

Alternative and complementary technologies for last-mile connectivity in South Africa



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Foreword



I am pleased to present this report on alternative and complementary technologies such as aerial fibre, satellite, and television white spaces (TVWS), for last-mile connectivity in South Africa. As technology becomes increasingly central to community development and empowerment, universal access to connectivity is essential to enabling all people to participate meaningfully in the digital economy and society.

This report aims to address common challenges South Africa faces by examining innovative alternative and complementary technologies, along with proposing strategies to overcome persistent barriers to affordable and reliable Internet access to contribute to universal meaningful connectivity. The findings of the report highlight possible regulatory and structural challenges, which if addressed, could improve the growth and sustainability of providers offering alternative connectivity solutions, particularly in underserved areas.

The findings confirm that alternative and complementary technologies can offer viable alternative solutions for extending connectivity to rural and underserved communities. It is therefore crucial that service providers such as the Wireless Internet Service Provider (WISPs) and Community Networks receive the necessary support from the government and the regulator to deliver services effectively and continue to ensure that no one is left behind.

A handwritten signature in black ink, appearing to read "Dr. Cosmas Luckyson Zavazava".

Dr Cosmas Luckyson Zavazava
Director of the Telecommunication Development Bureau
International Telecommunication Union

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Executive summary

This report examines alternative and complementary technologies aimed at improving last-mile Internet access and advancing universal meaningful connectivity in South Africa. It addresses persistent challenges related to affordability, infrastructure gaps, and regulatory obstacles that impede the expansion of Internet access in underserved communities.

By identifying and promoting alternative solutions, this report aims to guide the implementation of connectivity programmes in underserved communities in South Africa, fostering digital empowerment and contributing to broader socio-economic development. The proposed creative and innovative solutions leverage emerging technologies to address diverse connectivity needs.

The information presented in this report is derived from desktop research, analysis of policy documents, and informal conversations and interviews with diverse stakeholders. The research methodology involved a comprehensive review of relevant literature, policy frameworks, and industry reports, as well as consultations with experts and practitioners in the field of telecommunications and digital transformation. Policy analysis focused on evaluating the existing regulatory framework and identifying areas for reform to promote alternative connectivity solutions. Stakeholder consultations provided valuable insights into the practical challenges and opportunities associated with expanding Internet access in South Africa.

The recommendations proposed in this report span various domains, including spectrum allocation, regulatory framework adjustments, infrastructure sharing, financing mechanisms, digital skills development, and technology adoption. Leveraging current initiatives and grounded in practical realities, the recommendations and guidelines provide a strategic direction for implementation of alternative last-mile connectivity solutions.

Key findings

Despite significant progress in expanding digital access, South Africa continues to face a persistent digital divide, particularly in terms of affordability and rural access. The current regulatory framework poses obstacles for alternative connectivity providers, including complex licensing processes and high spectrum costs. Additionally, limited access to affordable backhaul, expensive high sites, and complex wayleave processes hinder the expansion of alternative connectivity solutions, restricting efforts to bridge the gap in underserved areas.

The State of the Nation Address (SONA) in January 2025, and public hearings held by the Independent Communications Authority of South Africa (ICASA) on a new satellite licensing framework, demonstrated the commitment of the Government of South Africa to addressing connectivity challenges. The emphasis placed in the SONA address on digital infrastructure, digital transformation, and investments in these areas reflects a clear recognition of the importance of connectivity for economic growth and social development. Additionally, the G20 presidency of South Africa presents a unique opportunity to shape global digital governance and promote more inclusive digital development.

Recommendations

The report proposes a comprehensive set of recommendations and guidelines to address the digital divide in South Africa and enhance last-mile connectivity.

In terms of spectrum management, the report suggests exploring more flexible and inclusive approaches that could benefit underserved areas and smaller players. The regulatory framework recommendations aim to streamline processes and accommodate emerging technologies, particularly in the satellite sector. To address infrastructure challenges, the report proposes policies that could ensure more affordable access to critical resources for alternative connectivity providers. The recommendations also emphasize the importance of redesigning financing mechanisms and leveraging new funding opportunities to support last-mile connectivity solutions.

Capacity building and digital skills development initiatives, such as expanding existing programmes and establishing support ecosystems, are highlighted as crucial for the success of alternative connectivity solutions. The report also encourages the adoption of innovative technologies such as dynamic spectrum access. Finally, the recommendations stress the importance of continued research and development, as well as the need for integrated infrastructure development that aligns digital connectivity initiatives with other major projects.

By considering the implementation of these recommendations, South Africa could make significant strides in bridging its digital divide, leveraging a diverse range of technologies and approaches to ensure meaningful connectivity for all citizens. The key to success lies in creating a supportive regulatory environment, fostering innovation, and prioritizing affordable access in underserved areas.

To achieve universal meaningful connectivity, South Africa needs a multi-faceted approach that combines policy reforms, technological innovation, and targeted support for alternative connectivity providers. Success will require continued collaboration between government, private sector, and community stakeholders, as well as a flexible regulatory environment that can adapt to rapidly evolving technologies and market conditions.

Connectivity technology strategies

In this report, the following technologies have been identified as worthy of further exploration with a view to enhancing last-mile Internet access and contributing to universal meaningful connectivity in South Africa.

Community-centred solutions: Complementary access solutions, such as community networks (CNs) and small wireless Internet service providers (WISPs) have emerged as key alternatives for connecting underserved areas, though they face sustainability and scalability challenges.

Aerial optical fibre: Rapid and cost-effective deployment of aerial optical fibre in dense township environments offers a promising solution for last-mile connectivity.

Dynamic spectrum access (DSA): Exploring DSA technologies, including TV white space (TVWS) and the potential use of the 3 800-4 200 MHz band, could optimize spectrum use and support smaller players.

Satellite connectivity: Low earth orbit (LEO) satellite constellations present opportunities for connectivity in ultra-remote areas and particularly as backhaul solutions for complementary access solutions, such as community networks and WISPs.

Public Wi-Fi initiatives: While not providing comprehensive connectivity, public Wi-Fi projects contribute to bridging the digital divide in specific areas.

Part 1: Context analysis: Connectivity status and the digital divide in South Africa

In recent years the Republic of South Africa has made significant strides in advancing digital inclusion. However, the digital divide persists, highlighting the need to address ongoing challenges. Exploring these challenges and identifying innovative solutions could help accelerate meaningful connectivity in underserved areas.

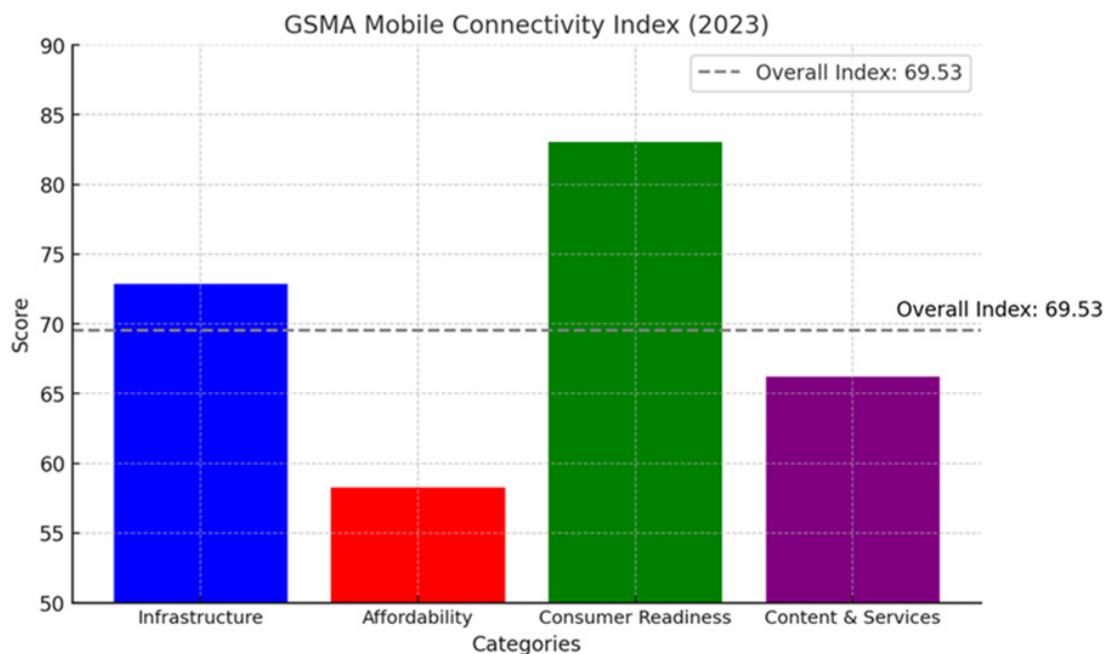
Several indices serve to highlight the progress South Africa has made in digital connectivity. According to the International Telecommunication Union (ITU) ICT Development Index that measures levels of universal and meaningful connectivity, South Africa attained a score of 83.6, with 99.9 per cent mobile coverage and 74.7 per cent of individuals using the Internet.¹

The GSMA Mobile Connectivity Index evaluates mobile Internet adoption.² As can be seen in Figure 1, in 2023 South Africa scored 69.53 overall, with the following category breakdown:

- Infrastructure: 72.89
- Affordability: 58.29
- Consumer readiness: 83.06
- Content and services: 66.24

Notably, the low affordability index score stands out. Despite strong broadband infrastructure, reflected in a network coverage index score of 91.89, high costs continue to place Internet access beyond the reach of many households.

Figure 1: South Africa category ratings in the GSMA Mobile Connectivity Index



Source: GSMA

¹ <https://datahub.itu.int/dashboards/idi/?e=ZAF&y=2024>

² <https://www.mobileconnectivityindex.com/>

Demand-side data reveals that Internet usage among South Africans reached 76 per cent in 2022, representing a significant increase from 49 per cent in 2018. Rural areas have experienced significant growth, with usage rising from 35 per cent in 2018 to 66 per cent in 2022, while the gender gap with respect to Internet use has been reduced to a negligible figure.³ However, this data focuses solely on Internet usage and does not provide insights into whether marginalized groups can engage with the Internet in meaningful and equitable ways. Furthermore, 70 per cent of Internet users cite high data costs as the primary barrier to more frequent usage.

Some policy interventions have primarily benefited existing Internet users. For example, during the COVID-19 pandemic, the Competition Commission mandated price reductions for dominant operators, focusing on regulating retail data prices. However, this policy focused on reducing data prices and failed to address the issue of the high cost of mobile devices in the country, which is a crucial barrier to broader Internet adoption. While existing Internet users benefited from lower data costs, the upfront cost of acquiring an Internet-enabled device remained prohibitively expensive for many South Africans.⁴ This oversight in policy intervention has meant that the cost of devices continues to be a significant obstacle for those not yet connected, limiting the expansion of Internet access to new users.

National challenges

Despite overall improvements in infrastructure rollout and service quality largely driven by the 5G spectrum auction in March 2022, significant disparities in connectivity remain a challenge across South Africa. While urban areas, particularly Gauteng and the Western Cape, enjoy high-quality Internet services, rural provinces such as Limpopo and the Northern Cape continue to experience limited and inconsistent connectivity. A key constraint remains the difficulty of sustaining robust network performance in rural areas. The national energy crisis compounds these challenges, disrupting network performance and undermining reliability.⁵

Institutional framework and regulatory environment

Overview of the general institutional framework enabling connectivity

The primary ICT regulatory body in South Africa is the Independent Communications Authority of South Africa (ICASA), mandated to regulate the telecommunication, broadcasting, and postal services sector. ICASA grants and revokes licences to operators and service providers for electronic communications, including registration, transfers, and exemptions. Licences ensure efficient allocation of scarce resources such as spectrum frequencies and protect consumers. Two licence types exist:

- 1) Electronic Communications Service (ECS) licences allow providers to offer services such as voice and data over their own or other networks.
- 2) Electronic Communications Network Service (ECNS) licences permit building, operating, and sharing of network infrastructure such as for example fibre optic or wireless network infrastructure.

³ Andrew Partridge, 'After Access 2022: Internet Usage Trends in South Africa - Research ICT Africa' (2022) <<https://researchictafrica.net/publication/after-access-2022-internet-usage-trends-in-south-africa/>>

⁴ <https://researchictafrica.net/research/digital-africa-post-the-pandemic-south-africa-report-after-access-2022-2023/>

⁵ Omar, N. (2022). *Analysing South Africa's Internet performance 2022*. Digital New Deal Project Policy Brief no. 7. Research ICT Africa. <https://researchictafrica.net/publication/analysing-south-africas-internet-performance-2022/>

ICASA also monitors regulation compliance and enforces consumer protection measures. The Minister of Communications and Digital Technologies is responsible for setting policy and may issue policy directions to ICASA on any relevant matters. The Competition Commission and ICASA have signed a Memorandum of Understanding (MoU) to engage and collaborate in order to address areas of co-jurisdiction seamlessly. Furthermore, ICASA publishes annual reports on the state of the ICT sector in South Africa.⁶

Overview of the telecommunication and ICT policy and regulations

The following laws set out the general legal framework for telecommunications in South Africa:

- Independent Communications Authority of South Africa Act, 12 of 2000 (ICASA Act),
- Electronic Communications and Transactions Act 25 of 2002 (ECT Act),
- Electronic Communications Act, 2005.⁷

Collectively these laws define and elaborate the institutional framework of the sector, notably providing for the establishment of ICASA. Key regulatory elements include licensing, competition policy, quality of service, interconnection, scarce resources management, universal service, tariffs regulation, penalties and sanctions, and dispute resolution processes.

Connectivity plans and strategies

A number of government programmes and initiatives have prioritized addressing the three core socio-economic challenges of poverty, unemployment and inequality, with information and communication technologies (ICTs) playing a central role in these efforts. The National Development Plan (NDP) 2030, adopted by Cabinet in 2012, aims to eradicate poverty, generate quality employment, and reduce inequality by 2030.⁸

One of the key priorities of the NDP is broadband expansion, which led to the formulation and adoption of the national broadband policy, SA Connect.⁹ SA Connect set a 2030 goal to achieve 100 per cent population coverage with broadband services delivering at least 10 Mbit/s, priced at no more than 2.5 per cent of the average monthly income.

Phase 1 focused on providing broadband connectivity to schools, healthcare facilities, and other government facilities. In 2022, Cabinet approved the revised SA Connect Phase 2 model. The key interventions of this phase include ensuring universal broadband access for all communities and government facilities, alongside the implementation of universal service obligations.

State-owned entities Broadband Infraco (BBI) and Sentech, form an integral part of the government strategy to expand broadband coverage, particularly in underserved and rural areas. BBI is tasked with providing backhaul connectivity ensuring that government facilities, schools, clinics and underserved communities are connected to broadband networks. In addition, BBI is assigned to manage the Broadband Access Fund, which is part of the Presidential Employment Stimulus, providing connectivity to households and public hotspots while simultaneously

⁶ <https://www.icasa.org.za/legislation-and-regulations/state-of-the-ict-sector-in-south-africa-2024-report>

⁷ Republic of South Africa. (2005). Electronic Communications Act 36 of 2005. <https://www.gov.za/documents/electronic-communications-act>

⁸ Government of South Africa, National Development Plan 2030: Our Future - Make It Work (August 2012), https://www.gov.za/sites/default/files/gcis_document/201409/ndp-2030-our-future-make-it-workr.pdf

⁹ Department of Communications and Digital Technologies (DCDT), SA Connect: The South African National Broadband Policy Implementation Plan (2013), <https://www.dcdt.gov.za/sa-connect-document.html>.

creating employment opportunities.¹⁰ Sentech, by contrast, primarily focuses on wireless broadband solutions and the provision of last-mile connectivity.

The Universal Service and Access Agency of South Africa (USAASA) has collaborated with BBI to deliver broadband services in the OR Tambo District Municipality in the Eastern Cape and Pixley Ka Seme District Municipality in the Northern Cape. In addition, Nyandeni Local Municipality in the OR Tambo District Municipality, and Harry Gwala District Municipality in KwaZulu-Natal were identified for the expansion of broadband.¹¹ According to stakeholder interviews, to date 412 sites in the Eastern Cape and Northern Cape have been completed, while a further 200 sites for Kwazulu-Natal and Eastern Cape are planned.

In 2016, the Cabinet approved a National Integrated ICT Policy White Paper that aims to advance digital infrastructure, promote the adoption of emerging technologies, and strengthen digital skills across the population. The policy white paper addresses a wide range of topics, including revised institutional arrangements for the ICT sector and promotion of universal access and service.¹² However, implementation has been a gradual process, facing challenges due to the lack of coordination among government departments and overlapping roles of institutional players which has created inefficiencies. Additionally, regulatory frameworks have struggled to keep pace with the rapidly evolving ICT landscape.¹³

In 2019, President Cyril Ramaphosa, established the Presidential Commission on the 4th Industrial Revolution Strategy (PC4IR), to develop a comprehensive national strategy to leverage the transformative potential of the 4IR and address associated challenges.¹⁴ In 2020, the Commission finalized and published the 4IR report. The report has seven key strategic priorities, and while some have been implemented, such as the establishment of the Artificial Intelligence Institute, implementation of many of the recommendations has been limited. Key challenges include inadequate digital infrastructure, a shortage of digital skills, fragmented governance, outdated policies, limited funding, and socio-economic inequalities that exacerbate the digital divide.¹⁵ To support implementation, a monitoring and evaluation framework was developed to oversee the PC4IR Strategic Implementation Plan, the main aim being to assess the socio-economic impacts of various 4IR initiatives across the country.¹⁶

These plans and initiatives clearly demonstrate the commitment of South Africa to leveraging ICTs to address socio-economic challenges and expand digital inclusion. The NDP recognition of broadband expansion as a key priority and the ambitious goals set forth in SA Connect national broadband policy highlight the acknowledgement of broadband as a key enabler of economic growth and social development. The National Integrated ICT Policy White Paper and the PC4IR Strategy further underscore the intent of the Government to foster innovation and build digital skills. However, the success of these strategies hinges on effective implementation, which has been hindered by a lack of coordinated effort between government departments to

¹⁰ https://static.pmg.org.za/240821_BBI_Presentation.pdf

¹¹ https://static.pmg.org.za/USAASA_Annual_Report_2022-2023.pdf

¹² https://www.gov.za/sites/default/files/gcis_document/201610/40325gon1212.pdf

¹³ <https://researchictafrica.net/wp-content/uploads/2018/10/the-state-of-ict-in-south-africa.pdf>

¹⁴ Presidential Commission on the 4th Industrial Revolution (PC4IR), 'Report of the Presidential Commission on the 4th Industrial Revolution' (2020) <https://www.gov.za/sites/default/files/gcis_document/202010/43834gen591.pdf>

¹⁵ <https://www.uj.ac.za/wp-content/uploads/2021/10/sarchi-wp-2021-08d-alexander-october-2022.pdf>

¹⁶ https://www.parliament.gov.za/storage/app/media/Pages/2023/27-03-2023_Three_Sphere_Planning_Session/session2/Communications_and_Digital_Technologies_Input.pdf

translate strategy into tangible outcomes, and duplication of responsibilities among institutional players which has led to inefficiencies.

National spectrum strategies

The efficient use and management of spectrum resources can play a pivotal role in expanding Internet access to underserved areas and in bridging the digital divide in South Africa. This critical resource directly impacts the cost of connectivity, as efficient spectrum utilization translates into more competitive retail pricing for consumers. In a country where Internet access is primarily wireless, spectrum resources naturally take centre stage in national policy discussions.

The process of allocating high-demand spectrum in South Africa has faced significant delays and legal challenges, primarily due to the protracted digital migration from analogue to digital broadcasting, which was originally scheduled for completion in 2015. To date, the migration from analogue to digital broadcasting remains incomplete.

As a way to increase competition in the mobile market and provide more affordable access to spectrum for smaller players, the Government of South Africa proposed the Wholesale Open Access Network (WOAN) in 2016. The WOAN was envisioned to provide wholesale services using shared spectrum. It was intended to be a tool for transformation in the ICT telecommunication sector, potentially introducing broader ownership and allowing small and medium enterprises to access spectrum and participate in network deployment. ICASA began concrete steps towards implementing the WOAN in 2019, but the project faced delays and challenges, partly due to issues related to the allocation of emergency spectrum during the COVID-19 pandemic.¹⁷

In March 2022, the Minister of Communications formally cancelled the WOAN project, citing the view that commercial operators were capable of providing universal services without it.¹⁸ Instead, the Government opted for other solutions, such as spectrum auctions with coverage obligations, to connect less profitable areas. Other factors that influenced this decision to cancel the WOAN project were the lack of comprehensive economic analyses or impact assessments to substantiate claims that the WOAN could lower consumer prices and expand access.¹⁹

In the same month, ICASA conducted a spectrum auction in which a substantial allocation of 110 MHz was assigned to established large operators for ZAR 5.38 billion (approximately ZAR 49 million per MHz). This highlights how current spectrum allocation processes primarily favour large commercial operators. The high cost creates a barrier for smaller operators and community-led initiatives from participating, limiting alternative connectivity solutions. ICASA has planned another spectrum auction to release additional IMT spectrum suitable for mobile broadband, including 4G/LTE and 5G.^{20,21}

¹⁷ <https://researchictafrica.net/publication/temporary-covid-19-spectrum-a-missed-opportunity-for-some-regulatory-innovation/>

¹⁸ <https://www.ellipsis.co.za/wireless-open-access-network-woan/>

¹⁹ <https://archive.opengazettes.org.za/archive/ZA/2018/government-gazette-ZA-vol-639-no-41935-dated-2018-09-27.pdf>

²⁰ <https://techcentral.co.za/icasas-spectrum-auction-plans-for-2024-a-happy-story/224542/>

²¹ The bands targeted for allocation include IMT450 (450-470MHz), IMT850 (825-830MHz and 870-875MHz), and IMT1500 (1.427-1.518GHz). These are in addition to seven other bands identified in December 2023: IMT700 (703-733MHz and 758-788MHz), IMT750 (733-758MHz), IMT800 (791-821MHz and 832-862MHz), IMT900 (880-915MHz and 925-960MHz), IMT2300 (2.3-2.4GHz), IMT3300 (3.3-3.4GHz) and IMT3500(3.4-3.6GHz).

In May 2023, ICASA authorized the use of the lower 6 GHz spectrum band (5 925 – 6 425 MHz) for the provision of Radio Local Access Network (RLAN / Wi-Fi) services.²² The introduction of this band for Wi-Fi services has the potential to enable community access networks in underserved areas, by removing spectrum licensing costs, minimizing signal interference in congested bands, and allowing increased simultaneous connections at higher speeds.

The Dynamic Spectrum Alliance conducted studies to assess the economic value of unlicensed use of the 6 GHz band in six countries, including South Africa.²³ The report suggests that policy-makers in South Africa could consider allocating the entire 6 GHz band for unlicensed use to maximize its economic and social benefits. This could be particularly beneficial for expanding coverage in rural and underserved areas. Wireless Internet Service Providers (WISPs) are expected to play a crucial role in leveraging this spectrum to reach remote communities.

Spectrum sharing

There may be opportunities for spectrum sharing with the recently gazetted 2024 “Next-generation radio frequency spectrum policy for economic development”.²⁴ The policy emphasizes the need for a legislative review as the current framework, established in 2006, no longer aligns with significant changes in markets, technology, and consumption. There has been a shift from licensees having exclusive rights to spectrum usage to a model where licensees are granted protection from interference. This shift, aimed at enabling spectrum sharing, requires prior authorization from ICASA to ensure proper coordination and management. The policy mandates that spectrum inventories and licensee databases, mapping both licensed and unlicensed spectrum, should be publicly accessible at all times to enhance transparency. The policy permits spectrum trading, sharing, dynamic spectrum access, and spectrum ‘sub-letting’ and/or sharing between licensees, provided they align with public policy objectives. The policy supports community networks as a means to address universal service challenges.²⁵

Additional aspects that promote last-mile connectivity

The Internet Service Providers' Association (ISPA) and the Wireless Access Providers' Association (WAPA) play crucial roles in shaping and supporting the connectivity ecosystem in South Africa. ISPA advocates for open access optical fibre cable installations, and works to influence spectrum policy, both of which are crucial for last-mile connectivity.²⁶ WAPA members collectively own and rent over 5 700 high sites around the country, contributing to the expansion of wireless Internet coverage. They advocate for the use of fixed wireless access as an alternative to optical fibre and cellular networks, and lobby for more progressive and efficient spectrum management.²⁷ These efforts directly contribute to improving last-mile connectivity by promoting infrastructure development, advocating for policies that benefit smaller providers, and expanding wireless coverage options in underserved areas.

²² <https://www.icasa.org.za/news/2023/icasa-releases-more-spectrum-for-wi-fi-services-in-the-lower-6ghz-band>

²³ <https://www.dynamicspectrumalliance.org/2022/05/31/bridging-the-digital-divide-across-the-continents/>

²⁴ Department of Communications and Digital Technologies (DCDT), Next-Generation Radio Frequency Spectrum Policy for Economic Development (May 2024), https://www.gov.za/sites/default/files/gcis_document/202407/50725proc166.pdf

²⁵ By 28 May 2025, ICASA is required to report to the Minister on a new licensing framework for community networks, and a framework for the release of spectrum for community use.

²⁶ https://ispa.org.za/press_releases/

²⁷ <https://wapa.org.za/news/unlocking-the-future-of-connectivity>

South Africa has a well-developed Internet exchange point (IXP) infrastructure that plays a crucial role in improving Internet connectivity and efficiency both domestically and across the African continent. As of January 2025, South Africa has 10 active IXPs.²⁸ The main IXP operators in the country are INX-ZA, an autonomous division of the ISPA which is community-run and data centre agnostic, and NAPAfrica which operates IXPs within Teraco data centre facilities. Teraco is the largest data centre provider in Africa and played a key role in introducing carrier-neutral data centres in South Africa, enabling major international cloud providers to establish local hosting operations in the country. According to the Internet Society Pulse IXP Tracker, South Africa ranks among the top 10 countries globally with the highest share of local Internet traffic exchanged through IXPs.²⁹ South Africa is a hub and attracts traffic from the sub regions.³⁰ IXPs are essential components of Internet infrastructure and contribute to improving last-mile connectivity by reducing latency, lowering costs, enhancing network resilience, and bringing content closer to users.

There are plans to merge two state-owned entities, the signal distribution company Sentech, and the provider of backhaul connectivity Broadband Infracore (BBI), establishing the State Digital Infrastructure Company (SDIC). The rationale being that the infrastructure of BBI and Sentech are complementary, and the SDIC merger is intended as a wholesale digital infrastructure provider, expected to potentially lower costs and improve access in underserved areas.³¹ While the strategic rationale for consolidating state digital infrastructure assets remains sound, the proposed merger of Sentech and BBI faces substantial financial and operational hurdles, such as solvency and liquidity challenges at BBI, integration challenges, and lack of a clear business case.

The National Research and Education Network (NREN) of South Africa has a connection policy which provides for participating institutions, such as universities and research institutions, to share their connections with non-profit entities that they collaborate with or support, particularly in areas such as education, research, or community engagement.³² Some complementary access solutions have benefitted from this arrangement. For example, Zenzeleni networks in the Eastern Cape was originally connecting through the National Research and Education Network via Walter Sisulu University in Mthatha, before transitioning to an uncontended optical fibre connection provided by Easttel. This demonstrates how the National Research and Education Network can serve as a stepping stone for complementary access solutions to establish and improve connectivity services.

Universal service funds and financing of last mile connectivity

The Universal Service and Access Fund (USAF) is managed by the Universal Service and Access Agency of South Africa (USAASA) and is financed by contributions from all licensed service providers. While plans to dissolve USAASA and create a new Digital Development Fund have been in place since 2016, the process has been delayed. The current USAF is limited to funding supply-side initiatives, prompting the idea of establishing the Digital Development Fund (DDF)

²⁸ https://pulse.internet-society.org/en/ixp-tracker/?country_code=ZA

²⁹ <https://www.afpif.org/wp-content/uploads/2024/08/Pulse-IXP-Tracker.pdf>

³⁰ Since many content providers are based in South Africa, most operators in the region naturally route their traffic there. Some neighbouring countries, such as Botswana, rely almost entirely on South Africa for Internet connectivity. Broadly, Internet traffic from Southern, Eastern, and Central Africa is directed toward South Africa, while North African traffic typically routes to Europe, and West African traffic is primarily directed to the United States.

³¹ <https://www.parliament.gov.za/press-releases/media-statement-communications-committee-concerned-stagnation-establishment-state-digital-infrastructure-company>

³² <https://www.tenet.ac.za/downloads/connection-policy/view>

to enable funding for demand-side initiatives as well.³³The planned transition to the Digital Development Fund offers an opportunity to address some of the limitations of the USAF by expanding the scope to include demand-side initiatives while improving governance structures. However, the prolonged transition period risks creating continued uncertainty and operational inefficiencies that could undermine the impact of the fund on the digital transformation goals of South Africa.

According to the recently gazetted 2024 “Next-generation radio frequency spectrum policy for economic development”, ICASA must review or develop a universal service obligations (USOs) framework by 28 May 2025 to maximize societal and State benefits from obligations assigned to mobile network operators. USOs should align with the national developmental goals, help bridge the digital and connectivity divides, and be strictly enforced.

Recent developments

Recent developments in digital connectivity and infrastructure in South Africa demonstrate a strong commitment to addressing the connectivity challenges and to fostering inclusive digital development. This commitment is evident in three key events: the State of the Nation Address (SONA), the ICASA public hearings on a new satellite licensing framework, and the G20 South Africa presidency.

The State of the Nation Address delivered by President Cyril Ramaphosa on February 6, 2025, emphasized the focus of the Government on digital infrastructure, transformation, and connectivity.³⁴ The address highlighted investments in digital public infrastructure to improve government services accessibility, the implementation of a digital identity system, and prioritization of connectivity for digital services and business process outsourcing. The Government also announced the establishment of an Innovation Fund to support tech startups, modernization of state-owned enterprises, and improvements in connectivity for rail and freight sectors. A significant allocation of ZAR 940 billion (USD 51 billion) for infrastructure investment over a three-year period underscores the commitment of the Government to digital transformation.

In August 2024, ICASA published an inquiry document into the proposed “Licensing Framework for Satellite Services” and conducted public hearings in February 2025, where operators that submitted comments to the inquiry were given the opportunity to further elaborate on their positions.³⁵ The initiative aims to establish a transparent regulatory environment, develop procedures for user-terminal operations, review spectrum fees, and create a registration process for international space segment providers. Stakeholders presented diverse perspectives, emphasizing the need for fair competition, simplified licensing processes, and recognition of satellite technology as critical national infrastructure.

³³ The USAF funded a variety of initiatives including community access centres, Internet connectivity for educational institutions, underserved area licensees, ICT skills training, and research projects, while more recently focusing on subsidizing broadband installations for qualifying households and connected sites in identified municipalities.

³⁴ <https://www.gov.za/SONA2025>

³⁵ <https://www.icasa.org.za/news/2025/icasa-concludes-3-day-public-hearings-on-the-new-satellite-services-framework>

In 2025 South Africa held the G20 presidency, where the focus was on enhancing digital connectivity for inclusive development, amongst others. The "Connectivity for Inclusive Digital Development" initiative aims to address challenges in broadband access, bridge the digital divide, and promote global digital cooperation.³⁶ This G20 presidency presented a strategic opportunity for South Africa to shape global digital governance and drive connectivity and innovation, and advance sustainable digital development across Africa and beyond.

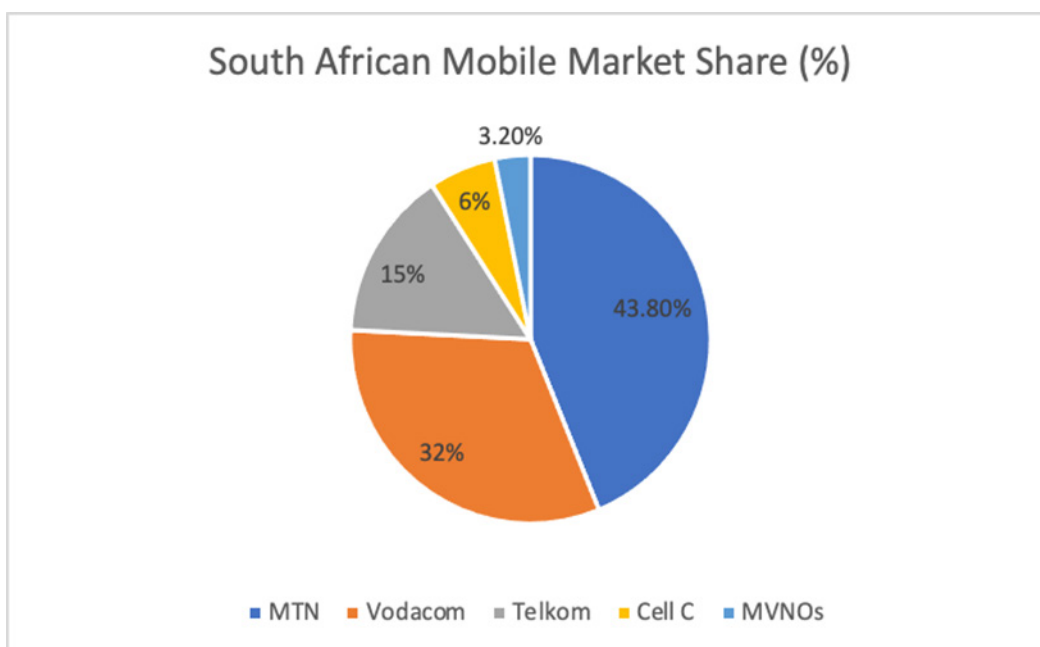
In summary, South Africa has made significant progress in digital inclusion, with Internet usage reaching 76 per cent in 2022, up from 49 per cent in 2018. While some challenges persist, recent policy initiatives and infrastructure investments demonstrate the commitment of the Government to addressing connectivity issues and fostering digital transformation across the country.

³⁶ https://g20.org/wp-content/uploads/2024/12/Issue-Note_Digital-Economy-WG-1.pdf

Part 2: Current state of last-mile connectivity

The telecommunication market in South Africa is dominated by mobile services. This dominance is reflected in the high mobile penetration rate, with 7 000 000 mobile connections active at the beginning of 2024, with a mobile penetration rate of 185.2 per cent. In contrast, fixed-line penetration remains low at just 2.8 per cent.³⁷ The market is primarily controlled by two major mobile network operators (MNOs), with MTN and Vodacom controlling about 75 per cent of the market. Vodacom holds 43.8 per cent of the market share, while MTN holds 32 per cent. Telkom at 15 per cent and Cell C at 6 per cent operate smaller, regional networks. In 2021, there were 21 mobile virtual network operators (MVNOs) all of which used the network infrastructure of Cell C to provide services. Comprehensive data on MVNOs is unavailable, but these operators illustrate the diversity of service models within the telecommunication landscape of the country. It is estimated that the MVNO market of South Africa comprises less than 4 per cent of the total retail base.

Figure 2: Mobile market share in South Africa



Source: ITU

Fixed wireless connections, which are not tracked by ICASA, are primarily provided by members of the Wireless Access Providers Association (WAPA). With over 350 members, WAPA collectively delivers more than 200 000 connections, playing a critical role in expanding connectivity, particularly in underserved regions. Wireless Internet Service Providers (WISPs) are instrumental in bridging the digital divide in these areas. WISPs offer cost-effective and rapidly deployable solutions to underserved regions where traditional infrastructure is lacking or too expensive. Utilizing technologies such as fixed wireless access, WISPs overcome geographical challenges and extend Internet access to remote areas and informal (not-formally planned) settlements. Their flexibility and affordability make them a key player in connecting previously disconnected communities.

³⁷ <https://www.icasa.org.za/uploads/files/The-State-of-the-ICT-Sector-Report-31-March-2024.pdf>

Alternative last-mile connectivity solutions in South Africa

Alternative last-mile connectivity solutions are considered alternatives to traditional, large-scale telecommunication infrastructure deployed by major operators, which often struggle to reach or adequately serve certain areas due to economic or geographical constraints. Alternative approaches often prioritize community involvement, cost-effectiveness, and adaptability to local conditions, making them valuable complements to mainstream telecommunication infrastructure. Examples of alternative last-mile connectivity solutions currently employed in South Africa include:

Complementary access solutions

Complementary access solutions in South Africa such as community networks (CNs) are uniquely positioned to address socio-economic challenges by using technology to connect and empower underserved communities. Focused on local ownership and operation, these networks foster resilience, independence, and sustainable development in areas deemed unprofitable by commercial providers. Emerging from initiatives such as wireless user groups and university projects, complementary access solutions in South Africa today include diverse models, such as community-owned cooperative Zenzeleni Networks in the rural Eastern Cape, V-NET in the Western Cape, and TooMuchWiFi in urban townships. In terms of technologies used, most complementary access solutions are Wi-Fi based, often in a mesh network configuration, and rely on low-cost off-the-shelf hardware, open-source tools, and unlicensed spectrum. These networks range from informal neighbourhood-driven setups to structured organizations serving tens of thousands. This diversity underscores their adaptability in addressing the unique needs of the varied socio-economic landscape.

While most complementary access solutions in South Africa are registered as NGOs or public benefit entities, their exact number remains unknown due to the broad and evolving definition of what constitutes a complementary access solution. However, there are records of some form of complementary access solutions in every province. They mainly use license-exempt spectrum, such as the 2.4 GHz and 5 GHz bands, often using mesh networks and offering low-cost access, but face challenges such as limited range, line-of-sight issues, environmental interference, and reduced capacity. Additionally, power infrastructure is a major issue, as many networks operate in areas with unreliable electricity, often relying on costly backup solutions. In low-income areas, power-saving practices by homeowners can lead to inconsistent service availability.

Complementary access solutions in South Africa rely on grants, mixed with income generation, to fund their operations. Financial sustainability remains a challenge due to high infrastructure costs and low-paying capacity in communities. Some networks cross-subsidize services, offering affordable basic connectivity while providing value-added services for wealthier users or so called anchor tenants. For example, one network provides uncapped connectivity for ZAR 35 per month in areas with 94 per cent unemployment. Factors contributing to the financial sustainability challenges of complementary access solutions include high licence fees; exorbitant wayleave costs such as for instance in the city of Cape Town that charges approximately ZAR 6 000 per linear metre for trenching; limited backhaul options and high costs in marginalized areas; and limited exposure to business skills. These issues create barriers to scaling and maintaining operations effectively.

Complementary access solutions address sustainability issues by focusing on replicability through open-source sharing of designs and operational models, modular infrastructure

development, and peer-to-peer knowledge transfer, allowing other communities to easily adopt and customize successful approaches without starting from scratch. This process is currently being facilitated by the Association for Progressive Communications (APC) and local partners in South Africa.

Figure 3: Connecting communities using mesh networks



Source: ITU

Public Wi-Fi

A large number of free public Wi-Fi initiatives have emerged in South Africa in the past decade. The Western Cape Government's Public Wi-Fi Project partnered with Liquid Intelligent Technologies in 2015 to expand free public Wi-Fi hotspots from 178 to 1 600 across the Western Cape by 2018.³⁸ It provides 3 GB of free data per device per month at speeds of at least 10 Mbit/s and includes unlimited free access to government websites and basic mobile digital literacy information. The partnership between Liquid Intelligent Technologies and the provincial Government has been renewed in 2024 to expand the project across the province.³⁹

Project Isizwe, a non-profit organization founded in 2013, deployed over 1 000 free Wi-Fi sites in eight provinces across the country.⁴⁰ Project Isizwe has connected 115 schools to free Wi-Fi since its inception, as well as hospitals, libraries, and community centres. In the past year alone,

³⁸ <https://www.westerncape.gov.za/department-premier/service/public-wi-fi-hotspots-across-western-cape>

³⁹ <https://www.itweb.co.za/article/liquid-sa-wcape-expand-free-public-wifi-hotspots/rxP3jMBEQm27A2ye>

⁴⁰ <https://projectisizwe.org/>

the organization has provided Internet access to over 500 000 South Africans in underserved communities, including Alexandra township in Johannesburg.⁴¹ Other communities where Project Isizwe helped connect the unconnected include Mpophomeni and Lamontville in Kwazulu Natal and Embalenhle in Mpumalanga.

While public Wi-Fi initiatives can contribute to bridging the digital divide and improving Internet access, they generally fall short of the comprehensive requirements for meaningful connectivity. Public Wi-Fi is often limited in terms of availability, speed, and consistency compared to the always-on, high-speed, unlimited access envisioned in the meaningful connectivity framework.⁴²

Satellite

The regulatory status of using satellites for connectivity in South Africa is currently in a state of transition, with ICASA working to update the licensing framework to accommodate new satellite technologies and services.⁴³ Current regulatory hurdles include licensing requirements for foreign operators, spectrum fees, type approval, and registration and authorization procedures. Ownership requirements also present an additional barrier for foreign entrants.

MorClick, Q-KON, and Openserve are local companies providing different types of satellite connectivity services in South Africa, each catering to specific market segments and needs. MorClick offers satellite Internet connectivity primarily for residential and small business customers in remote areas, using UAE-based YahClick satellite technology (powered by Hughes) to deliver its services.⁴⁴

Q-KON integrates low earth orbit (LEO) connectivity from Eutelsat OneWeb, and partners with Avanti to serve specialized sectors such as businesses, telco backhaul, retail, healthcare, fintech, and industrial applications in underserved or off-grid areas.⁴⁵ Liquid Intelligent Technologies also partnered with Eutelsat OneWeb, to offer enhanced performance to their Liquid Dataport (wholesale connectivity) customers.⁴⁶

Openserve, a Telkom subsidiary, has partnered with Intelsat and this partnership is set to modernize the largest fixed broadband network in South Africa, potentially transforming connectivity across the country, and especially in previously underserved areas.⁴⁷ SEACOM launched a LEO satellite service in April 2024, targeting enterprise clients in South Africa.⁴⁸

⁴¹ <https://www.itweb.co.za/article/project-isizwe-counts-over-1-000-free-wifi-sites-across-sa/Olx4z7kaV1oq56km>

⁴² www.itu.int/itu-d/meetings/statistics/wp-content/uploads/sites/8/2022/04/UniversalMeaningfulDigitalConnectivityTargets2030.pdf

⁴³ <https://www.icasa.org.za/news/2025/icasa-to-conduct-public-hearings-on-the-proposed-new-licensing-framework-for-satellite-services>

⁴⁴ <https://morclick.co.za/>

⁴⁵ <https://www.qkon.com/2024/05/06/avanti-communications-launches-leo-services-in-south-africa/>

⁴⁶ <https://www.reuters.com/business/media-telecom/liquid-eutelsat-bring-oneweb-leo-satellite-services-africa-2024-05-21/>

⁴⁷ <https://www.intelsat.com/newsroom/intelsat-and-openserve-advance-connectivity-throughout-south-africa/>

⁴⁸ <https://communicationsafrica.com/satellite/seacom-launches-leo-satellite-boosts-south-african-connectivity>

Table 1: Local companies providing satellite connectivity services in South Africa

Company	Technology	Use case/market segment
MorClick	YahClick (Hughes, UAE-based)	Residential & small businesses in remote areas
Q-KON	LEO (Eutelsat OneWeb), Avanti	Business, telco backhaul, retail, healthcare, fintech, industrial
Liquid Intelligent Technologies	LEO (Eutelsat OneWeb)	Wholesale connectivity (Liquid Data-port)
Openserve	GEO (Intelsat)	Fixed broadband network modernization
SEACOM	LEO	Enterprise connectivity

Several strategic partnerships are forming across the continent, aiming to leverage LEO satellites to address connectivity challenges and bridge the digital divide across Africa. Bayobab, a prominent digital infrastructure provider in Africa, is partnering with the Eutelsat OneWeb constellation to deliver fixed connectivity services across the continent.⁴⁹ Paratus started partnering with global LEO satellite operators, complementing its existing V-SAT infrastructure in the Republic of Angola, the Republic of Botswana, the Republic of Namibia, and the Republic of South Africa.⁵⁰ Mobile operators have shown interest in partnering with LEO satellite providers. The biggest operator in South Africa Vodacom announced a partnership with Amazon Leo (Project Kuiper), while MTN and Cell C are exploring partnerships with satellite operators.⁵¹

Affordable optical fibre

Affordable optical fibre Internet service has started to emerge in South African townships over the last couple of years. Fibertime introduced a new approach to fibre-to-the-home (FTTH) service in the Kayamandi township, in Stellenbosch, using aerial optical fibre. The model offers a unique pay-as-you-go model with free installation and equipment, allowing users to purchase Internet access in small increments (as little as ZAR 5 for 24 hours of 100 Mbit/s uncapped Internet). The billing model is specifically designed to fit the realities of township residents, catering to the cash-based economy prevalent in informal settlements. Population density plays a crucial role in the profitability of the Kayamandi Fibre Project.⁵² While not community-operated, the project has open-sourced its township optical fibre blueprint, providing a step-by-step guide for others to replicate the model.⁵³

The Zoom Fibre Community Project is another commercial initiative aimed at expanding high-speed Internet access and fostering digital inclusion in underserved communities. It includes special projects such as school connectivity and smart city development projects.⁵⁴

⁴⁹ <https://spaceinafrica.com/2024/08/17/eutelsat-and-bayobab-forge-partnership-to-boost-connectivity-across-africa-with-leo-satellites/>

⁵⁰ <https://www.itweb.co.za/article/how-paratus-and-leo-satellite-solutions-will-help-unlock-africas-potential/mQwkoq6YzYZM3r9A>

⁵¹ <https://www.reuters.com/technology/south-africas-mtn-exploring-partnerships-with-satellite-internet-providers-2024-11-18/>

⁵² <https://www.kayamandifibreproject.org/>

⁵³ https://pdfhost.io/v/0YWW.vTpu_The_Kayamandi_Fibre_Project_Playbook

⁵⁴ <https://zoomfibre.co.za/>

Television white space

ICASA finalized regulations for TV White Space (TVWS) in March 2018, enabling advanced white space devices (WSDs) to use specific TV spectrum bands (470 MHz to 694 MHz excluding the radio astronomy sub-band from 606 MHz to 614 MHz) under strict control of channel availability managed by a Geo-location Spectrum Database (GLSD).⁵⁵ While TVWS offers significant benefits including wide-area coverage and cost reduction for low-density areas, challenges include high equipment costs, limited availability in urban areas, and underwhelming performance due to lack of widespread adoption and investment.⁵⁶ Current licensing permits secondary use under the ICASA TVWS rules, with Sentech retaining primary terrestrial TV broadcasting rights.

A trial of the TVWS technology in Cape Town in 2013 demonstrated the potential of TVWS technology for providing affordable broadband Internet access without interfering with TV reception and provided evidence to support the regulatory process.⁵⁷ Since the regulations were finalized, several deployments have been rolled out. In 2019, the United States Trade and Development Agency (USTDA) supported a project led by Adaptrum, with partners including Microsoft, International Data Corporation, Project Isizwe, and WAPA to demonstrate the technical, socio-economic, and commercial benefits of TVWS technology for connecting rural South Africa.⁵⁸ The project proved the commercial viability of using TVWS technology to connect previously unconnected communities.⁵⁹

The Council for Scientific and Industrial Research (CSIR) and United Nations Development Programme (UNDP) have collaborated on an initiative to deploy TVWS technology in rural areas of KwaZulu-Natal. The initiative involves collaboration with local small and medium enterprises (SMEs), such as AdNotes and Mdantsane Mobile, to deploy and operate the networks.⁶⁰ These deployments build on a decade of successful TVWS trials involving big tech firms, research institutions, and educational stakeholders, which have demonstrated the potential of the technology for delivering connectivity to underserved areas. Nine licensees have deployed TVWS solutions as part of this initiative. Following the implementation of the first phase, the CSIR signed an MoU with SEACOM⁶¹, under which SEACOM offered to the beneficiaries (youth and women-owned SME network operators) up to 1 Mbit/s IP transit, direct Internet access, national private lines, collocations, and cloud solutions for a 12-month period free of charge. The initiative provided 67 public Wi-Fi hotspots, and provided coverage to 153 small businesses, over 1 800 households, and 56 public facilities, and created job opportunities thereby contributing to socio-economic development.⁶² However, while these trials have proved the feasibility of the

⁵⁵ <https://www.icasa.org.za/uploads/files/Regulations-on-the-use-of-Television-White-Spaces-2018.pdf>

⁵⁶ Performance of equipment still not reaching capacity promised in TVWS standards due to lack of uptake and reluctance of investors or companies to fund engineering required for certain features. This is a chicken and egg problem, as some of the lack of uptake is due to complaints about the lack of performance compared to Wi-Fi.

⁵⁷ A. A. Lysko *et al.*, "First large TV white spaces trial in South Africa: A brief overview," *2014 6th International Congress on Ultra Modern Telecommunications and Control Systems and Workshops (ICUMT)*, St. Petersburg, Russia, 2014, pp. 407-414, doi: 10.1109/ICUMT.2014.7002136.

⁵⁸ <https://wapa.org.za/sites/default/files/2021-04/TV%20Space%20key%20to%20bring%20affordable%20internet%20to%20rural%20communities%20Final.pdf>

⁵⁹ <https://www.africanwirelesscomms.com/Media/Default/archive/AWCY/2021/chapter8.pdf>

⁶⁰ <https://www.csir.co.za/adnotes-collaboration-csir-and-undp-launches-tv-white-space-infrastructure-network-rural-kzn>

⁶¹ SEACOM is a pan-African telecommunication infrastructure provider. The company has evolved from its initial focus on submarine cable systems to offer a comprehensive range of digital and telecommunication services across Africa.

⁶² Interview with representative

technology, and have provided some promising partnerships, it is yet to be seen if they can be scaled and sustainable.

Examples of alternative regulatory interventions

Argentina

The Argentine Republic has implemented two programmes that enable complementary access solutions to receive funding from universal service funds. These programmes are the Roberto Arias Programme and the Barrios Populares Programme. Both initiatives were established by the national telecommunication regulator (ENACOM), which is responsible for managing and deploying universal service funds.⁶³ To facilitate and promote access to the funds available under the Roberto Arias Programme, the civil society organization AlterMundi established an incubator for community Internet networks (*Semillero de Redes Comunitarias de Internet*).⁶⁴

Following recent political developments, reports indicate that the new Argentine Government moved to dissolve the universal service trust fund in the first week of January 2025.⁶⁵ This development illustrates how political shifts and instability can directly impact ICT policies, particularly those focused on addressing socio-economic issues.

Brazil

The telecommunication landscape in the Federative Republic of Brazil has evolved from state-led provision to the emergence of a diverse range of stakeholders, including a significant presence of small- and medium-sized enterprises. This shift has fostered new models of service delivery and network arrangements, with a particular focus on underserved regions across the country. Anatel, the telecommunication regulator, has introduced measures such as asymmetric regulation, which imposes fewer regulatory obligations on smaller operators while requiring major operators with substantial market power to share their network resources equitably and transparently with smaller stakeholders.

Brazil has successfully promoted small ISPs to expand broadband access, thanks to regulatory simplification for small fixed Internet providers, which hold less than 5 per cent of the market share in relevant sectors. These reforms have increased coverage and fostered competition. Additionally, licence-exemption policies have allowed smaller players to capture a significant share of the fixed broadband market.⁶⁶

The universal service fund, *Fundo de Universalização dos Serviços de Telecomunicações* (FUST) was recently redesigned during a significant process involving multiple stakeholders including the Ministry of Communications, Anatel, and the National Bank for Economic and Social Development (BNDES) and now offers financial support using FUST resources. Telecommunication service providers now have opportunities to use FUST resources for projects, while civil society, academia and the technical community are contributing to discussions and public consultations. For a period of almost 20 years, FUST had not disbursed collected funds

⁶³ https://www.apc.org/sites/default/files/universal_service_funds_failure_and_promise.pdf

⁶⁴ <https://altermundi.net/altermundi/formacion-y-acompanamiento/semillero-de-redes-comunitarias-postulantes-al-roberto-arias/>

⁶⁵ <https://www.bnamericas.com/en/news/regulatory-watch-universal-service-fund-environmental-regulations-and-more>

⁶⁶ APC (2021). Policy brief and recommendations for an enabling environment for community networks in Brazil. November 2021. https://www.apc.org/sites/default/files/policy_brief_brazil_eng_final.pdf

to support connectivity projects. The original law from this period restricted funds to landlines or fixed telephony networks, which have since become almost obsolete. The revised fund regulations now aim to stimulate the expansion, use, and improvement of telecommunication networks and services throughout Brazil, as well as promote new connectivity technologies. The funds distribution process began in August 2023 when BRL 883 million was allocated to network expansion while BRL 230 million was assigned to increasing schools connectivity.⁶⁷ As of October 2024, FUST had attained BRL 1.1 billion in approved operations for Internet connectivity projects.

Since March 2023, Anatel has hosted a community network working group focused on strengthening complementary access solutions and contributing to regulatory updates for 2023-2024. The working group, consisting of representatives for Anatel, the Ministry of Communications, and complementary access solution providers, seeks to shape public policies for the promotion and sustainability of complementary access solutions.⁶⁸

In conclusion, Brazil is employing a multi-faceted approach to improve last-mile connectivity, leveraging a combination of cellular networks, satellite Internet solutions, complementary access solutions, and investments in projects to expand optical fibre infrastructure, both by implementing underwater optical fibre cables in the Amazon region as part of the Norte Conectado⁶⁹ programme, and by expanding last-mile optical-fibre connectivity in urban and suburban areas, mostly led by small local operators.

Kenya

The status of last-mile connectivity in the Republic of Kenya has seen significant progress in recent years, with various technologies and initiatives being deployed to expand access to electricity, via the Last-Mile Connectivity Programme,⁷⁰ and Internet services, via TVWS trials and regulations, satellite connectivity, and complementary access solutions.

Following a public consultation by the Communication Authority in Kenya in May 2021, the community network and service provider (CNSP) licence was introduced later that year.⁷¹ This licence, designed for non-profit organizations, allows for the provision of Internet services within a sub-county division using non-commercial models. The CNSP licence features a low application fee of KES 1 000 and an annual renewal fee of KES 5 000, making it accessible to grassroots organizations. Additionally, licensees are exempt from Universal Service Fund (USF) contributions, while being allowed to benefit from the fund. These regulatory changes were designed to benefit complementary access solutions such as community networks, however, despite these positive developments, the implementation of complementary access solutions faces several challenges in the country. According to a survey study carried out by KICTANet, 80.6 per cent of surveyed networks reported never having accessed the USF, indicating a significant lack of awareness or ability to utilize available resources. Only 3.3 per cent of respondents had applied for or benefited from the USF, highlighting a substantial gap between policy intent and practical implementation.⁷²

⁶⁷ <https://www.gov.br/mcom/pt-br/noticias/2024/outubro/fust-atinge-marca-de-r-1-1-bilhao-para-levar-inclusao-digital-aos-brasileiros>

⁶⁸ <https://www.gov.br/anatel/pt-br/regulado/universalizacao/redes-comunitarias>

⁶⁹ <https://www.gov.br/mcom/en/access-to-information/programs-and-actions/north-connected>

⁷⁰ <https://www.kplc.co.ke/last-mile-connectivity>

⁷¹ <https://www.kictanet.or.ke/kenya-ratifies-the-community-networks-licensing-framework/>

⁷² <https://www.kictanet.or.ke/study-report-digital-inclusion-of-persons-with-disabilities-in-kenyan-community-networks/>

The uptake of satellite Internet services in Kenya has grown significantly in recent years, to the extent that one provider had to suspend new subscriptions in Nairobi and neighbouring counties due to network saturation. In response to the expanding satellite ISP market, the Communications Authority of Kenya (CA) has proposed significantly increasing licensing fees for satellite ISPs to regulate the sector and promote fairness.

Mexico

The Social Coverage Programme/*Programa de Cobertura Social* (PCS) is an initiative funded by the Government of Mexico and is intended to expand telecommunication coverage, and particularly Internet access, to underserved areas of the country. Specifically, the programme aims to:

- identify and prioritize localities lacking Internet coverage,
- promote increased coverage and penetration of telecommunication services,
- support the goal of extending Internet connectivity nationwide.

The PCS programme serves as a tool for various stakeholders such as the Federal Telecommunications Institute (IFT), to establish coverage obligations for telecommunication service providers. Government agencies, service providers, and the public can provide feedback through a validation mechanism. For example, in the latest iteration PCS 2023-2024 identified 51 632 localities without Internet coverage, and 4 510 localities were designated as priority attention zones.⁷³

The Mexican Wholesale Open Access Network (WOAN),⁷⁴ “Red Compartida” is structured as a public-private-partnership (PPP) between the Government of Mexico and a Mexican company *Altán Redes*. Multiple service providers, including mobile virtual network operators (MVNOs), can use the network infrastructure. There is a focus on digital inclusion meaning that Red Compartida has specific coverage requirements, including serving underserved areas and smaller communities. Red Compartida is considered the most significant telecommunication project in Mexico in recent years. It utilizes 4.5G LTE technology on the 700 MHz spectrum band and fully virtualized (cloud-based) infrastructure, that offers low latency and high-speed connectivity. The Red Compartida structure comprises specific requirements that benefit social operators including a requirement that at least 15 per cent of its population coverage must be in communities of less than 10 000 people. Over 60 service providers currently use the network, and it reaches over 100 million people.⁷⁵

Mexico is one of the few countries in the region without a universal service fund. However, the country has achieved a significant increase in coverage by implementing public policies aimed at promoting digital inclusion.

⁷³ <https://www.gob.mx/sct/prensa/publica-sict-programa-de-cobertura-social-2023-2024-instrumento-para-reducir-la-brecha-digital>

⁷⁴ A WOAN operates as a wholesale-only network, not selling directly to end-users. The network offers equal access to any service provider, fostering competition at the retail level.

⁷⁵ <https://digitalregulation.org/red-compartida-mexico/>

Part 3: Opportunities

Given the current last-mile connectivity landscape in South Africa, a number of opportunities have been identified to provide further coverage. Some of these alternative connectivity solutions have been established for decades, while others remain ambitious emerging technologies. With the right regulatory support, these innovations have the potential to become viable and transformative solutions.

Technological solutions

Community centred connectivity in underserved areas

Community-oriented Internet service providers, such as complementary access solutions, community networks (CNs), cooperatives, and small not-for-profit WISPs, have emerged as key alternatives for connecting underserved areas. However, as discussed in Part 1, they continue to face significant challenges. Although the technical feasibility of complementary access solutions, many of which operate in licence-exempt spectrum, has been demonstrated (with numerous networks fully operational, although with widely varying levels of service quality), issues related to long-term sustainability and scalability persist.

Small WISPs, in particular, struggle with limited access to spectrum and significant interference in unlicensed spectrum bands, which affects service quality.⁷⁶ One practical step to alleviate operational pressures and address immediate challenges for both complementary access solution providers and small WISPs could be to designate the entire 6 GHz frequency band for unlicensed use, thereby maximizing its economic and social benefits in underserved areas. Additionally, streamlining licensing processes could further reduce barriers to market entry and network expansion.

Aerial optical fibre in townships

Aerial optical fibre deployment offers several advantages for rapid and cost-effective deployment in dense township environments. Many shacks (informal homes) use metal sheeting in their construction, which can behave as partial Faraday cages and block or weaken Wi-Fi and cellular signals. For this reason, the provider Fibertime switched from a wireless model to installing individual optical fibre connections directly to homes. Additionally, they leverage existing infrastructure such as electricity poles for aerial optical fibre installation. Exploring partnership opportunities with other infrastructure and utility providers would help accelerate and expand aerial optical fibre initiatives, offering scalable solutions for last-mile connectivity in dense township environments. A major underpinning innovation is the business model employed, which offers a pay-as-you-go subscription to low-income residents. Other providers such as Vumatel have begun launching similar deployments, with Kayamandi and Alexandra being among the first townships to receive these services.⁷⁷ This highlights a scalable business opportunity, where even low fees can drive profitability through sufficient volume and market reach.

⁷⁶ <https://www.itweb.co.za/article/icasa-at-odds-with-wisps-over-wifi-6e-spectrum/WnxpE74YG4zMV8XL>

⁷⁷ <https://mybroadband.co.za/news/fibre/560988-fibre-war-in-south-african-township.html>

Dynamic spectrum access

TVWS spectrum

Although TV White Space (TVWS) pilots and trials have been conducted in South Africa since 2013, the technology has struggled to gain traction due to delays in regulatory finalization, reliance on geo-location spectrum databases,⁷⁸ and high equipment costs. However, TVWS has globally paved the way for dynamic spectrum access (DSA) approaches in other bands. Automated Frequency Coordination (AFC) protocol is used in 6 GHz Wi-Fi to avoid interference with primary users and some countries, including Brazil, Canada, the Kingdom of Saudi Arabia, the Republic of Korea, and the United States of America, already have regulations in place, while others are evaluating the feasibility of 6 GHz Wi-Fi under control of the AFC system.⁷⁹

ICASA and CSIR are exploring dynamic spectrum access for the 3 800-4 200 MHz band, currently used for terrestrial point-to-point links and satellite links. Research is being focused on using the CSIR geo-location spectrum database to enable broadband fixed wireless access while protecting existing licensed fixed point-to-point wireless links. This initiative aligns with the Next Generation Radio Frequency Spectrum Policy, aiming to optimize spectrum use and support smaller players, such as community-centred networks.

Other equipment such as WiFrost makes use of TVWS frequencies to deliver 4G/5G fixed wireless access, offering broader coverage than standard long-term evolution (LTE) networks (in 3.5 GHz) and operating effectively in non-line-of-sight scenarios. This development could be transformative for rural WISPs, reducing connectivity gaps. WiFrost are also working with CSIR to make use of the CSIR TVWS geo-location spectrum database.

Community cellular

Dynamic Spectrum Access (DSA) is likely to play an increasing role in providing ideal spectrum for alternative connectivity solutions in the future. Given the limitations of licence-exempt spectrum, alternative connectivity solutions need access to spectrum that enables improved coverage, performance, scalability, and reliability to address their unique connectivity challenges effectively.

DSA techniques allow a network to access valuable spectrum in regions where a primary user does not utilize it. This concept is being extended globally to other frequency bands beyond TVWS and the 6 GHz band mentioned above, such as the citizens Broadband Radio Service (CBRS) in the United States which was adopted in 2015. CBRS utilizes the 3 550-3 700 MHz band and features a three-tier user hierarchy of incumbents (e.g. United States Navy), Priority Access Licences (PALs), and general Authorized Access (GAA) for opportunistic use. A Spectrum Access System (SAS) governs sharing among these three tiers, enabling efficient spectrum use while balancing licensed and unlicensed access.

In South Africa, the "Next-generation radio frequency spectrum policy for economic development" supports a regulatory framework that clarifies spectrum trading rules and prevents monopolization. By fostering a balanced spectrum trading system and releasing International

⁷⁸ CSIR is hosting the secondary geo-location spectrum database, with which licensees interact. The reference database is hosted at ICASA premises, and only the CSIR database has communication with the reference database.

⁷⁹ <https://www.wi-fi.org/regulations-enabling-6-ghz-standard-power-wi-fi>

Mobile Telecommunications (IMT) spectrum for community use, this policy could empower smaller providers, enabling them to offer mobile access to underserved areas.

Licensed spectrum offers significant benefits for alternative last mile wireless solutions, including:

- Enhanced connectivity: IMT spectrum enables faster, more reliable cellular services, essential for scaling.
- Higher capacity: Advanced techniques such as LTE interference coordination maximize capacity per MHz, crucial for densely populated networks.
- Improved backhaul reliability: Licensed microwave spectrum ensures high-capacity, interference-free backhaul links, critical as last-mile wireless solutions scale.

ICASA is drafting a "Regulatory Sandbox" for public consultation to facilitate the implementation of Dynamic Spectrum Access (DSA) in the 3.8 GHz - 4.2 GHz sub-band, known as the "DSA innovation spectrum." This framework is designed to function in a similar way to the CBRS model.⁸⁰ The "Regulatory Sandbox" aims to provide market innovators with an opportunity to test new products and services that push the boundaries of existing legislation and regulation responsibly, all under the responsible supervision of relevant regulators.

ICASA is in the process of building a database of systems operating in the frequency sub-bands 3 800 to 4 200 MHz and 5 925 to 6 425 MHz, as the primary mechanism to protect incumbent licensed services from harmful interference.⁸¹ Even with the sandbox approach being in its infancy, ICASA has demonstrated its willingness to explore innovative and creative ways of supporting alternative last-mile connectivity solutions. The aim is to invite applications for specific sandbox-style deployments and use cases.

Satellite

Low earth orbit (LEO) satellites are reshaping the connectivity landscape in Africa and presenting both challenges and opportunities. The regulatory status of using satellites for connectivity in South Africa is currently in a state of transition, with ICASA working to update the licensing framework to accommodate new satellite technologies and services.

The recent market saturation of LEO satellite broadband services, such as is the case in Nairobi in Kenya, poses questions on the viability of their retail business mode in densely populated regions. However, satellite backhaul, widely used by complementary access solutions and WISPs in Brazil, offers a promising solution for ultra-remote areas in South Africa. It provides a vital connectivity option where terrestrial infrastructure is impractical, enabling last-mile access and supporting marginalized communities. With several international companies offering LEO satellite constellations, it is worthwhile to examine their diverse business models, which target not only individual consumers but also enterprises and backhaul solutions.

⁸⁰ <https://www.ellipsis.co.za/wp-content/uploads/2023/05/Findings-and-Position-Paper-into-the-Implementation-of-Dynamic-Spectrum-Access-and-Opportunistic-Spectrum-Management.pdf>

⁸¹ <https://www.ellipsis.co.za/wp-content/uploads/2024/03/Request-for-information-regarding-systems-operating-in-the-frequency-bands-3800-4200-MHz-and-5925-6425-MHz-21-June-2024.pdf>

Figure 4: Satellite connectivity



Source: ITU

Summary of technological solutions

Table 2 provides a concise overview of the key technological solutions discussed, highlighting their target geographies, feasibility, scalability, and sustainability. This summary serves as a reference for evaluating the potential of these technological solutions to address connectivity challenges in underserved and remote areas.

Table 2: Alternative technology solutions

Solution	Geography	Feasibility	Scalability	Sustainability
Complementary access solutions	Suburban/rural	Demonstrated (fully operational).	Constrained, yet replicable with the right ecosystem.	Challenging, highly dependent on external funding.
WISPs	Suburban/rural	Demonstrated (fully operational).	Constrained, yet replicable with the right ecosystem.	Moderately sustainable, with the right balance of higher and lower average revenue per user.
Aerial fibre	Dense urban	Demonstrated (fully operational).	Expandable/ replicable.	Moderately sustainable in dense urban environments.

Table 2: Alternative technology solutions (continued)

Solution	Geography	Feasibility	Scalability	Sustainability
TVWS	Rural and semirural	Demonstrated in pilots/ challenging in practice.	Conditional on specific equipment and geo-location spectrum database (GLSD).	Challenging due to high equipment cost.
Community cellular	Rural	To be demonstrated.	Conditional upon regulations.	Conditional upon regulations.
Satellite	Deep rural	Demonstrated (fully operational). Ideal for higher income remote farms and backhaul for complementary access solutions and WISPs.	Conditional upon licensing and regulations. Problematic in dense urban areas.	Conditional upon regulations and equipment pricing. Becomes more sustainable with aggregation in lower income communities.

Ecosystem enabling alternative last-mile connectivity solutions

In South Africa, a growing ecosystem, comprising a diverse range of stakeholders, including community-led initiatives, research institutions, industry associations, and international development partners, supports alternative last-mile connectivity solutions. By fostering collaboration, knowledge sharing, and capacity building, this ecosystem enables the development and implementation of innovative connectivity approaches tailored to local needs.

Digital skills development

Digital skills development is key for complementary access solutions to evolve into holistic and comprehensive connectivity solutions. Zenzeleni Networks NPC leads the School of Community Networks, a programme that delivers foundational skills development training to persons from digitally marginalized communities, empowering them to establish, deploy and maintain their own connectivity solutions.

The programme was designed to build capacity in four areas: digital/technical skills; business skills; social/community work skills; and personal development. Seven complementary access solution providers participated, each with three trainees, totalling 21 participants. An audit in late 2024 found that 52.3 per cent of participants have remained active in the field, and the creation of a larger ecosystem of ongoing support was identified as crucial for success. This would include launching a short-term mentorship programme, continuing training, establishing a support or incubation body for complementary access solutions, developing a financial sustainability toolkit, and establishing a dedicated fund or network of funders.

An ecosystem-building approach recognizes that CNs can achieve greater success by collaborating with existing organizations rather than by developing all of the components independently. This strategy leverages complementary services, resources, and expertise from partners to enhance the effectiveness of CNs.

Research

Several research institutions across the country have contributed to the development of an enabling ecosystem through academic collaborations, research, and policy briefs. These efforts help in documenting best practices and case studies, which are crucial for the replication and scaling of successful alternative network implementations. For example, the process of getting a licence exemption for complementary access solutions has been documented by researchers from the University of the Western Cape.⁸² Think tanks such as Research ICT Africa⁸³ and the LINK Centre at Wits University⁸⁴ contribute to shaping regulatory frameworks that foster innovative connectivity approaches by providing evidence-based policy recommendations, engaging diverse stakeholders, advocating for digital equality, and monitoring ICT developments. CSIR is leading the deployments of TVWS in the country.⁸⁵

International support

International support has also been significant, with programmes such as the United Kingdom Foreign, Commonwealth, and Development Office (FCDO) Digital Access Programme providing financial backing for projects that catalyse affordable and inclusive connectivity in underserved areas of South Africa. Additionally, international donors such as the Swedish International Development Cooperation Agency (SIDA) and the International Development Research Centre (IDRC) have supported research and implementation of complementary access solutions in the country.

Joint advocacy

Both the Wireless Access Providers' Association (WAPA) and the Internet Service Providers' Association (ISPA) create important ecosystems for their member organizations. WAPA acts as a collective voice for independent wireless operators and acts as an interface between members, the regulator (ICASA), and consumers. For example, WAPA actively participates in public consultations and submissions to the Government on regulations affecting the wireless industry, including spectrum allocation. Both associations run technical training and knowledge-sharing forums and provide regulatory advice and representation. They provide platforms for smaller providers to collectively advocate on regulatory matters and to stay informed about industry developments.

Impediments to the development of alternative connectivity solutions in the country

The development of alternative connectivity solutions in South Africa faces several challenges that hinder their widespread adoption and impact. Regulatory constraints, limited investment, spectrum allocation complexities, policy uncertainties, and lack of underlying infrastructure all contribute to slowing innovation in this space. Addressing these impediments is crucial to unlocking the full potential of diverse connectivity solutions and ensuring inclusive and meaningful access.

⁸² Rey-Moreno, C., Tucker, W. D., Cull, D., & Blom, R. (2015). Making a community network legal within the South African regulatory framework. ICTD '15: Proceedings of the Seventh International Conference on Information and Communication Technologies and Development.

⁸³ <https://researchictafrica.net/ria-research/find/>

⁸⁴ <https://www.wits.ac.za/linkcentre/about-link/>

⁸⁵ <https://www.undp.org/south-africa/blog/undp-and-csir-launch-low-cost-internet-mdantsane-eastern-cape>

Licensing framework

ICASA grants Electronic Communications Service (ECS) and Electronic Communications Network Service (ECNS) licences to operators and service providers for electronic communications, including registration, transfers, and exemptions. There are certain conditions under which a license exemption can be obtained, for example by providing services on a non-profit basis or operating as a private network. The process of getting a licence exemption for a community network in South Africa has been well documented and elaborated by the founders of Zenzeleni.⁸⁶ Zenzeleni successfully obtained both ECNS and ECS exemption. By registering the network as a cooperative, Zenzeleni was able to obtain a ECNS licence exemption for being a private network and the ECS licence was exempt due to the non-profit nature of the cooperative. Community ISPs often face challenges navigating complex legal frameworks, making it difficult for them to apply for necessary licences and operate within regulatory requirements.

Many providers follow the Zenzeleni guidelines when registering. However, a licence exemption is not the same as being a license holder and for example, license exempt complementary access solutions are not eligible to apply for universal service funds. The proposed Electronic Communications Amendment Bill of 2022, introduces a new definition of “community network”, emphasizing provision of ECNS and ECS in underserved areas by non-profit entities.⁸⁷ Under the Bill ICASA is required to prioritize the assignment of unused spectrum to these networks.

In terms of spectrum, licensing fees are often prohibitively expensive for alternative, small operators, putting them at a disadvantage compared to large telecommunication companies. The emphasis on national-scale spectrum licences does not align well with the needs of small WISPs serving specific local areas.

Obtaining a TVWS licence is still challenging, since the equipment needs to not only be type approved by ICASA, but must also be compatible with the CSIR geolocation database essential for TVWS operation, to insure there is no interference with incumbents in said band which in this case is broadcasters. In addition to ECS and ECNS licences, optical fibre network operators must acquire wayleaves from individual municipalities, leading to inconsistencies and high costs. Obtaining the necessary licences and approvals can be time-consuming and costly.

The licensing framework for satellite services is currently under review.⁸⁸ These complex and often inconsistent licensing requirements across different technologies create barriers to entry for new operators and hinder the rapid deployment of alternative connectivity solutions in underserved areas.

Infrastructure sharing

Infrastructure sharing is a critical component in expanding last-mile connectivity. By allowing multiple operators to utilize the same physical infrastructure, such as towers, optical fibre networks, and other facilities, infrastructure sharing can significantly reduce deployment costs, accelerate network rollout, and improve coverage in underserved areas. This approach is particularly important for alternative connectivity providers, small ISPs, and complementary

⁸⁶ Rey-Moreno, C., Tucker, W. D., Cull, D., & Blom, R. (2015). Making a community network legal within the South African regulatory framework. ICTD '15: Proceedings of the Seventh International Conference on Information and Communication Technologies and Development. <https://doi.org/10.1145/2737856.2737867>

⁸⁷ https://www.gov.za/sites/default/files/gcis_document/202306/48841gon3567.pdf

⁸⁸ <https://www.ellipsis.co.za/satellite-licensing-framework/>

access solutions as it enables them to extend their services without the need for substantial capital investments in duplicative infrastructure. The challenges related to infrastructure include high startup costs, limited access to affordable backhaul, expensive and difficult access to high sites and towers, complex and costly wayleave processes, and a lack of standardization in municipal procedures.

The initial investment required to establish infrastructure, such as towers, optical fibre networks, and necessary equipment, can be prohibitively expensive, particularly for smaller operators. The costs associated with obtaining necessary licences and permits further exacerbate this issue. Limited access to affordable backhaul connectivity also hinders the ability of smaller operators to extend their networks to underserved areas. Moreover, expensive and difficult access to high sites and towers creates additional financial burdens.

Infrastructure access policies, especially those concerning leasing facilities and wayleaves, have been insufficient in promoting equitable access. While the Electronic Communications Act (ECA) includes regulations for facilities leasing and mandates licensees to lease facilities to other licensees, the interpretation and enforcement of these provisions have been problematic. Requests for facilities access are often met with resistance or outright refusal from incumbent operators.

The ECA Amendment Bill mandates the creation of standard draft by-laws under the Municipal Systems Act, 2000, to regulate the rapid deployment of infrastructure. These by-laws are required to establish a uniform wayleave process, set cost-based wayleave application fees, and create a framework for sharing municipal property and communications infrastructure. The bill also introduces a new licensing category for Electronic Communication Facilities Services (ECFS), and licensees will be subject to the obligation to lease facilities upon request.

This report recommends ensuring access to critical infrastructure at affordable prices. This measure would include affordable backhaul, lower rental costs for shared towers, and reduced wayleave fees. Licensing conditions could mandate affordable pricing for commercial providers offering services to alternative providers, potentially reducing the universal service fees for each provider connected. Municipal by-laws could establish lower prices for alternative last-mile providers seeking access to wayleaves.

Figure 5: Informal settlement in South Africa (dense urban area)



Source: ITU

Lack of affordable backhaul

In terms of backhaul costs, market conditions and prices present significant challenges for small community operators and complementary access solutions. For instance, Black Equations in Cape Town accesses a 10 Mbit/s uncontended line terminating at Ocean View High School for ZAR 3 100 per month.⁸⁹ This cost is approximately five times higher than a retail 50 Mbit/s optical fibre line from Telkom or VOX in nearby middle-class suburbs. However, these retail lines do not reach the working-class suburb of Ocean View, and the only alternative for backhaul in the area is unreliable wireless links from WISPs. As a result, the complementary access solution has little choice but to rely on the more expensive and slower option.

To address the availability and cost of backhaul, a mandatory open access policy for backhaul operators could be implemented, along with a requirement for operators to publish a basic rate card.⁹⁰ Additionally, full transparency through the publication of network maps and the adoption of open data standards, such as the Open Fibre Data Standard, would make it easier for complementary access solutions to find affordable backhaul options.⁹²

⁸⁹ Interview with Black Equations.

⁹⁰ <https://www.d4d.net/news/telecommunications-and-the-state-of-open-data/>

⁹¹ <https://manypossibilities.net/2017/06/the-case-for-open-data-in-telecoms/>

⁹² <https://linktr.ee/opentelecomdata>

IMT spectrum

The development of alternative last-mile connectivity solutions in South Africa has faced several impediments in the realm of spectrum allocation and policy implementation.

The Wireless Open Access Network (WOAN) initiative, initially proposed as a solution to increase competition in the mobile market, faced significant hurdles. The CSIR had provided the technical assessment, providing recommendations regarding the unassigned high-demand spectrum needed to support the viability and sustainability of WOAN, assuming a 20 per cent market share. According to some studies, the WOAN bears similarities to initiatives implemented by Sentech and Second Network Operator (SNO), trading as Neotel, which were misaligned with economic realities and market dynamics.⁹³ The WOAN also resembles the underserved area licences (USALs), a policy that ultimately failed due to issues such as limited scale, insufficient managerial and technical expertise, and inadequate governmental support. The specifications for forming a consortium for the WOAN were overly complex, coupled with a requirement to present an exceptionally detailed business plan.⁹⁴ These arguments have collectively been used to portray the WOAN as impractical, and ultimately have contributed to the decision to abandon the initiative.

Another notable decision by ICASA was to open the lower 6 GHz spectrum band (5 925-6 425 MHz) for Wi-Fi. The limited release of only the lower portion of the 6 GHz band restricts the full potential of this spectrum for bridging the digital divide. Industry groups have called for exempting the entire 1 200 MHz of the 6 GHz band from licensing requirements, including the upper band (6 425-7 125 MHz). Consequently, one potential approach to consider would be allocating the entire 6 GHz band for unlicensed use, which could help expand coverage in rural and underserved areas. However, relying on unlicensed spectrum alone is not sufficient for meaningful connectivity. Specifically, affordable licensed spectrum is required for high-capacity point-to-point links, while affordable IMT spectrum is essential for enabling alternative providers to deploy small cell technology in their networks and offer widespread, low-cost mobile broadband to users.

The recent policy document from the Ministry of Communications and Digital Technologies, *Next-generation radio frequency spectrum policy for economic development*, outlines a framework for releasing spectrum for community use and directs ICASA to identify IMT spectrum suitable for community networks (as defined in the ECA amendment) by May 2025. This presents a critical opportunity to collaborate with the regulator and provide support to the development of this framework, which could include changes such as expanding its focus to include community centred last-mile connectivity solutions more broadly.

The framework could include any combination of the following options:

- A reserved block of currently available IMT spectrum for alternative last-mile solutions
- Affordable spectrum leasing options.

⁹³ https://papers.ssrn.com/sol3/papers.cfm?abstract_id=1988136

⁹⁴ <https://www.wits.ac.za/media/wits-university/faculties-and-schools/humanities/research-entities/link/documents/public-policy-series/Public%20Policy%20Series%20-%202021%20-%20Spectrum%20Regulation%20South%20Africa%20-%20Sutherland-Abrahams.pdf>

- A local spectrum licence model, such as the “Non-competitive Local Licence” in Canada for 3.9 GHz⁹⁵, the “Shared Access Licence” in the United Kingdom⁹⁶, or the “Managed Spectrum Park” in New Zealand.⁹⁷
- A dynamic spectrum access regime for IMT spectrum not in use nationally by an operator.

LEO satellite

LEO satellite deployment has faced resistance from many African governments, due to concerns over sovereignty, security, monopolistic risks, and cross-border regulatory challenges. To address these issues and maximize the potential of LEO satellites, research by the Tony Blair Institute for Global Change suggests creating adaptive regulatory frameworks for licensing and spectrum allocation, fostering public-private partnerships to align deployments with national priorities, and investing in local expertise to enhance regulation and innovation. Governments are encouraged to balance privacy and security with flexible policies for affordability and promote international cooperation to manage orbital congestion and harmonize spectrum use.⁹⁸

ITU continues to update the regulation on LEO satellites,⁹⁹ while the African Telecommunications Union has worked to harmonize spectrum policies, however, many countries still lack comprehensive frameworks. The rapid deployment of LEO satellites has outpaced the development of corresponding policies, leading to inconsistent allocation practices, misalignment with international standards, and concerns over equitable spectrum access and control.

Type approval

The ICASA type approval process ensures that all electronic communications equipment used in South Africa complies with the necessary technical standards and regulations. This includes assessing the equipment for conformity, safety, and performance. Manufacturers or importers must submit an application, including product details, and undergo testing. Once approved, the equipment is granted a certification, allowing it to be legally sold and used in the country.¹⁰⁰

The ICASA type approval process in South Africa faces several significant challenges. Processing delays have been a persistent issue. Streamlining the type approval process could reduce delays and lower costs. In order to ease the burden on manufacturers, simplified compliance and labelling are recommended, particularly for smaller devices. Faster handling of minor modifications could also improve efficiency without compromising regulatory standards.

ICASA is in the process of modernizing its type approval framework to accommodate the type approval of equipment using emerging technologies. However, ICASA does have a framework in place that permits provisional type approval, and a framework that allows for test licensing. Provisional type approval from ICASA is issued for up to six months and serves to enable the use

⁹⁵ Fees vary based on bandwidth and geography (urban, rural, remote). <https://ised-isde.canada.ca/site/spectrum-management-telecommunications/sites/default/files/attachments/2023/ncldecisionpaper2023-en-v2023jun.pdf>

⁹⁶ Introduced in 2019 and offering low- and medium power licenses in four frequency bands, Ofcom has issued over 1500 shared access licences by 2024. <https://www.ofcom.org.uk/spectrum/frequencies/shared-access/>

⁹⁷ The MSP is intended for local and regional services, operating in the 2.5 GHz band. <https://www.rsm.govt.nz/licensing/licences-you-must-pay-for/managed-spectrum-park-licences>

⁹⁸ <https://institute.global/insights/tech-and-digitalisation/bridging-the-digital-divide-in-africa-the-promising-role-of-leo-satellites>

⁹⁹ <https://www.itu.int/hub/publication/r-reg-rr-2024/>

¹⁰⁰ <https://www.icasa.org.za/pages/type-approval>

of equipment for trials, demonstrations, or research on a non-commercial basis, and to facilitate the testing of equipment in an Accredited Testing Laboratory (ATL) within South Africa. The test licence provided by ICASA is intended for sandbox-style pilot deployments and applications, allowing for experimental testing and innovation within a controlled regulatory framework.

Financing

According to the report "*Regulatory and Market Analysis for Wireless Internet Service Providers (WISPs)*" by the Dynamic Spectrum Alliance, there is limited targeted public support for WISPs as small and medium enterprises (SMEs) in South Africa.¹⁰¹

Complementary access solutions and not-for-profit operators often rely on grants and international development programmes for funding. However, sustainability becomes a challenge when grant funding ends and no long-term plan is in place. While South African complementary access solutions do not qualify for universal service funds as they are licence exempt, at least until the ECA Amendment Bill gets approved, they have successfully accessed other public funding sources. Zenzeleni Networks, for instance, received support from the Department of Science and Innovation Technology Innovation Agency after winning a national award for social impact, enabling the establishment of a second cooperative. Additionally, the South African branch of APC led National Schools on Community Networks initiative is co-funded by multiple government entities, including the Northern Cape Department of Economic Development and Tourism, the University of the Western Cape, and the Department of Science and Technology, demonstrating official support for such initiatives.¹⁰²

In South Africa ICT policies advocate for public-private partnerships (PPPs) to expand digital inclusion, but their profit-driven structures often prioritize affluent areas, neglecting underserved communities. Dominance by large telecommunication companies, supported by favourable government policies, reinforces this imbalance, concentrating resources and benefits within a few organizations.

Several development-focused organizations are investing in infrastructure rollout and pilot deployments. The United States Trade and Development Agency (USTDA) supported a feasibility study to demonstrate TVWS as a practical and commercially relevant solution for connecting rural South Africa¹⁰³ and the agency provided USD 1 million to kick-start the project. USTDA also supported a feasibility study with Dark Fibre Africa to assess the technical and commercial viability of extending optical fibre to underserved residential areas with low population density and income levels.¹⁰⁴

UNDP South Africa financed the pilot of TVWS technology and SMME support programme, which was driven by the (CSIR). In this programme four small businesses in selected pilot districts were supported in implementing the TVWS rollout. The initiative supported SMMEs by providing equipment, operational funding, and training to facilitate the deployment of low-cost Internet services in rural South African communities. For example, Mdantsane Mobile, led by CEO Songezo Mhambi, received 15 high-performance outdoor Wi-Fi client stations, a year's worth of operating capital, and training in business management and TV white space technology. With

¹⁰¹ <https://dynamicspectrumalliance.org/2024/FinalreportWISPAAnalysis.pdf>

¹⁰² <https://www.kictanet.or.ke/school-of-community-networks-south-africa/>

¹⁰³ <https://www.ustda.gov/ustda-expands-affordable-internet-access-in-south-africa-creates-new-u-s-export-opportunities/>

¹⁰⁴ <https://dfafrica.co.za/newsroom/press-release/2021-06-10/dfa-partners-with-ustda-for-feasibility-study-on-rural-digital-infrastructure-roll-out/>

this approach, the initiative enabled entrepreneurs to develop self-sustaining models rather than relying on continuous external funding.¹⁰⁵ UNDP allocated additional funding to scale up the pilot project and expand to ten more communities across South Africa.¹⁰⁶

The Digital Economy for Africa (DE4A) initiative from the World Bank Group helps increase broadband access in Africa by enhancing regulatory capacity in the telecommunication sector, and by extending last-mile connectivity to rural and remote areas. It has supported regulatory reforms to promote fair competition, attract investment, and bridge the digital divide. Through its Maximizing Finance for Development (MFD) and Private Capital Mobilization (PCM) approach, the World Bank Group focuses on expanding broadband coverage in underserved areas by leveraging private investment and minimizing the need for public funding.¹⁰⁷

Underlying infrastructure

The national energy crisis and persistent load shedding resulted in a requirement for operators to deploy alternative energy solutions such as solar panels, batteries, etc. While major operators could afford these investments, alternative connectivity providers and small ISPs often operate on tight budgets, leaving them unable to allocate resources for additional investments in energy or other underlying infrastructure.

¹⁰⁵ <https://www.undp.org/south-africa/blog/q-undp-beneficiary-songezo-mhambi-ceo-mdantsane-mobile>

¹⁰⁶ <https://www.undp.org/south-africa/blog/undp-and-csir-launch-low-cost-internet-mdantsane-eastern-cape>

¹⁰⁷ <https://www.worldbank.org/en/results/2023/06/27/from-connectivity-to-services-digital-transformation-in-africa>

Part 4: Recommendations

To fully leverage the opportunities presented by alternative last-mile connectivity solutions, and considering the gaps that were identified in this report, it is recommended that South Africa consider taking action across several domains.

1. Regulatory framework

The ongoing implementation by ICASA of a regulatory sandbox approach should be designed to accommodate alternative technologies and smaller players, rather than just incumbents, and should be future-proofed to accommodate emerging technologies. While a new licensing category for complementary access solutions is in the process of being formulated by ICASA, these solutions require more than just a legislative framework, they also need policy intervention and support, including funding and financial assistance. The licensing framework should be updated to accommodate new emerging technologies and services, including satellite technologies that can be considered as a backhaul solution for ultra-remote areas. Additionally, the type approval framework should be modernized and future-proofed to align with international standards, ensuring a streamlined process while maintaining South Africa-specific requirements where necessary.

2. Spectrum allocation and management

Consideration should be given to designating the entire 6 GHz frequency band for unlicensed use to maximize economic and social benefits in underserved areas. Implementing a dynamic spectrum access regime for IMT spectrum not in use nationally by operators should be explored, as well as creating a framework for releasing spectrum for community use, using a reserved block of currently available IMT spectrum for alternative last-mile solutions. A local spectrum licence model similar to those in Canada, the United Kingdom, or New Zealand could also be considered.

3. Infrastructure sharing and access

Policies should be developed to ensure access to critical infrastructure for alternative connectivity providers at affordable prices, including affordable backhaul, lower rental costs for shared towers, and reduced wayleave fees. An open access policy for backhaul providers, potentially coupled with a pricing transparency mandate, should be considered. There is an opportunity to leverage existing frameworks, fast-tracking and enhancing them to better serve alternative connectivity providers.

4. Financing and support

In terms of financing and support, targeted public support programmes should be created for WISPs and complementary access solutions as a distinct category of small and medium enterprises in the telecommunication sector. The Universal Service and Access Fund should be assessed and improved to enable funding for both robust connectivity infrastructure and programmes addressing barriers to adoption, particularly for marginalized communities. Public-private partnerships that prioritize financing access in underserved communities should be developed, and the new Innovation Fund should include support for initiatives focusing on last-mile connectivity solutions and digital services for underserved communities (addressing both supply and demand side). Ideally, the Universal Service Financing Efficiency Toolkit from ITU

should be used during the fund design phase.¹⁰⁸ Infrastructure investments should be aligned with connectivity goals, ensuring that the ZAR 940 billion infrastructure spending announced in the SONA includes significant allocations for digital connectivity projects.

5. Capacity building and digital skills development

Programmes such as the School of Community Networks should be expanded to provide essential skills development for community members, including expertise in regulatory compliance and licensing procedures. A larger ecosystem of ongoing support for alternative last-mile connectivity solutions, including mentorship programmes and financial sustainability toolkits, should be established.

6. Technology adoption

The use of innovative solutions, such as aerial optical fibre deployment in dense township environments should be encouraged, along with support for the development and implementation of community cellular networks using technologies such as dynamic spectrum access. The use of satellite backhaul for ultra-remote areas where terrestrial infrastructure is impractical should also be explored.

7. Research and development

Continued support should be provided to research institutions and think tanks studying and documenting best practices for alternative connectivity solutions. Investment in local expertise to enhance regulation and innovation in emerging technologies is crucial.

8. Integrated infrastructure development

Digital connectivity initiatives should be coordinated with other infrastructure projects, such as rail and port developments, to create synergies, enhance cost efficiencies, and ensure comprehensive coverage.

¹⁰⁸ <https://www.itu.int/itu-d/reports/regulatory-market/usf-financial-efficiency-toolkit/>

Appendix 1: Guidelines

When implementing complementary technologies to enhance last-mile connectivity in South Africa, it is crucial to consider the unique characteristics and challenges of different geographical and socio-economic contexts. The following guidelines provide tailored approaches for urban, rural, and ultra-rural areas:

Urban areas

In densely populated urban areas in South Africa, the primary challenge is affordability. While traditional operators provide coverage, residents in informal settlements often cannot afford mobile data. Therefore, the following guidelines are recommended for these areas:

- Prioritize aerial optical fibre deployment in dense township environments to provide high-speed, reliable connectivity.
- Consider innovative approaches to specific problem areas: support pay-as-you-go payment models for ISPs, as these fit the reality of township residents (cash-based, often informal economy).
- Encourage the development of community-centred solutions in underserved neighbourhoods to address affordability issues.
- Explore dynamic spectrum access technologies to optimize the use of available spectrum in congested areas.

Rural areas

In rural regions with scattered populations, challenges revolve around limited coverage, affordability, and the sustainability of business models for alternative providers. Therefore, the guidelines for these areas are as follows:

- Leverage TV White Space (TVWS) technology to provide broader coverage, especially in areas with challenging terrain.
- Promote the establishment of complementary access solutions such as community networks, using a mix of Wi-Fi and dynamic spectrum access technologies.
- Consider existing versus necessary basic infrastructure requirements and adapt solutions appropriately: implement hybrid solutions combining optical fibre backhaul with wireless last-mile connectivity.
- Encourage partnerships between small WISPs and local communities to develop sustainable connectivity models.

Ultra-rural areas

In remote, sparsely populated regions, there is often a lack of coverage and low population density reduces commercial viability. Lack of reliable power further affects connectivity solutions. The guidelines for ultra-rural areas are as follows:

- Consider the geographical features and match them to appropriate technologies.
- Prioritize satellite connectivity, particularly LEO constellations, for both direct-to-user services for higher income remote farms, and as backhaul for local distribution networks (complementary access solutions and WISPs) in low-income remote areas.
- Support the development of off-grid power solutions, such as solar-powered base stations, to address energy infrastructure challenges.

- Implement community cellular networks using dynamic spectrum access to provide mobile connectivity in areas lacking traditional cellular coverage.

When implementing these technologies in each geographical and socio-economic context, the following principles should be considered:

- 1) Community engagement: Involve local communities in the planning, implementation, and maintenance of connectivity solutions to ensure relevance and sustainability.
- 2) Digital skills development: Provide training and support to local technicians and community members to maintain and troubleshoot the deployed technologies.
- 3) Flexible regulatory approach: Work with ICASA to develop region-specific regulatory sandboxes that allow for innovative solutions while ensuring compliance with national standards.
- 4) Sustainable funding models: Develop tailored funding mechanisms that combine public support, private investment, and community contributions to ensure long-term viability of the projects.

By following these guidelines and adapting them to specific local contexts, there is potential for South Africa to make significant progress in bridging the digital divide across its diverse geographical landscape.

Appendix 2: Stakeholder consultation

People and organizations consulted in the preparation of this report include:

Title	Organization
Councillor	ICASA
Project manager	ICASA
Principal researcher	CSIR
President	Dynamic Spectrum Alliance
Adjunct Professor	University of Cape Town
Founder	Black Equations
Internet measurements expert	Internet Society

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