at Escola Superior de Administração e Gestão***

During the mission to Togo, the study team visited the TogoRER Network Operations Centre, the Catholic University of West Africa, the Ecole Superieure d'Administration et de Gestion Notre Dame de l'Elise and the University of Lomé. TogoRER, in partnership with WACREN, organised the two training workshops and a meeting with the Honourable Octave Nicoué Broohm, former Minister of Education, who had been very supportive in the early days of TogoRER's establishment and had been instrumental in ensuring that the Togolese government found the resources to pay for TogoRER's membership and participation in AfricaConnect as part of WACREN.

## 4.2 Study Tour to Mozambique

A team of five stakeholders selected by WARDIP-GB and the local task team conducted a study tour mission to the Mozambique Research and Education Network (MoRENet)[29] in Maputo, Mozambique, from 22nd to 27th April 2024. The study tour team was hosted by the Instituto Nacional de Governo Electrónico (INAGE),[30] which is the government agency that oversees MoRENet and consisted of the following participants:

i. Mr Edualdo Maurício Porfírio da Costa – Ministério da Educação Nacional, Ensino Superior e Investigação Científica (MENESIC) – Chefe de Missão

[29] https://morenet.ac.mz/

[30] https://inage.gov.mz/

ii. Mr William Gomes Ferreira – Pro-Reitor da Universidade Jean Piaget (UNIPIAGET)
iii. Mr Ndoy Luis Ié da Silva – Diretor dos S. Académicos da Universidade Virtual Africana GB (UVA-GB)
iv. Ms Vinícia José Nhaga – Diretora da ESE – Unidade do Ensino Bafatá
v. Mr Robert Djono – WARDIP, Connectivity Specialist and Contract Manager

Mr Francisco Mabila, based in Maputo, Mozambique, supported the study team on the ground in Mozambique.


*Figure 13: Members of the Guinea-Bissau Study Tour with their colleagues from INTIC*

During the mission to Mozambique, the team visited INAGE (Instituto Nacional de Governo Electrónico), the Mozambique Research and Education Network (MoRENet), INTIC (Instituto Nacional de Tecnologias de Informação e Comunicação), a research institution—Centro de Investigação e Transferência de Tecnologia (CITT), a private higher education institution— Instituto Superior de Transportes e Comunicações (ISUTC)[31] and a public higher education institution—Centro de Informática da Universidade Eduardo Mondlane (CIUEM),[32] located on the main campus of the University in Maputo.

[31] https://www.isutc.ac.mz/

[32] https://www.ciuem.mz/

## 4.3 Summary of Workshops and Study Tours

In April 2024, KCL, in partnership with WARDIP-GB, organised three half-day workshops in Bissau to engage stakeholders and socialise the idea of establishing a NREN in Guinea-Bissau. Held at the Bissau Royal Hotel, the workshops were attended by a wide range of stakeholders and officially opened by Dr Aníbal Balde, the coordinator of WARDIP-GB. During this interaction, the workshop participants also worked together to select a tentative name for the new NREN in Guinea-Bissau: Rede Nacional de Educação e Pesquisa da Guiné Bissau (RNEP-GB). It was agreed that the name is provisional and can be changed at any time by the stakeholders as they embark on their journey to build an NREN that meets the needs of higher education institutions and the development needs of Guinea-Bissau.

*Figure 14: Participants of the first training workshops held in Guinea-Bissau in April in 2024*

In July 2024, KCL, in partnership with WARDIP-GB, organised two training workshops in Bissau, the first to validate and finalise a proposal for the establishment of a NREN and the second to validate the roadmap and action plan.

The training workshops and study tours to Togo and Mozambique were successful in raising awareness of the opportunities and challenges of the NREN among a wide range of stakeholders in Guinea-Bissau. They have helped to create a critical mass of stakeholders in Guinea-Bissau who appreciate the potential benefits of establishing an NREN, understand potential management and ownership options/business models, and gain insight into the technical set-up and operation of an NREN.

The study tours also provided an insight into the operations of TogoRER and MoRENet, two NRENs at different stages of development and with different

business models. TogoRER is at an early stage of development and is essentially owned and managed by Togo's higher education institutions as a non-profit organisation. MoRENet, on the other hand, is an older and more established NREN, owned by the government and serving higher education institutions in Mozambique. In addition, the study team gained insight into the operations of the two regional RENs - WACREN and the UbuntuNet Alliance. TogoRER falls within the WACREN region in West Africa, which is largely French-speaking, while MoRENet falls within the UbuntuNet Alliance region in East and Southern Africa, which is largely English-speaking. The study teams have also established a number of contacts and relationships that will be crucial in assisting Guinea Bissau in its efforts to establish a NREN.

# 5 Proposal to Establish an NREN

The establishment of the Rede Nacional de Educação e Pesquisa da Guiné-Bissau (RNEP-GB) is a critical step in connecting higher education institutions and linking them to regional and global networks, improving governance, and building capacity in network management and service delivery that can contribute to improved teaching, research and learning in higher education.

The vision of RNEP-GB is aligned with the vision developed in the World Bank Group's Feasibility Study for Connecting All African Higher Education Institutions to High-Speed Broadband:

**Vision**

> *"A country where all higher education institutions achieve global parity in intellectual output and national development impact through access to and exploitation of broadband connectivity at capacities, quality, and costs comparable to the rest of the world".*

**Mission**

i. *To catalyse teaching, learning, and research collaboration nationally, regionally, and globally by providing affordable high-speed broadband that connects higher education and research institutions in Guinea Bissau to the global research and education fabric.*
ii. *To enable collaborative access for the country's higher education and research institutions to services that include training, cloud, cybersecurity, and other major information systems and applications.*

The objective of RNEP-GB is to build and operate an advanced high-speed data network for the benefit and use of its members, to provide state-of-the-art educational applications and services on this network, to establish an inclusive governance framework, and to build the capacity of its members to foster collaboration and knowledge sharing nationally, regionally and globally.

This objective will be achieved through the pursuit of the following five strategic priorities, which will guide RNEP-GB's activities over the next five years:

i. Establishing the institutional framework.
ii. Deploying a scalable data network.
iii. Delivering applications and services
iv. Building the capacity of RNEP-GB members and staff.
v. Promoting sustainable operation of RNEP-GB.

Each of these is expanded upon further in subsequent sections.

## 5.1 Establish the Institutional Framework

A well-designed institutional framework, created in collaboration with members, is crucial for ensuring effective governance and management of any National Research and Education Network (NREN) to sustain its operations. A competent Director General/CEO and technical staff are vital for the smooth functioning of the network and service delivery. Establishing the institutional framework for RNEP-GB will be carried out in two phases. The first phase will be driven by an RNEP-GB Project Implementation Committee (PIC) and a Project Manager, appointed by MENESIC and MTTED, to lay the foundation for the NREN, interconnect institutions, enhance technical capacity, and launch network services. In the second phase, RNEP-GB will transition into a private, non-profit association, develop its constitution and establish a secretariat.

### 5.1.1 Legal Status

The legal status of an NREN is crucial for its governance. NRENs operate as either membership-based, non-governmental, not-for-profit entities or under government ministries or universities. All current WACREN member NRENs offering services are non-profit, suggesting that RNEP-GB should be incorporated as a non-profit association under Guinea-Bissau law. This move will make RNEP-GB an independent organisation with ties to the government, enabling it to provide network and application services to its members.

Once it is established under the law, the constitution of RNEP-GB will be approved and signed by the founding members.

### 5.1.2 Membership

RNEP-GB will be open to all higher education and research institutions accredited by MENESIC, with all institutions expected to be founding members subject to the signature of the membership agreement (see

Table 4). MTTED and ARN-TIC will provide the necessary support during the first phase.

RNEP-GB's membership includes corporate and associate members. Corporate members are higher education institutions and organisations that support education and research. Associate members are ICT industry players and international partners. RNEP-GB aims to build member loyalty by understanding their needs and involving them in strategic decisions. Membership terms will be defined in the founding documents.

*Table 4: Potential Founding members of RNEP-GB*

| Institution | Level | Status | Region | Sector |
|---|---|---|---|---|
| **Centro de Formação Domingos Ramos** | Bacharel | Public | Bafata | Bafatá |
| **Universidade Colinas de Boé** | Licenciatura | Private | Biombo | Safim |
| **Escola Nacional de Saúde** | Licenciatura | Publico | Biombo | Prábis |
| **Universidade Católica da Guiné-Bissau (UCGB)** | Licenciatura | Private | Biombo | Prábis |
| **Universidade Livre de Bissau** | Licenciatura | Private | Biombo | Safim |
| **Instituto Superior Nova Esperança (IP9)** | Licenciatura | Private | Bissau | Zona-I |
| **Instituto Nacional de Pedagogia e Administração Educacional** | Bacharel | Private | Bissau | Zona-I |
| **Escola Superior de Informática** | Licenciatura | Private | Bissau | Zona -V |
| **Instituto Superior de Gestão (ISG)** | Licenciatura | Private | Bissau | Zona -V |
| **Escola Normal Superior Tchico Té** | Bacharel | Public | Bissau | Zona -V |
| **Escola Normal 17 de Fevereiro** | Bacharel | Public | Bissau | Zona -V |
| **Escola Nacional da Educação Física e Desportos** | Bacharel | Public | Bissau | Zona -V |
| **Faculdade de Direito de Bissau** | Licenciatura | Public | Bissau | Zona -V |
| **Escola Nacional de Administração (ENA)** | Licenciatura | Public | Bissau | Bissau |
| **Instituto S. Politécnico São Francisco de Assis** | Licenciatura | Private | Bissau | Bissau |
| **Universidade Jean Piaget** | Licenciatura | Private | Bissau | Bissau |
| **Universidade Lusófona da Guiné** | Licenciatura | Private | Bissau | Bissau |
| **Bimantecs** | Licenciatura | Private | Bissau | Bissau |
| **Universidade Amílcar Cabral** | Licenciatura | Public | Bissau | Bissau |
| **Instituto Superior Horizonte** | Licenciatura | Private | Bissau | Bissau |
| **Universidade Nova da Guiné** | Licenciatura | Private | Bissau | Bissau |
| **Faculdade de Medicina** | Licenciatura | Public | Bissau | Bissau |
| **Instituto Superior de Formação Mompó** | Licenciatura | Private | Bissau | Bissau |
| **Escola de Formação Amílcar Cabral (ESE)** | Bacharel | Public | Bolama | Bolama |
| **Escola Formação de Professores Domingos Mendonça (ESE)** | Bacharel | Publico | Cacheu | Cacheu |
| **Escola de Formação Superior "DNS"** | Bacharel | Private | Cacheu | Cacheu |
| **Centro de Formação de Professores "O Pedagogo"** | Bacharel | Private | Gabú | Gabú |
| **Centro de Formação de Professores** | Bacharel | Private | Oio | Mansoa |
| **Instituto de Formação Superior** | Bacharel | Private | Oio | Bissorã |
| **Instituto de Formação Superior** | Bacharel | Private | Oio | Farim |
| **Escola de Formação Serifo Fall Camara (ESE)** | Bacharel | Public | Quinara | Buba |
| **Universidade Virtual Africana na Guiné-Bissau (UVAGB)** | Bacharel e Licenciatura | Private | Bissau | SAB |
| **....** | | | | |

*Source: FEC, Diagnostic Study of Higher Education and Scientific Research and other sources*

### 5.1.3 Governance

The governance structure of the RNEP-GB, which will be fully developed in the third phase, will emulate that of many other NRENs, as summarised in Figure 15 below, and will include the following components:

i. General Assembly of Members
ii. Board of Directors
iii. Technical Advisory Committees
iv. Chief Executive Officer and Management Team

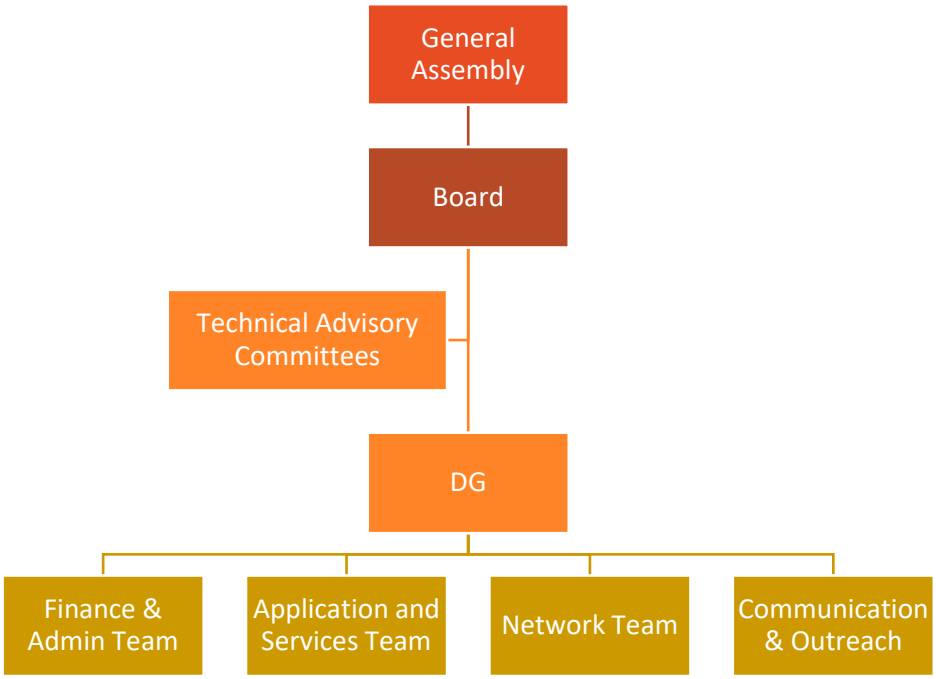


*Figure 15: Proposed governance and organisational structure of RNEP-GB*

RNEP-GB will have two levels of governance: the General Assembly and the RNEP-GB Board. The General Assembly ensures accountability and collaboration between members, appoints and dismisses the Board, and approves annual accounts, work plans and budgets.

The RNEP-GB Board governs the organisation on behalf of its members, appointing the DG and management team, approving the business plan, reviewing annual accounts and budgets, monitoring progress and supporting advocacy programmes. The Board consists of a Chair, a Secretary and members drawn from key sponsors and stakeholders. The Board will establish ad hoc Technical Advisory Committees (TACs).

### 5.1.4 RNEP-GB Secretariat

The RNEP-GB Secretariat will evolve over time, starting with Phase 1 where a Project Sponsor, Advisory Board and Project Manager will oversee project

activities. The focus will be on establishing the RNEP-GB network, laying the foundations for a fully operational NREN and recruiting staff. As the network expands, new staff will be essential to strengthen the campus networks and launch new services.

In Phase 2, RNEP-GB will become a fully-fledged organisation with a central office and staff to support operations. The office will manage day-to-day network operations, shared resources, security, disaster recovery, training and resource management. The three core functional units will be Network Management, Service Management and User Support, each responsible for different aspects of network operations and member services.

The selection of a dynamic Project Manager and Director General will be critical to the success of RNEP-GB, as demonstrated by other NRENs. The Director General should have experience in higher education and research management with a strong affinity for ICT.

## 5.2 Deploy a Scalable Network

RNEP-GB plans to deploy a high-speed network across Guinea Bissau, consisting of strategically located Points of Presence (PoPs) to connect higher education and research institutions and form the RNEP-GB backbone. The network will connect multi-campus institutions, interconnect higher education and research institutions in Guinea Bissau, connect to global NRENs via WACREN, and exchange traffic with local networks at a local IXP. In addition, RNEP-GB will provide services such as videoconferencing, data storage, and high-performance computing. At present, RNEP-GB plans to connect thirty-two higher education institutions, as listed in Table 4.

### 5.2.1 Network Design

The RNEP-GB network will be implemented in phases, with Phase 1 (see Figure 16) connecting seven institutions near the Universidade Amílcar Cabral campus and establishing the first RNEP-GB PoP. The institutions include Escola Nacional da Educação Física e Desportos (ENEFED), Escola Normal 17 de Fevereiro (ENF), Faculdade de Direito de Bissau (FDB), Instituto Nacional de Estudos e Pesquisa (INEP), Instituto Superior de Gestão (ISG), Universidade Virtual Africana (UVA-GB), and Universidade Amílcar Cabral (UAC). The network will include a redundant fibre connection from the WACREN PoP to the RNEP-GB PoP and approximately 3km of aerial fibre connecting the various members.

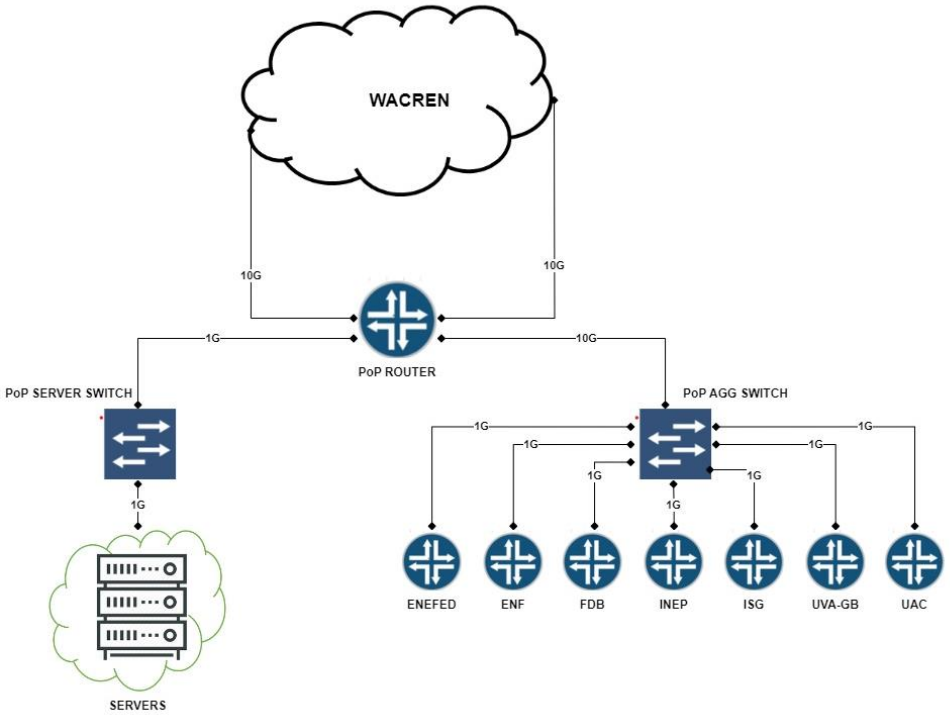


*Figure 16: RNEP-GB Network during Phase 1*

Phase 2 (see Figure 17) will connect the rest of the higher education institutions in Bissau and Biombo, including:

- Bimantecs
- Escola Nacional de Administração (ENA)
- Escola Nacional de Saúde (ENS)
- Escola Normal Superior Tchico Té
- Escola Superior de Informática
- Faculdade de Medicina
- Instituto Nacional de Pedagogia e Administração Educacional
- Instituto Superior de Gestão (ISG)
- Instituto Superior Horizonte
- Instituto Superior Nova Esperança (IP9)
- Universidade Católica da Guiné-Bissau (UCGB)
- Universidade Colinas de Boé
- Universidade Jean Piaget (UNIPIAGET)
- Universidade Lusófona da Guiné
- Universidade Nova da Guiné

These institutions in Bissau and Biombo are located close to existing operator fibre networks, with the exception of UNIPIAGET, which is 3km away from the nearest operator fibre network.


*Figure 17: Phase 2 – connecting all members in Bissau and Biombo to RNEP-GB*

Phase 3 will connect the rest of Guinea-Bissau's higher education institutions. Most of these are far from existing fibre networks and will need to be connected using wireless technologies. Some may also become more accessible to fibre through the planned national backbone network.

RNEP-GB's planning should assume that all member sites will eventually require fibre-based last mile connections between RNEP-GB PoPs and their sites. RNEP-GB should consider leasing fibre connections from current network providers to provide fast, reliable Internet connectivity to its members. This will reduce administrative costs and the technical burden on the team.

As an NREN, RNEP-GB will require its own Network Identity and Autonomous System Number from AfriNIC, as discussed in Section 5.2.3.

### 5.2.2 Connecting to WACREN

The West Africa Regional Research and Education Network (WACREN) provides secure, affordable broadband connectivity to NRENs in West and Central Africa. By joining WACREN, RNEP-GB will be connected to a global network of NRENs. Current WACREN PoPs are located in Abidjan, Accra, Cotonou, Lagos, Ouagadougou and London. A new PoP in Dakar will serve Guinea-Bissau and connect RNEP-GB to other NRENs in West Africa and beyond. FASOREN (Burkina Faso), GARNET (Ghana), NGREN (Nigeria), RBER (Benin), RITER (Ivory Coast) and TogoRER (Togo) are already interconnected through WACREN.

*Source: WACREN, 2024*

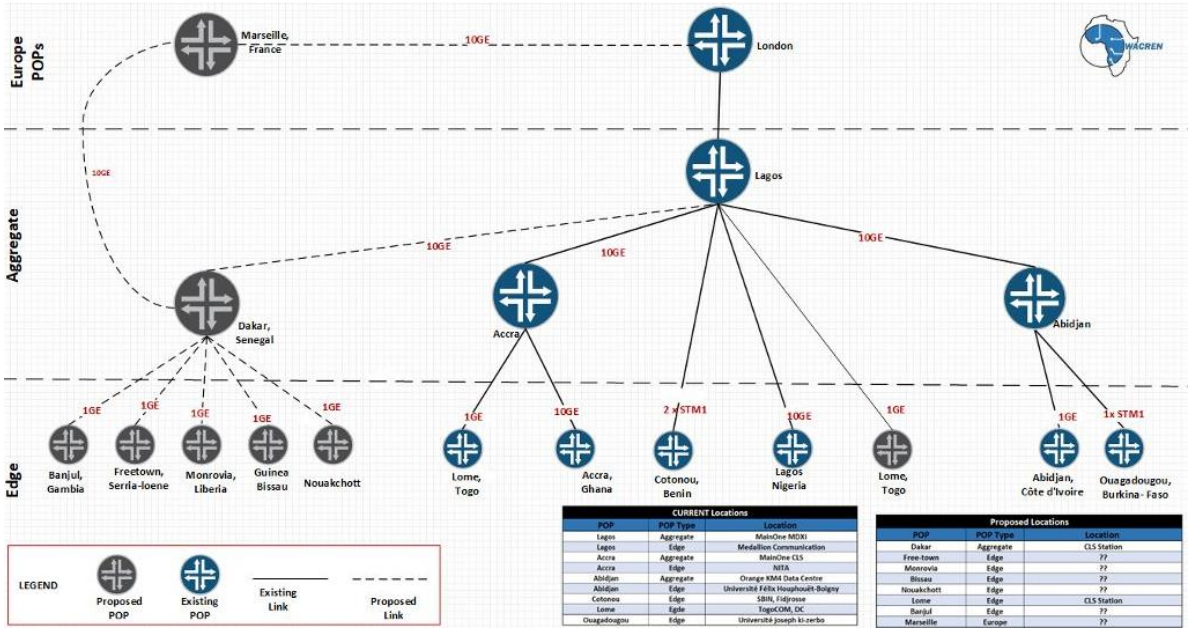


*Figure 18: Current WACREN network*

RNEP-GB will join the future Guinea-Bissau Internet Exchange and establish peering agreements with service providers to improve efficiency and strengthen its contribution to the Internet industry in Guinea-Bissau.

### 5.2.3 AfriNIC and Number Resources

An Autonomous System Number (ASN) is used to identify a network in Internet routing tables. When a network connects to an Internet Service Provider (ISP), the ISP provides public IP addresses for the customer to use. This allows the customer's network to become an extension of the ISP's Internet network and ASN. In Guinea-Bissau, higher education and research institutions rely on their ISP's ASN for Internet connectivity. To access global research and education networks, RNEP-GB needs to set up its own ASN and public IP addresses so that its border routers can use the Border Gateway Protocol (BGP) to exchange route announcements with other networks, such as WACREN.

AfriNIC, a not-for-profit organisation based in Mauritius, is the Regional Internet Registry for the African region and the sole issuer of new Internet number resources, including ASNs, IPv4 IP address space and IPv6 IP address space. It is one of five Regional Internet Registries worldwide, all of which report to and receive globally unique number resources from the Internet Assigned Number Authority (IANA). All organisations seeking Internet numbering resources from AfriNIC must become members, which allows them to attend general meetings, contribute to policy formulation and participate in the election of the Board of Directors. AfriNIC recognises two categories of membership: Local Internet Registries (LIRs) and end-user members. LIRs often allocate address space from

their AfriNIC allocations to other entities, while end-user members can only use their AfriNIC allocations to number their own networks. RNEP-GB will need to register with AfriNIC as a LIR member.

RNEP-GB should not provide each campus with enough IPv4 addresses to eliminate Network Address Translation (NAT). Instead, RNEP-GB should allocate the minimum necessary block of public IPv4 addresses to replace external interfaces allocated by commercial ISPs. In the meantime, campuses should continue to use private IPv4 addresses, NAT and Dynamic Host Configuration Protocol (DHCP) for internal interfaces.

RNEP-GB is advised to allocate a /24 prefix to each of its 32 members, for a total of /19 prefixes. It should also secure IP addresses for connection to other institutions and its own routers and network equipment. RNEP-GB should apply to AfriNIC for LIR membership, an /18 IPv4 allocation, an /32 IPv6 allocation and an ASN. The annual membership fee for a "Small LIR" is US$6,400, with a one-time fee of US$2,500 for IPv4 and US$400 for the ASN. For two years, RNEP-GB would need US$15,700, but could save US$1,450 as a non-profit organisation eligible for a 50% discount on one-off fees.

## 5.3 Deploy RNEP-GB Applications and Services

The provision of applications and services requires a combination of administrative aspects, including a Service Level Agreement (SLA) and an Acceptable Use Policy (AUP), and technical aspects, such as the provision of numbering resources.

### 5.3.1 The Service Level Agreement (SLA)

RNEP-GB will provide services to institutions on the basis of a Service Level Agreement (SLA), which sets out the rights and responsibilities of both parties. The SLA specifies service levels that RNEP-GB must strive to meet, ensuring that services are provided as ordered within the capacity of the network. The agreement allows the RNEP-GB Board to set service charges on a cost recovery basis. Member institutions must comply with RNEP-GB's Acceptable Use Policy (AUP), Connection Policy and pay for services. The SLA also outlines procedures for dealing with faults and service incidents. The AUP allows connecting member institutions to use RNEP-GB's services for lawful activities that further the institution's objectives, are consistent with good Internet practice, and do not involve unacceptable use or abuse.

### 5.3.2 RNEP-GB's Acceptable Use Policy

RNEP-GB's Acceptable Use Policy (AUP) allows connected member institutions to use its services for lawful activities that further its objectives, comply with RNEP-GB's SLA, are consistent with current good Internet practice, and do not involve unacceptable use or abuse. This policy is similar to those of other NRENs.

A sample Acceptable Use Policy, which may be modified to suit the purposes of the RNEP-GB, is included in the detailed proposal for the establishment of the RNEP-GB report.

### 5.3.3 Network Management and Services

Network management is a critical process that maximises the availability and performance of a network. RNEP-GB needs to establish a network management function in its operating model to maintain the service levels agreed with its member institutions. This includes fault management, which involves the detection and reporting of network faults, configuration management, performance management, security management and accounting management. These functions help to maintain acceptable performance levels, plan capacity upgrades and identify bottlenecks. Performance metrics include network throughput, packet round-trip time, packet loss and circuit utilisation. Security management ensures authorised access to network devices and resources, while accounting management provides information on network resource usage for billing or capacity planning purposes.

The RNEP-GB Network Operations Centre (NOC) will be equipped with various tools and equipment to assist personnel in managing network functions. The NOC will have several display screens to show alarms, incidents and network performance. It will also have computers running software to monitor critical network systems and services, network performance measurement software, incident management software, and a service desk to handle service outages. The service desk will use incident management software to record, track, assign, escalate and document incidents. An example of such software is Best Practical's Request Tracker.[33]

The proposed NOC will be managed by a Network Team Manager who will ensure that service levels are met through capacity planning and resource utilisation. Service targets include network availability, reliability, mean time to restore and network latency. The NOC will also provide a service desk and service specialists, including network engineers and other systems specialists, to deal with service

[33] https://bestpractical.com/request-tracker

incidents or failures. The roles and escalation paths of these specialists will depend on the RNEP-GB service portfolio (see Figure 19). The NOC functions may be outsourced to other organisations, with the Network Team Manager coordinating to ensure that service levels are met. For example, the Service Desk function could be outsourced to the IT department of one of the member institutions.

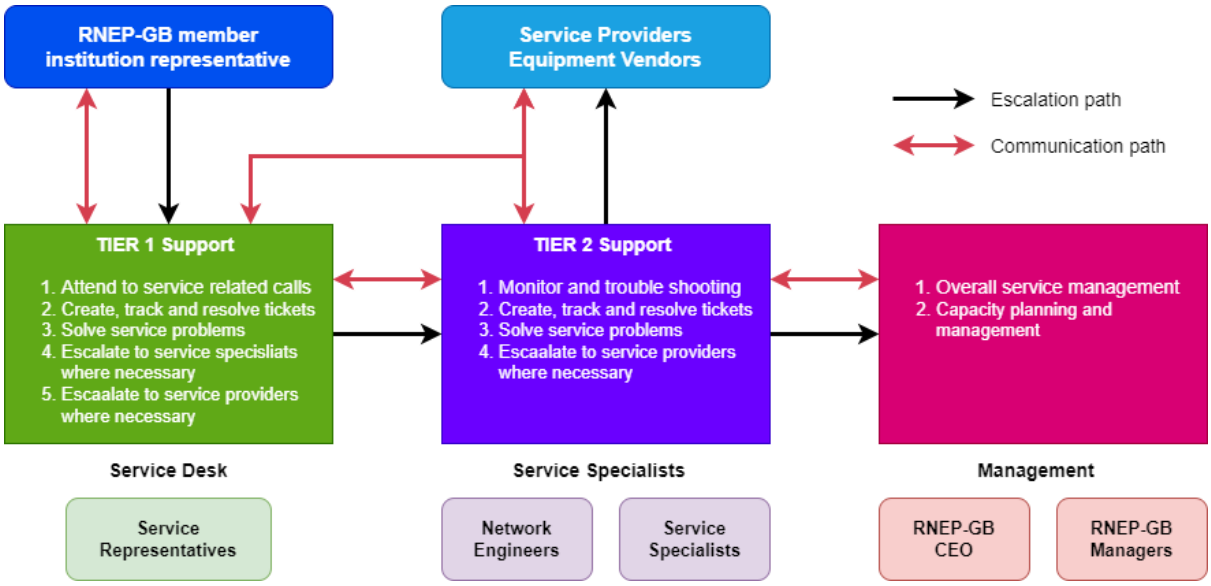


*Figure 19: NOC roles and escalation path*

### 5.3.4 Applications and Services

RNEP-GB will offer various services to member institutions' campuses, each with a name, specified order quantity, and unit charge in West African CFA francs per unit order quantity. Four service categories include Connectivity Service, Campus IT support services, Advanced services, and Organisational services. Initially, the focus will be on providing connectivity services, followed by support and capacity development services, with advanced shared services introduced later to meet evolving needs. The REN Services Agreement governs the provision of services, requiring institutions to enter into the agreement before ordering services.

Internet Connectivity Service will provide access to the entire Internet via commodity and REN routes, connecting campuses globally. Additionally, interconnectivity with local and African networks will be ensured, facilitating access to content hosted by various entities. Campus IT Support Services include email, hosting, content, security, and central procurement services. RNEP-GB may negotiate consortia contracts with providers for cloud-based email services, host servers for institutions, and provide operational and cybersecurity services like incident handling and cyber audits.

In addition, RNEP-GB network will offer common content services and establish mirrors for popular aggregators and datasets required by member institutions. Advanced services will include video conferencing, high-performance computing resources, and identity federation to enhance teaching and research activities. Institutions can request access circuits at specified bandwidths, and RNEP-GB can operate a system for identity federation, facilitating user access to services across institutions.

RNEP-GB could become the National Roaming Operator for eduroam in Guinea Bissau, providing secure, Wi-Fi-based roaming Internet access for the research and education community. Organisational services like training, software licensing, and an electronic learning environment will also be provided. Table 5 summarizes the services offered by RNEP-GB, some of which are essential for its operation, while others can be introduced based on demand and network development progress.

*Table 5: Summary of RNEP-GB services*

| **Main Services** | | **Service types** | **Must have** | **Should have** |
|---|---|---|---|---|
| **Connectivity** | | Internet access | √ | |
| | | IPV6 | √ | |
| | | DNS, NTP | √ | |
| | | Peering with national and regional research and education networks | √ | |
| | | Mail relay | √ | |
| | | Mirroring, cache | √ | |
| **Advanced Services** | Middleware services | Eduroam | √ | |
| | | Identity federation | √ | |
| | | Spam filtering | √ | |
| | | CERT | | √ |
| | | FTP archive | | √ |
| | **Collaborative services** | Voice and video conferencing | √ | |
| | | SSL | √ | |
| | | Social media | | √ |
| | | IP telephony | | √ |
| | Applications | Cloud services | | √ |
| | | Grid computing | | √ |
| | | Light path | | √ |

| | | | | |
|---|---|---|---|---|
| | | Web hosting | √ | |
| **Organisational services** | | Training and capacity building | √ | |
| | | Software licensing | √ | |
| | | Electronic learning environment | √ | |
| | | Access to electronic content | √ | |
| | | Annual conference | √ | |

## 5.4 Build the Capacity of RNEP-GB Members and Staff

Capacity building is critical to the success of RNEP-GB, with strong ICT departments in universities playing a key role. To support member institutions, RNEP-GB needs to implement capacity development programmes from the outset. Training programmes are needed to improve technical skills, covering topics such as campus network design, connectivity optimisation and e-services. Network engineers from key institutions, including RNEP-GB staff, will be trained to deploy national networks and provide advanced services. RNEP-GB management will also receive training in business planning, marketing and resource mobilisation. Organisations such as WACREN, the Network Start-up and Resource Centre (NSRC), the African Network Operators Group (AfNOG) and others will provide technical training to network engineers in West Africa. In Phase 1, basic network training will be provided, along with twinning arrangements with experienced networks. Phase 2 will focus on advanced network training, while Phase 3 will cover the deployment and management of advanced network services. Training events will be held in conjunction with conferences to ensure continuous skills development for RNEP-GB members.

RNEP-GB could consider establishing a "twinning" relationship with an established NREN in Africa or elsewhere, such as MoRENet in Mozambique and RNP in Brazil. In this partnership, engineers from RNEP-GB could learn how to deploy and operate a large high-speed network by spending time at the partner's NOC, and vice versa. To facilitate this, logistics such as accommodation and travel would need to be arranged. Consultation with members to identify development needs and seeking donor support for capacity building programmes is strongly recommended. The RNEP-GB should appoint a senior officer to oversee this project and take advantage of twinning opportunities for learning.

## 5.5 Promote the Sustainable Operation of RNEP-GB

RNEP-GB needs to mobilise resources for sustainable operation through innovative marketing and communication. This includes funding for connectivity, institutional development, capacity building and services. RNEP-GB will need to mobilise start-up funding to cover one-off infrastructure costs, such as initial hardware and software, and to connect its pilot members to the Internet and WACREN. This start-up funding is expected to come from the WARDIP project and government allocations.

Once fully operational, RNEP-GB will collect membership fees and service charges to cover its operating costs. The service charge is a 'unit charge' per unit of quantity ordered and delivered to the campus for each service. For Global REN, Internet Service and REN Transport Service, the unit charge will be expressed in Mbps per month. The Board of Directors will review and reset the Unit Charges on an annual basis. RNEP-GB has the right to reset the unit charges from time to time in accordance with the SLA with member institutions.

RNEP-GB's monthly income from membership fees should cover all operating expenses, excluding government and donor grants. The Board must set prices to ensure sustainability and may need to build up cash reserves. They are committed to cost recovery, aiming to cover projected costs without overcharging. Setting circuit rental fees based on bandwidth and distance accurately reflects cost structures, but this will favour urban members over rural and interior members. To promote equity, RNEP-GB, which serves educational and research institutions in Guinea-Bissau, will charge all sites the same for services. Despite urban advantages, fees should not vary by location in order to support all campuses in Guinea Bissau equally.

Effective communication and marketing are essential to the success of RNEP-GB. RNEP-GB will initially hire a communications expert to develop marketing and communication tools, with plans to hire a full-time or part-time communications and marketing position to help mobilise resources and attract new members.

Many multilateral development organisations, foundations and multinational companies have supported higher education development in the past, focusing on different aspects such as capacity building, content development and increasing connectivity for NRENs. RNEP-GB aims to target different donors for support, including The European Union for connecting countries to the global REN, the Rockefeller Foundation for ICT projects, the Carnegie Corporation for

strengthening higher education, the Michael & Susan Dell Foundation for technology in education projects, and Google.org for technology-enabled solutions. Kenya and Rwanda have received technical assistance and equipment donations from multinational companies such as CISCO, IBM, Intel, Juniper Networks and Microsoft. In addition, organisations such as NSRC are focusing on capacity building through training programmes. While Guinea-Bissau hasn't yet benefited from these initiatives, there is potential if the government prioritises research and education networks and implements a strong resource mobilisation strategy.

# 6 Roadmap and Action Plan

The Roadmap and Action Plan sequentially detail what needs to be done and when, along with timelines and costs, in order to establish the RNEP-GB. The detail is guided by the identified strategic priorities discussed in section 4.

## 6.1 Roadmap

The development of a functional and sustainable RNEP-GB will require the efforts of all stakeholders, led by MENESIC. RNEP-GB will unite Guinea-Bissau's higher education institutions to jointly secure Internet services. The roadmap details activities and milestones for the establishment and operation of an NREN in Guinea-Bissau, with a phased approach from planning to continuous improvement. Each phase builds on the previous one, ensuring a structured and strategic deployment of the NREN.

### 6.1.1 Phase 1 – Establishing RNEP-GB as a Legal Entity and Piloting the RNEP-GB Network

During the first year of the RNEP-GB project, the focus will be on building the foundation of the network. This includes securing commitments from member institutions, establishing RNEP-GB as a legal entity, launching the NREN, forming a Project Implementation Committee (PIC), appointing a Project Manager and the rest of the Project Implementation Team (PIT), and setting up the network infrastructure at pilot institutions in Bissau. The team will install routing equipment, provide campus access circuits and operate RNEP-GB as an independent NREN network with its own ASN. Organisational development will also be an important part of this phase to ensure the sustainability of the network. By the end of this phase, the pilot institutions will be connected to RNEP-GB and the network will be formally registered as a legal entity.

### 6.1.2 Phase 2 – Expanding the Network and Continuing Operationalisation of RNEP-GB

In the second year, the RNEP-GB project will focus on expanding the pilot network in Bissau and Biombo and establishing RNEP-GB as an independent member-based association with proper governance and financial capacity. The General Assembly will elect the first RNEP-GB Board, which will then set up a formal secretariat, launch services and provide training for members. It will also work to secure funding from national and international sources.

### 6.1.3 Phase 3 – Achieving National Reach and Sustainable Operation of RNEP-GB

Phase three of the RNEP-GB project, spanning years three to five, focuses on consolidating sustainable operations and expanding the network. This phase includes finalising a governance framework, forming key committees and establishing a secretariat. The network will reach out to the remaining higher education institutions, especially those in remote areas. A Network Operations Centre (NOC) will be established with trained staff to oversee the monitoring and management of the network, provide advanced services and ongoing training. The Secretariat will continue to seek resources and partnerships, including public-private partnerships and cooperation with government agencies and international organisations.

## 6.2 Action Plan

The establishment of the National Research and Education Network (NREN) in Guinea Bissau, referred to as RNEP-GB, is outlined in a comprehensive action plan divided into three distinct phases and involves a number of tasks highlighted in Figure 20. These are briefly discussed in the following sections.

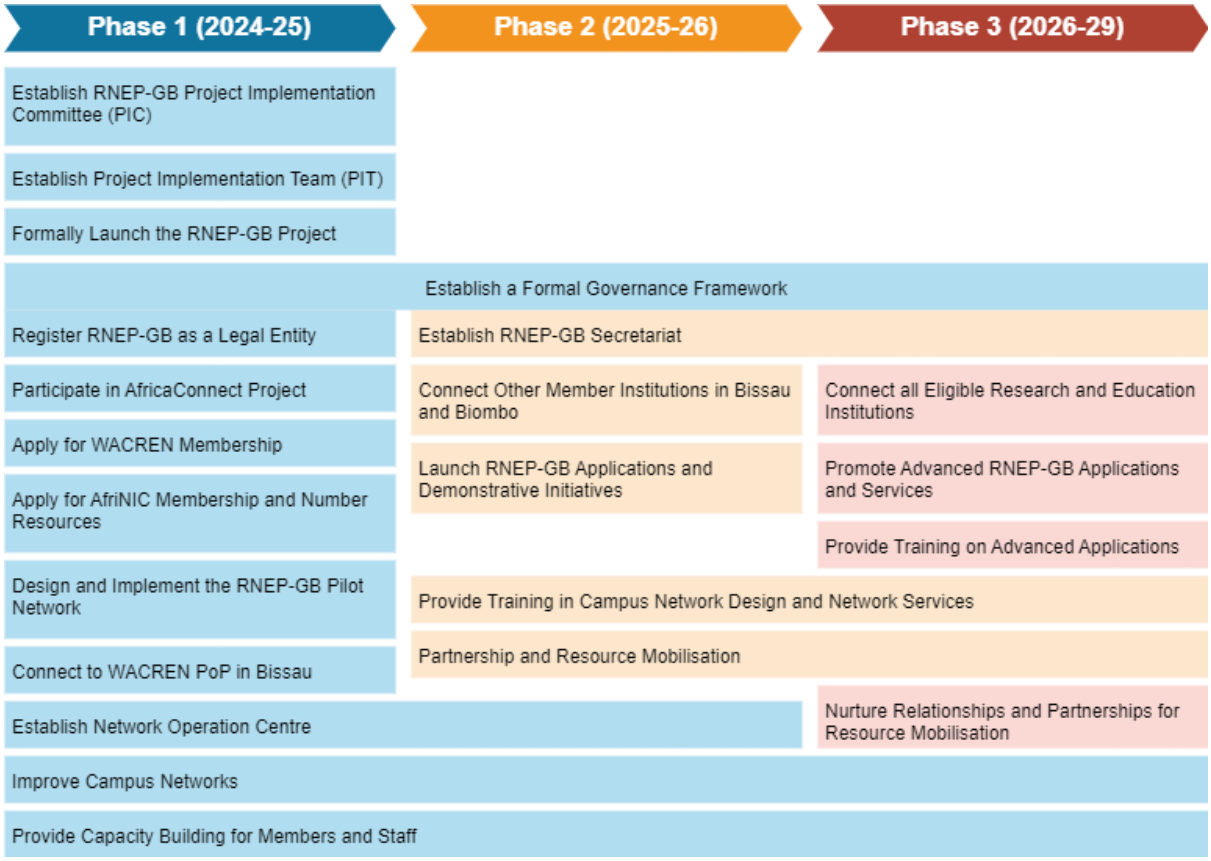


*Figure 20: Overview of the different phases and activities in the action plan*

### 6.2.1 Phase 1 – Establishing RNEP-GB as a Legal Entity and Piloting the RNEP-GB Network

Phase 1 of the project focuses on establishing the RNEP-GB network and connecting pilot member institutions to demonstrate immediate value. Guinea-Bissau's participation in the AfricaConnect project will ensure that the WACREN regional REN backbone is extended to include a PoP in Bissau to which RNEP-GB can connect. Phase 2 will begin once RNEP-GB is connected to the WACREN network in Bissau or another location and can directly use WACREN's Internet services.

The main steps of Phase 1 include:

i. **Establishment of the Project Implementation Committee (PIC):** MENESIC will establish a Project Implementation Committee (PIC) to oversee the RNEP-GB project. The PIC, consisting of key stakeholders such as Rectors and MENESIC representatives, will assist the Project Manager in achieving the project objectives. The PIC will be dissolved once a General Assembly of RNEP-GB member institutions appoints the first RNEP-GB Board.

ii. **Establishment of the Project Implementation Team (PIT):** MENESIC will establish a Project Implementation Team (PIT) responsible for the implementation of the RNEP-GB network. The PIT will include at least the Project Manager, Network Engineer and Systems Engineer. If funding permits, MENESIC may also add a Finance and Administration Manager, a Communications Officer and two support staff.

iii. **Formal launch of the RNEP-GB project:** MENESIC will formally launch RNEP-GB with a public announcement with the support of the higher education institutions, the government and the World Bank in Guinea-Bissau. The announcement will introduce the project sponsors and members of the PIC, explain the phased implementation approach, and describe the purpose of RNEP-GB joining WACREN. Representatives from WACREN, neighbouring NRENs and Portuguese-speaking countries may be present at the launch event.

iv. **Establish a formal governance framework:** This is critical to the successful operation of the RNEP-GB. It will facilitate resource management, regulatory compliance, alignment with strategic objectives, stakeholder engagement and accountability. The PIC will work to register the association as a legal entity and develop other components of the institutional framework outlined in Section 3 for the growth and success of RNEP-GB.

v. Register RNEP-GB as a legal entity to enable the necessary activities.

vi. **Apply for WACREN membership** after RNEP-GB's formal launch to benefit from regional interconnectivity. Visit the WACREN website for more information.

vii. **Apply for AfriNIC membership and numbering resources:** This will enable RNEP-GB to become a member of AfriNIC and to secure IPv4 addresses, IPv6 addresses, and an Autonomous System Number.

viii. **Design and implementation of the RNEP-GB pilot network:** The PIT and PIC with support from MENESIC, will procure and install the necessary equipment, manage the deployment of campus access circuits, and configure the RNEP-GB router. The PIT will oversee the renumbering of external interfaces using RNEP-GB IP address assignments to enable network exchange route announcements as an autonomous system.

ix. **Participation in the AfricaConnect project:** The EU-funded AfricaConnect3 programme aims to improve Internet connectivity for research and education in Africa by deploying high-speed networks for NRENs. Guinea-Bissau is working with WACREN to deploy an edge PoP in Antula as part of the project. RNEP-GB has to lobby the government and

the local ICT community for the success of the project. Planning for AfricaConnect4 is underway, and RNEP-GB needs to communicate support requirements to WACREN for engagement with the EU and other regional RENs.

x. **Connect to the WACREN PoP in Bissau:** Once RNEP-GB joins WACREN, it can connect to the network at one of its PoPs. PIT will provide a fibre connection from the WACREN PoP to the first RNEP-GB PoP for access to WACREN Global REN, Regional Connectivity and Internet services.

xi. **Establish a Network Operations Centre (NOC):** As RNEP-GB expands its operations, the establishment of a NOC is essential to manage and maintain its network infrastructure and services. Key activities include planning, infrastructure development, technical set-up, staffing and training, development of operational procedures, security measures and regulatory compliance. Skilled staff and comprehensive training are critical to the efficient operation of the NOC. RNEP-GB must comply with Guinea-Bissau's data protection laws and regulations.

xii. **Improve campus networks:** Campus networks pose a significant challenge to higher education institutions due to poor design and limited technical capacity. RNEP-GB aims to address this by providing funding and support for capacity building and equipment to improve network efficiency and overall development benefits.

xiii. **Provide capacity building for members:** The PIT will also initiate capacity building efforts during this phase. This will include training on network basics and how to connect to the global research and education network.

By taking these steps in Phase 1, RNEP-GB aims to build a strong foundation for future growth and connectivity in Guinea-Bissau's higher education institutions. The project will work towards improving the network infrastructure, increasing opportunities for collaboration and ensuring sustainable operation for the benefit of the academic community in the region.

### 6.2.2 Phase 2 – Expanding the Network and Fully Operationalising RNEP-GB

Phase 2 of the RNEP-GB project begins with the establishment of the first RNEP-GB PoP and the connection of pilot members to the network. The key steps in Phase 2 are

i. **Establish a formal governance framework:** The PIC will organise a General Assembly to appoint the first formal RNEP-GB Board or Management Committee. The Board will delegate project responsibilities

to this committee and establish Technical Advisory Committees (TACs) for technology guidance in education and research in Guinea-Bissau.

ii. **Establishment of the RNEP-GB Secretariat:** The Board will appoint a Secretariat, headed by the Director General, to oversee the day-to-day operations and implementation of the strategic plan. Different teams will handle administrative, technical, financial and operational tasks.

iii. **Connecting other member institutions:** RNEP-GB will connect additional higher education institutions in Bissau and Biombo, using the existing fibre networks of the operators.

iv. **Launching applications and demonstrations:** Implement services to demonstrate the benefits of RNEP-GB, such as registration of educational domain names, hosting of institutional websites, access to e-journals and e-mail services.

v. **Improving campus networks:** Enhance the campus networks of member institutions through capacity building, equipment interventions and internships for technical staff development.

vi. **Provide more training:** Provide training in campus network design, deployment, traffic optimisation and incident management to member institutions.

vii. **Partnership and resource mobilisation:** Work with multilateral and bilateral institutions for funding and support. Potential partners include IPAD, CPLP, Calouste Gulbenkian Foundation, RedCLARA and bilateral organisations such as Sida, GIZ, JICA and NORAD, as well as domestic sources such as UAF.

By implementing these steps, RNEP-GB aims to strengthen its network infrastructure, improve services and foster collaboration to support research and education in Guinea-Bissau.

### 6.2.3 Phase 3 – Achieving National Reach and Sustainable Operation of RNEP-GB

Phase 3 of RNEP-GB in Guinea-Bissau will begin once it is formally established as a membership-based, non-profit National Research and Education Network (NREN). During this phase, RNEP-GB's members and board will take charge of its operations, improving its services and governance practices. Key steps in Phase 3 include:

i. **Establishment of a full governance framework:** The RNEP-GB Board will assume full responsibility for the assets, liabilities and operations of the project. This includes the establishment of an institutional framework to effectively oversee and manage RNEP-GB. Components of this framework

include legal registration as a non-profit organisation, the General Assembly as the decision-making body, the Board of Directors, a Secretariat headed by a Director General, various committees, strategic planning, financial management, stakeholder engagement, monitoring and evaluation, and risk management.

ii. **Connecting all eligible research and education institutions:** RNEP-GB will expand its network to include all remaining higher education institutions in Guinea-Bissau, particularly those in rural and remote areas with limited infrastructure. The network may also consider connecting lower education institutions and other organisations such as national libraries, government education agencies, cultural heritage institutions, distance learning providers, academic hospitals and innovation centres.

iii. **Promotion of advanced applications and services:** RNEP-GB will provide its members with advanced applications and services beyond basic networking capabilities. These include e-learning platforms, digital identity management, cloud computing infrastructure, data storage solutions, collaborative research tools, cyberinfrastructure services, high performance computing clusters, big data analytics, geospatial analysis and more.

iv. **Provide training in advanced applications:** Training programmes will be developed to enhance the technical skills and operational capacity of RNEP-GB staff and member institutions. This will include the use of e-learning platforms, virtual classrooms, digital libraries and best practices for data security. Research collaboration platforms will also be introduced to facilitate data sharing and remote collaboration.

v. **Fostering relationships and partnerships for resource mobilisation:** RNEP-GB will seek partnerships with development organisations, foundations and multinational companies to improve its infrastructure and services. Strategic planning and alignment with the objectives of potential partners will be essential. Capacity building programmes will be critical to securing partnerships and funding opportunities will be explored through grant writing, public-private partnerships and government advocacy.

In summary, Phase 3 of the RNEP-GB in Guinea-Bissau will focus on strengthening governance, expanding network connectivity, introducing advanced services, providing training and fostering partnerships to improve research and education in the country through advanced network infrastructure.

*Table 6 Five- Year Action Plan for 2024-2028*

| Action | Description | Key Stakeholders | KPI | Estimated Cost (US$) |
|---|---|---|---|---|
| **PHASE I (2024-2025)** | | | | |
| **Governance and Institutional Development** | Establish the RNEP-GB Project Implementation Committee (PIC) | MTTED, MENESIC, WARDIP | Formal appointment of PIC | - |
| | Establish Project Implementation Team (PIT) | PIC, MTTED, MENESIC, WARDIP | Appointment of Project Manager and PIT staff | 484,800 |
| | Formally Launch the RNEP-GB Project | MTTED, MENESIC, WARDIP | Formal launch of RNEP-GB | 5,000 |
| | Register RNEP-GB as a Legal Entity | PIC, Project Manager, PIT | | 50,000 |
| | Participate in AfricaConnect project | PIC, PIT | WACREN PoP launched in Bissau | Cost included in AfricaConnect project contribution |
| | Apply for WACREN Membership | MENESIC<br>Project Manager | WACREN membership | 2,000 |
| **Network Deployment** | Apply for AfriNIC membership and number resources (US$ 6,400 payable annually for 5 years plus allocation fees of 2,900) | Project Manager<br>PIC | ASN and IP Numbers received, LIR registration granted | 15,700 |
| | Design and implement the RNEP-GB pilot | PIC, Project Manager | Initial Network | 802,440 |

| | | | | |
|---|---|---|---|---|
| | network | PIT | connected | |
| | Establish Network Operation Centre | DG and technical team | Operational NOC | |
| | Connect to the WACREN PoP in Bissau or other location | Project Manager<br>PIC, technical team from universities | Connection secured | Cost included in 802,440 initial cost |
| | Secure WACREN Global REN and Regional Connectivity Services | Project Manager<br>PIC, Technical Design Group | Global REN connectivity secured | Cost included in AfricaConnect project contribution |
| | Improve Campus Networks | Universities and technical team | Improved campus network design | 15,000 |
| **Application and Service Rollout** | Provide Internet connectivity | Project Manager<br>PIC, Technical Design Group | Affordable Internet connectivity achieved | Cost included in 802,440 initial cost |
| **Capacity Development** | Provide Capacity Building for Members and Staff | PIT, PIC, WACREN | Basic network training provided | 20,000 |
| **Sustainable Operation of RNEP-GB** | Initial contact is made with potential donors | MENESIC, MTTED | List of potential donors contacted | _ |
| **PHASE II (2025-2026)** | | | | |
| **Governance and Institutional Development** | Establish formal governance framework | Project Manager, PIC, PIT, RNEP-Members | DG in place, RNEP registered, formal governance framework in | 75,000 |

| | | | | |
|---|---|---|---|---|
| | | | place | |
| **Network Deployment** | Connect Other Member Institutions in Bissau and Biombo | Board, Project Manager, PIT | Additional institutions connected | 100,000 |
| | Strengthen campus networks | Board, Project Manager, PIT | Increased bandwidth consumption | |
| **Applications and services rollout** | Launch RNEP-GB applications and demonstrative initiatives | Board, Project Manager, PIT | Additional services rolled out | 50,000 |
| **Capacity Building** | Provide training on campus network design, network service rollout and cybersecurity | Board, Project Manager, PIT | Training on campus network and incident management is delivered | 20,000 |
| **Sustainable operation RNEP-GB** | Promote partnership and resource mobilisation | Board, Project Manager, PIT, MTTED, MENESIC | Projects designed and donors engaged | 10,000 |
| | Marketing of RNEP-GB Services | Project Manager, PIT, PIC | Awareness of RNEP-GB activities and services | 10,000 |
| **PHASE III (2026-2029)** | | | | |
| **Governance and Institutional Development** | Establish a full governance framework | Board, Project Manager, PIT, MTTED, MENESIC | Governance framework operational | 50,000 |
| | Establish RNEP-GB Secretariat | Board | | 250,000 |

| | | | | |
|---|---|---|---|---|
| **Network Deployment** | Connect all eligible Research and Education Institutions | DG and technical team | All institutions connected | 50,000 |
| | | | | |
| **Applications and Services rollout** | Rollout advanced application and services | DG and technical team | Catalogue of Applications and Services | 100,000 |
| **Capacity Building** | Offer training on advanced applications and services | DG and technical team | Applications and services training report | 60,000 |
| **Sustainable Operation of RNEP-GB** | Nurture relationships and partnerships for resource mobilisation | DG and administrative team, MENESIC, MTTED | Projects designed and donors engaged, resources mobilised | 10,000 |

# 7 Summary and Conclusion

National Research and Education Networks (NRENs) exist in over 120 countries to support teaching, learning, research and collaboration. Guinea-Bissau is one of the last countries without an NREN. The establishment of the RNEP-GB will have an impact on job creation and sustainable development as outlined in the Terra Ranka strategy. It also puts the country on the global NREN Map.

The establishment and operationlisation of RNEP-GB requires that the Government and higher education stakeholders to work together in establishing the institutional framework, deploying a scalable data network. delivering applications and services for all users, building the capacity of RNEP-GB members and staff and fostering international cooperation.

Providing Internet and research network connectivity is key for sustainable operation of RNEP-GB. The connectivity target is to achieve at least 0.5 Gbps per 1,000 students by 2025 and at least 5 Gbps per 1,000 students by 2030. Assuming that the current student enrolment of 19,369 higher education students increases to say 20,000 by 2025, higher education institutions in Guinea-Bissau will need about 10 Gbps to meet the bandwidth needs of higher education institutions across the country: this is the recommended bandwidth for initial procurement.

Mobilisation of resource is a key for ensuring all the activities related to networking, application and services, capacity building and institutional arrangement are implemented. RNEP-GB will require a total of US$675,000 to set up and operate in the first two years. The Government therefore needs to ensure these resources are mobilised locally and from development partners.

# Appendix A  Technology Specifications

This section contains the Technical Specifications to provide guidelines and standards for the design and implementation of the network infrastructure to the PIC, Project Manager, design teams and other stakeholders planning the proposed RNEP-GB network infrastructure. The specifications consider network scalability requirements to accommodate future growth in users, traffic, and services, and they define performance metrics and reliability standards that the network infrastructure must meet. The specifications also address interoperability requirements to ensure that the RNEP-GB network interoperates seamlessly with other networks, both nationally and internationally. They also guide procurement and vendor management.

| EQUIPMENT CATEGORY | MINIMUM SPECIFICATIONS | QUANTITY | UNIT |
|---|---|---|---|
| **PoP and campus fibre** | Fibre type: Single-mode (SMF)<br>Must comply with ITU-T G.652.D or ITU-T G.657.A1 standards and meet or exceed IEC 60794 standards for fibre optic cables<br>Must at least have a minimum of 24 fibres<br>Must have UV-resistant and weatherproof outer jacket<br>Must have a central strength member (steel wire or dielectric material) and tensile strength to withstand aerial deployment stress<br>Must have corrugated steel tape armour or other suitable armouring for added protection against physical damage<br>Must at least support operating temperature of 0ºC to 70ºC<br>Must at least support relative humidity of 5% to 90% (non-condensing) | 5 | km |
| **CORE NETWORK EQUIPMENT** | | | |

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| **Core Routers** | Must not exceed 5U form factor<br>Must at least have the following ports: 10x1GE, 10x10GE SFPs<br>Must at least support a capacity of 1.5 Tbps<br>Must at least support packet forwarding capacity of up to 1 billion packets per second<br>Must at least support a maximum of 16GB in the routing engine<br>Must support a wide range of protocols including MPLS, BGP, OSPF, IS-IS, IPv6 and more<br>Must include integrated security features including firewall filters, DDoS protection, and threat intelligence<br>Must at least support operating temperature of 0ºC to 40ºC<br>Must at least support relative humidity of 5% to 90% (non-condensing)<br>Must support high availability with at least 2 redundant power supplies, fans and routing engines<br>Must include costs for necessary software licenses, optics, and accessories<br>Must include at least two (2) year product warranty with technical support and advance replacement options | 1 | unit |
| **Aggregation Switches** | Must at least have these ports: 48x1GE, 4x10GE SFPs<br>Must at least support a switching capacity of 256 Gbps<br>Must at least support packet forwarding capacity of up to 150 million packets per second<br>Must at least support the following Layer 2 functions: ≥ 4K VLANs, IEEE 802.1d/1w/1s<br>Must at least support the following Layer 3 functions: RIPv1/v2, OSPF, BGP, IS-IS, RIPng, OSPFv3, IPv6, ISIS<br>Must at least support features for management and maintenance including RADIUS, RMON, SNMP and SSHv2 | 2 | unit |

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| | Must at least support operating temperature of 0ºC to 40ºC<br>Must at least support relative humidity of 5% to 90% (non-condensing)<br>Must at least support high availability with at least 2 redundant power supplies, fans and routing engines<br>Must include costs for necessary software licenses, optics, and accessories<br>Must include at least two (2) year product warranty with technical support and advance replacement options | | |
| **Firewall Appliances** | Must support at least performance of up to 20Gbps firewall<br>Must support at least 50,000 new sessions per second<br>Must support dynamic threat protection including malware sandboxing, threat intelligence feeds, and detection of malware hidden in SSL-encrypted traffic<br>Must support built-in secure SD-WAN solution<br>Must support at least the following WAN modules: T1/E1, ADSL2/2+, VDSL2, and 3G/4G LTE options<br>Must support network segregation to allow security and management policies based on zones, VLANs, and IPsec VPNs<br>Must at least include dual AC power supplies<br>Must include at least two (2) year product warranty with technical support and advance replacement options | 1 | unit |
| **ACCESS AND DISTRIBUTION** | | | |
| **Access Switches** | Must at least have these ports: 8x1GbE RJ-45, 4x1GbE SFP<br>Must at least support a routing throughput of 2 Gbps<br>Must at least support the following features stateful firewall, IPsec VPN, PoE+, Intrusion Detection and Prevention (IDP)<br>Must at least support operating temperature of 0ºC to 40ºC<br>Must at least support relative humidity of 5% to 90% (non- | 32 | unit |

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| | condensing)<br>Must at least support high availability with at least 2 redundant power supplies and fans<br>Must include costs for necessary software licenses, optics, and accessories<br>Must include at least two (2) year product warranty with technical support and advance replacement options | | |
| **Network Interface Cards** | Intel Ethernet Server Adapter I210-T1:<br>Ports: 1 x 1GE<br>Interface: PCIe 2.1<br>Features: Low power, high performance | 32 | unit |
| **Network Interface Cards** | SFP+ modules | 80 | unit |
| **MANAGEMENT AND MONITORING** | | | |
| **NMS Software** | Integrated with networking infrastructure | | |
| **Environment Monitoring** | Form Factor: Rack-mountable or wall-mountable<br>Must monitor temperature, humidity, and other environmental conditions in real-time to prevent potential issues<br>Must supports external camera integration for real-time video monitoring and recording<br>Must be expandable with additional sensor pods and external sensors to cover larger areas or multiple racks<br>Must be capable of sending alerts via email, SNMP traps, or syslog when environmental conditions exceed predefined thresholds<br>Must support role-based access control for secure management of the monitoring system.<br>Data Logging: Logs environmental data for historical analysis and compliance purposes.<br>Must include at least two (2) year product warranty with technical | 1 | unit |

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| | support and advance replacement options | | |
| **STORAGE AND COMPUTING** | | | |
| **Servers** | Form Factor: 2U rack server<br>CPU: Intel Xeon Processor, Up to 2 processors, 8-Cores or Higher<br>Memory: at least 128Gb Memory, up to 3TB (with Persistent Memory)<br>Memory Type: DDR4 RDIMM, LRDIMM<br>Drive Bays: supports at least 8 x 2.5-inch SAS/SATA or NVMe SSDs<br>RAID Controller<br>Network Controller Options: 1GbE or 10GbE LOM<br>Power Supplies: Dual Hot-plug redundant PSUs<br>Must include at least two (2) year product warranty with technical support and advance replacement options | 4 | unit |
| **Storage Systems** | Form Factor: Rack mountable<br>HDD Bays: Must support up to 24 x 2.5" drive bays<br>Processors: Intel Xeon Processor with 8-core and up to 2.7GHz<br>Memory: Can Support at least 64GB, maximum of 64GB configured<br>Storage: Must have at least a total of 100TB usable capacity. Must support single volume size up to 200TB<br>Network Interface Card: Must have at least 2 x 10GB SFP+, 2 x 10GbE RJ-45 and 2 x 1GbE RJ-45 ports<br>Must support the following file systems: BTRFS, Ext4, Ext3, FAT, NTFS, HFS+, exFAT<br>Must include at least two (2) year product warranty with technical support and advance replacement options | 1 | unit |
| **CONNECTIVITY AND CABLING** | | | |
| **Rack Cabinet** | W=800mm, D=1070mm, H= 1992mm (42U) | 2 | unit |

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| | Colour: Black<br>Loading capacity: 1500kgs<br>Adjustable EIA-310-E compliant mounting rails<br>Top panel with airflow or cable cover plates<br>High-flow perforated steel front &rear doors<br>Swing handles with key lock<br>Lockable sides<br>Castors, levelling feet and anti-tip brackets<br>Quick-connect grounding<br>Colour: Black (RAL9005)<br>Vertical air baffles with cable pass-thru<br>One (1) year warranty | | |
| **Fibre Optic Cable** | Single-mode fibre (SMF), LC/UPC,<br>Compliance: ITU-T G.652.D | 50 | km |
| **Fibre Patch cord** | Standard Length: 3 meters<br>Conforms Standard: TIA/EIA 568 C.3<br>Fibre type: OM3<br>Connector: SC-LC and LC-LC<br>Cable Construction: duplex | 40 | unit |
| **UTP CAT6 Cable** | Cat6a, RJ45,<br>24AWG solid bare copper conductors, non-plenum, Polyolefin insulation, twisted pairs, central spline, rip cord, PVC jacket<br>Compliance: ANSI/TIA-568-C.2<br>NEC/(UL) Specification: CM<br>CEC/C(UL) Specification: CM<br>IEC Specification: 11801 Category 6<br>EU RoHS Compliant (Y/N): Y<br>Suitable applications: Premise horizontal Cable, gigabit ethernet | 100 | unit |

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| **UTP Patch Cord** | Stranded conductors improve Flexibility<br>Improved strain relief and a flexible boot for optimum protection in high-density installations<br>Exceeds TIA and ISO transmission and mechanical performance requirements<br>Patch panel patch cord must be 2meters in length and light blue in colour compliant to TIA-606 colour shade<br>Workstation patch cord must be 3meters in length and light blue in colour compliant to TIA-606 colour shade | 100 | unit |
| **KVM Switch** | Stranded conductors improve Flexibility<br>Improved strain relief and a flexible boot for optimum protection in high-density installations<br>Exceeds TIA and ISO transmission and mechanical performance requirements<br>Patch panel patch cord must be 2meters in length and light blue in colour compliant to TIA-606 colour shade<br>Workstation patch cord must be 3meters in length and light blue in colour compliant to TIA-606 colour shade | 2 | unit |
| **POWER AND COOLING** | | | |
| **Backup power** | Generator, full set with changeover switch and power cable<br>Capacity: 45 kVA (Prime Power Rating)<br>Engine: Diesel engine (typically water-cooled)<br>Alternator Type: Brushless<br>Voltage Output: 208V - 240V, Single-phase or Three-phase<br>Frequency: 50 Hz<br>Fuel Type: Diesel, Integrated fuel tank<br>Sound Level: Soundproof or silent enclosure to minimize noise levels (typically around 70-75 dB at 7 meters) | 1 | unit |

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| | Controller: Automatic start/stop controller with monitoring and protection features<br>Cooling System: Radiator with fan<br>Automatic change over switch between mains and generator power during power outages with matching voltage and current, surge protection, delay timers and manual override capabilities<br>Copper conductor cables suitable for outdoor and high-current applications with all required connectors<br>Weatherproof and soundproof enclosure for outdoor installation<br>Professional installation by certified electricians and generator technicians<br>Must include at least three (3) year product warranty with technical support and advance replacement options | | |
| **UPS** | Output Power Capacity: 3000 VA / 2700 W<br>Output Frequency (sync to mains): 50/60 Hz +/- 3 Hz user adjustable +/- 0.1 Hz<br>Interface Ports: USB, Ethernet 10/100 Base-T<br>Control Panel: Multi-function LCD status and control console<br>Battery Type: Maintenance-free sealed Lead-Acid battery with suspended electrolyte<br>Communication Slots: USB, Ethernet 10/100 Base-T<br>Dimensions: Height 3.5 inches, Width 17.0 inches, Depth 26.0 inches<br>Protection: Overload, over temperature, short circuit, discharge, overcharge<br>Must include at least two (2) year product warranty with technical support and advance replacement options | 2 | unit |
| **PDUs** | Input Voltage: 220V AC, Single-phase<br>Input Connection: NEMA L6-30P twist lock plug | 2 | unit |

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| | Output Connections: 14 x C13, 2 x C19 outlets<br>Output Voltage: 220V AC<br>Maximum Total Current Draw per Phase: 30A<br>Maximum Power Capacity: 5.76kW (at 220V)<br>Mounting: Universal Mounting System including clip feet and flexible button, rear & side mounting system<br>Cord Length: includes a 10-foot (3-meter) input power cord with NEMA L6-30P plug<br>Overload Protection: Circuit breaker<br>Must include at least two (2) year product warranty with technical support and advance replacement options | | |
| **Cooling Systems** | Portable Air Conditioner<br>Cooling Capacity: at least 12,000 BTU (British Thermal Units)<br>Adjustable Speeds: Multiple fan speeds<br>Operating Modes: Cool, Fan, Dehumidify<br>Thermostat: Adjustable digital thermostat for precise temperature control<br>Noise Level: Typically ranges from 52 to 56 decibels (dB) depending on the model<br>Remote Control: Included for convenient operation from a distance<br>Air Filter: Washable and reusable air filter for easy maintenance<br>Additional Features: Programmable timer, auto-evaporation system, eco-friendly refrigerant | 4 | unit |
| **Fire Suppression System** | Must include at least 200kg of FM200/clean agent chemical with gas cylinder c/w all installation accessories<br>Must include a 2 zone gas extinguishing panel unit<br>Must include at least 2 conventional optical smoke and heat detectors | 1 | unit |

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| | Must have a conventional sounder bell<br>Must have a manual release button<br>Must have system abort switch<br>Must have stand by batteries to operate system<br>Must provide fire drill training for staff members<br>Includes all installation charges and accessories<br>Must include at least two (2) year product warranty with technical support and advance replacement options | | |
| **Door Access System** | Resolution: 120 x 160<br>Frame Rate: 25 fps<br>Type: Touch Screen<br>Pixel: 2MP<br>Lens: Dual<br>Multiple authentication modes are available: card and temperature, face and temperature, card and face and temperature<br>Triggers voice prompt when detecting abnormal temperature<br>Configurable door status (open/close) when detecting abnormal temperature<br>Face recognition duration $<$ 0.2 s/User; face recognition accuracy rate ≥ 99%<br>6000 face capacity, 6000 card capacity, and 100,000 event capacity<br>Must have supporting floor stand brackets<br>Warranty: One (1) year | 1 | unit |