

Proceedings Report



Building Profitable and Sustainable Community Owned Connectivity Networks

as Part of the Innovation for Inclusive Development (IID)

Seminar Series



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The Academy of Science of South Africa (ASSAf) was inaugurated in May 1996. It was formed in response to the need for an Academy of Science consonant with the dawn of democracy in South Africa: activist in its mission of using science and scholarship for the benefit of society, with a mandate encompassing all scholarly disciplines that use an open-minded and evidence-based approach to build knowledge. ASSAf thus, adopted in its name the term 'science' in the singular as reflecting a common way of enquiring rather than an aggregation of different disciplines. Its Members are elected based on a combination of two principal criteria, academic excellence and significant contributions to society.

The Parliament of South Africa passed the Academy of Science of South Africa Act (No 67 of 2001), which came into force on 15 May 2002. This made ASSAf the only academy of science in South Africa officially recognised by government and representing the country in the international community of science academies and elsewhere.

This report reflects the proceedings of Building Profitable and Sustainable Community Owned Connectivity Networks seminar as part of the Innovation for Inclusive Development (IID) Seminar Series held on Zoom Webinar.

Views expressed are those of the individuals and not necessarily those of the Academy nor a consensus view of the Academy based on an in-depth evidence-based study.



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The IID seminar titled: **Building Profitable and Sustainable Community Owned Connectivity Networks**, was hosted on 31 August 2020 on Zoom Webinar. The 2019 White Paper on science, technology and innovation (STI) recognise the pivotal enabling role of information and communication technologies (ICTs) in realising an inclusive and prosperous information society and knowledge economy. One of the Department of Science and Innovation (DSI)'s key role is to catalyse the digital ecosystem and develop scalable models for community owned connectivity networks to replicate in other areas. Rural areas provide challenging environment to implement communication infrastructure for data and Internet based services, including high cost of network implementation and lack of customer base, low income streams, highly scattered and low population density.

The DSI has thus partnered with the University of Western Cape (UWC), the Mankosi Village community, with support from the Technology Innovation Agency (TIA) to scale-up the Zenzeleni Community Owned Connectivity Networks (COCN). The Zenzeleni COCN has been in existence since 2012 and provides timely, reliable and affordable Wi-Fi connectivity to the remote rural areas of Mankosi and Zithulele in Mthatha. The webinar, facilitated by Ms Ellen Fischat from Story Room aimed to look at how rural and township wireless connectivity models, including Zenzeleni COCN can be scaled-up to increase the number of people connected in the rural settings, more so in light of the COVID-19 crisis. It is evident from the proceedings the need for community networks to provide access to connectivity and also more importantly, what connectivity enables. Subsequent discussions would need to focus on the users and owners of these community networks to understand how their lives have improved through the deployment of the technology. This will shed light of the financial feasibility and benefit.

ASSAf greatly acknowledges the DSI, all the speakers and over 100 participants in attendance from Zimbabwe, Uganda, Nigeria and from various industries across South Africa including public, private, academia, NPO/NGO and others. The contributions of the ASSAf Liaison Programme, led by Mr Stanley Maphosa and the contact person for this project Dr Tebogo Mabotha's contributions throughout the project are hereby acknowledged and appreciated.



Prof Himla Soodyall
ASSAf Executive Officer

Welcoming Remarks

Facilitator: Ms Ellen Fischat

Prof Himla Soodyall, Executive Officer, ASSAf

Prof Soodyall welcomed the speakers and the many participants linking in from different parts of the world through various portals.

ASSAf is privileged to partner with the DSI on the IID Seminar Series, which aims to promote open discussion and thinking between science policy and community engagement and attract a wider engagement that reaches beyond academia.

Purpose and Objectives of the Webinar

Ms Nonhlanhla Mkhize, Chief Director, DSI

The IID Seminar Series is one of the multi-stakeholder Science, Technology and Innovation (STI) platforms used by the DSI under its Innovation for Inclusive Development Programme. The outputs of these seminars are used and incorporated when engaging with other departments that are relevant in terms of enabling universal access. This webinar provides an opportunity for the experiences of multiple stakeholders to be shared and for policy and practice implications to be highlighted. The conversation about building profitable and sustainable community owned connectivity networks (COCNs) is key within the context of the White Paper for STI in the sense that it acknowledges that viable business models to enable universal access are critical for South Africa in order to attain an inclusive and prosperous system of innovation.

The fact that Information and Communication Technology (ICT) continues to change the way that people interact and transact, illustrated in how the internet became a critical service during the coronavirus disease (COVID-19) pandemic which highlighted the importance of overcoming the digital divide. The DSI is engaging in joint projects with relevant stakeholders in order to find locally developed solutions and business models that are realistic and appropriate to the South African context and contribute to reviving the economy. One of the DSI projects, called the Zenzeleni Network, is in partnership with the University of the Western Cape (UWC), a Non-Profit Organisation (NPO) and community cooperatives, and pursues a financially viable business model for COCNs.

Session 1

Community Networks: Local, Regional and Global Perspectives

Dr Carlos Rey-Moreno, Association for Progressive Communications (APC)

APC is an international network that was founded in 1990 and dedicated to empowering and supporting groups and individuals working for peace, human rights, development and protection of the environment, through the strategic use of ICTs including the internet. The APC network has 57 organisational members and 35 individual members active in 73 countries. The only South African member is the Zenzeleni Network.

One of the targets of Sustainable Development Goal number 9 (SDG#9) is increased access to ICTs. The COVID-19 pandemic has helped put a focus on the internet as a critical infrastructure and a vital tool for development, and on the importance of connecting rural and remote areas. Although the United Nations (UN) statistics show that there has been progress in the uptake of mobile technologies, the growth in the number of users each year is plateauing and the trend is declining. There are many reasons for the digital divide and digital inequality to continue increasing in different dimensions as a result of the current approach to connectivity. Most of the current models use big national and multi-national companies that not only focus on the provision of internet but also on profitability and shareholding, making it unsustainable for them to provide affordable universal connectivity in many areas of the world. These companies are investing in 5G and other technologies used to improve connectivity for those already connected and leave behind the rural and remote populations of the world.



The International Telecommunication Union (ITU)'s is stressing the need for complementary solutions in order to increase connectivity. These solutions are possible in part, because of the disaggregation of the value chain in the telecommunications industry. Most regulators think that the telecommunications industry requires considerable infrastructural investment, but much of the over one million kilometres of fibre cable in Africa is not being used to its full capacity. There is a new generation of low cost easy-to-use technologies that can be used to share the bandwidth available at the points of presence in the fibre optics networks by small providers of wireless internet services, community networks (CNs) and so forth to provide connectivity in underserved areas. Changing the approach will require a paradigm shift away from national operators having control of every part of the business to one where communities can engagement in connectivity via last mile networks. There is a need for regulation to enable the latter and several steps have been taken in this direction.

CNs are defined as networks collectively owned and managed by the community for non-profit and community purposes. They are constituted by collectives, indigenous communities or non-profit civil society organisations that exercise their right to communicate under the principles of democratic participation of their members, fairness, gender equality, diversity and plurality.

Examples of APC members who are CN providers are:

- guifi.net in Spain, which uses mostly fibre to inter-connect its 130 000 users providing 1 Gigabyte per second (Gbps). There are more than 30 operators in the ecosystem based on a fair-trade cost structure and infrastructure is built in commons. In 2018, guifi.net had a capital expenditure (Capex) of more than €7 million and an operating expenditure (Opex) of €3 million per year.
- *Rhizomatica* and *Telecomunicaciones Indígenas Comunitarias* in Mexico use other technologies to provide services (Global System for Mobile Communications (GSM) and Long-Term Evolution (LTE)) and comprise 18 community operators that provide services in more than 70 locations, with around 4000 users daily using 4-megahertz (MHz) spectrum. The government of Mexico (the regulator) allowed the company to use mobile broadband spectrum even though it has community operators with community cellular infrastructure.
- Zenzeleni Networks in South Africa uses Wi-Fi and has 60 hotspots and 11 businesses with 2 cooperatives providing over 8 thousand unique devices. It made over R100 000 in sales in 2020.

CNs use diverse access technologies but have the same need for backhaul. One of the sustainability models is a tiered structure with micro organisations (providing services to end-users) and meso organisations (providing services and support to micro organisations). The tiers create a mutually reinforcing ecosystem. Micro organisations rely on external expert support and meso organisations' sustainability is based on a percentage of the revenue from the micro organisations. Part of the reason why CNs can provide more affordable access than other providers is based on the shared backhaul costs because there are efficiencies at scale with more users at the micro level and more micro organisations at the meso level. The networks have to think of themselves as a public utility in terms of what is required in order to maximise usage rather than revenue. Maximising usage will contribute to local development.

The social and economic impact of CNs is not only about affordable universal access but also about local control over how the network is used and the content that is provided on the network. CNs pay attention to the gender and the age gaps and other community needs such as the COVID-19 response and foster the digital ecosystem as well as a sense of agency and empowerment. Their services are accessible at a lower cost than other service providers and they ensure that funds and skills are retained in the community.

Even though CNs have many benefits, comparatively few are a reality at present. APC has taken up the task of correcting the telecommunications environment in order to pave the way for many more CNs to be set up in the country. APC wants to see more micro organisations (instead of bigger micro organisations) and currently directly supports 16 meso organisations in Latin America, Asia and Africa through institutional strengthening, knowledge sharing and fostering the CN ecosystem. Rural development takes time as does the development of skills and confidence levels of the micro organisations. The tiered structure of micro and meso organisations is supported in the recent findings of South Africa's Competition Commission as well as the International Telecommunication Union's (ITU) blueprint for Smart Villages. The participation of women within the micro and meso organisations, and in the movement as a whole, is critical.

The macro level (organisations that support CNs although it is not their core mandate) requires:

- Enabling regulations: The licensing framework needs to be improved and CNs should be able to use mobile broadband spectrum, particularly in rural areas where mobile operators that have assigned mobile spectrum do not use it. CNs require access to fibre and backhaul. Government and other public entity networks that are not fully utilised (such as South Africa's Tertiary Education and Research Network) can provide backhaul for CNs.
- Access to funding and infrastructure: All services in rural areas require subsidies. The telecommunication industry has the Universal Service and Access Fund to subsidise the Capex and Opex but has failed to date. CNs require Capex to be subsidised, but not the Opex, which they can cover. Instead, they would require additional funding to build skills to contribute to building an inclusive digital ecosystem.

South Africa is ahead of the game, particularly when compared to any other country in Africa. There is already involvement and collaboration across the micro, meso and macro levels. Zenzeleni Networks has produced very interesting results and provided evidence on how to move forward with regards to CNs in this country. APC together with the UK development agency piloted a project around training and mentoring micro organisations and has started another project in South Africa and several other countries that will be implemented by Zenzeleni Networks.

In conclusion:

- The current model of internet expansion is plateauing
- CNs as a tiered structure (with micro and meso organisations) are proven viable alternatives to provide affordable universal access
- More support is required from the macro level (particularly in South Africa)
- The real innovation is about enabling people to connect with each other

Mr Michuki Mwangi, Internet Society

In Africa, the majority of the population lives in rural areas and more than 800 million people are not connected. Communities in rural areas have found innovative ways of self-provision in terms of basic essential needs and services because it is very difficult for these services to be made available to them whether through commercial arrangements or public service delivered by government. A lot of studies have been done to try to understand why it is difficult, but essentially the business case viability for connecting people in rural areas is a reality and only alternative solutions are likely to enable those services to become available to those communities. The South African Competition Commission initiated a study to assess the situation and one of the recommendations about what could be done to improve the situation was the need to improve regulation to enable rural CNs to emerge and to have more micro enterprises to provide services in underserved areas.

In 2017, the Internet Society commissioned a study to gain insight on existing CNs in Africa as an alternative and complementary solution for connecting the unconnected in under-served areas of Africa. It found that there were 22 CNs based in 16 countries on the continent. They shared similarities in terms of collective ownership, aiming to catalyse local economies, promoting local content development and circulation, and taking a holistic approach to digital inclusion (availability, affordability and access). Since the study, there have been policy wins across the region, such as:

- A declaration passed by the African Union's (AU's) Specialised Technical Committees (STC) recognising CNs as an alternative and complementary solution to bringing connectivity to rural and under-served areas
- Revisions made to Uganda's regulatory and licensing categories to include CNs
- A statement released by the South African government in recognition of CNs (although this has challenges with respect to application)
- The recognition of CNs that was captured in Kenya's revised national broadband strategy that highlights CNs as a way of providing access to the under-served.

The 2017 study highlighted the fact that in Africa, a CN is not simply telecommunications infrastructure deployed and operated by citizens to meet their own communication needs, but a tool to improve what a community is already doing in terms of growth and development by contributing to a local ecosystem that enhances the daily lives of those staying in the community.

With respect to understanding community, governance and ownership, the diversity of the region means that the definition of community varies from one place to another. The common point is the understanding that it concerns those living around the area where the CN is deployed. Social cohesion is key to the survival of tight-knit communities and is underpinned by community leadership which consists of traditional authority, religious leaders and local government. Anything that disturbs the cohesion will result in fragmented community, which hinders development. Governance is built upon existing social cohesion and existing governance structures. The collaboration builds trust and ensures that the initiative is aligned with local community needs and sensitivities. The ownership of the CN's is based on sharing and the commons approach in management of local resources.

The study found that most of the CNs take a different approach to sustainability. In the absence of infrastructure to supply electricity, BOSCO Uganda installed solar

systems to generate power in the places where it provides connectivity and has sold a substantive amount of power generation through systems in a certain area of the country. PamojaNET in the Democratic Republic of Congo (DRC) provides a mix of Wi-Fi and GSM and has an agreement with businesses to subsidise connectivity for 4000 public users. This relationship ensures that everyone has equitable access to connectivity. Some CNs also offer locally relevant mobile application to its users that allows local businesses and service providers to advertise and thereby share the costs of connectivity. CNs try to provide locally relevant content because even though the connectivity might be affordable, prioritisation will be based on the benefit that the community receives. This will determine whether or not there is uptake of the service. CNs have an important role with respect to making the network relevant in the community.

Building and operating a CN requires social engineering, financing and partnerships, technical support and a legal framework. Scalability of CN development requires a tiered approach, where each tier plays a different role, namely:

- Micro level partnerships draw from the local community, for example, local welders, local businesses, local government, schools and health centres.
- Meso level partnerships have the ability to reach out to communities and develop their skills and capabilities and help them with up-scaling, such as other CNs and Technology Partners.
- Macro level partnerships enable and facilitate the establishment of CNs through provision of resources, knowledge, skills and expertise, such as international development organisations, national governments, the Universal Service and Access Fund.
- Women need to be included across all levels to ensure they participate in CNs.



Session 2

Building Profitable and Sustainable Community Networks

Panel Discussion

Mr Jabhera Matogoro, University of Dodoma

According to ITU statistics from 2019, 87% of individuals in developed countries use the internet, and in the least developed countries, only 19% of individuals are online. Europe has the highest rates of internet usage and Africa has the lowest.

Recent statistics show that in Tanzania there are 48.9 million voice telephone subscriptions and only 26.8 million internet users. The reason for the disparity is that the government invested in the deployment of infrastructure (such as 2G) with the support of mobile network providers, leaving behind other modern technology such as 4G and 5G. It is also reported that the internet penetration trend in Tanzania is only 46%. A study that was carried out by Research for ICT Africa (RIA) reported that 86% of rural dwellers in Tanzania remain unconnected to the internet compared to 44.6% in urban areas. Fewer women than men have access and use of the internet in Tanzania.

CNs are established for the people, by the people and have been found to be a feasible bottom-up approach to connect the unconnected population in Tanzania.

Broadband internet has many benefits. It is the key for ICT based economic development, it helps to bridge the rural and urban digital divide, provides access to modern services including education, health, jobs and agriculture, allows people to work from anywhere and provides home entertainment and connectivity. A study by the World Bank concluded that a 10% increase in fixed broadband penetration would increase the Gross Domestic Product (GDP) growth by 1.21% in developed economies and 1.38% in developing economies.

Television White Space (TVWS) is licensed but unutilised TV band spectrum. These spaces are the unused portions of spectrum allocated for TV broadcasting in a continuous or discontinuous manner or in a specific geographical setting, also referred to as interleaved spectrum. These TV spectrum gaps, with advantageous propagation properties inherent to the Ultra-High Frequency (UHF) spectrum, have been identified as an alternative for providing commercial wireless services. The UHF TV band spectrum has very good wireless radio propagation characteristics to penetrate hills, walls and cover large geographic areas. There is growing recognition across the globe that dynamic spectrum sharing, especially on TVWS, enabled by geo-location databases has significant potential to increase the availability and range of broadband access.

Experiences taken from Tanzania's Kondo CN project:

- Extensive spectrum measurement was conducted with the support of Tanzania's national regulatory authority and found that only 17% of the spectrum available in urban areas was used and in some rural areas 100% of the spectrum was not used. The unused spectrum provided very high-speed connectivity that enabled the CN to provide connectivity to four schools.

- The Tanzania Geolocation Spectrum Database was developed with technical support from South Africa's Council for Scientific and Industrial Research (CSIR) and contains data from the digital terrestrial TVs including the transmission aids as well as their location and power of the transmitter. This information supported by the propagation models provided an estimation of the amount of TVWS that was available in a given location before the CN allocated a channel to the devices. The database has received a high level of acceptance around the world as an approach to address the interference between TVWS equipment and digital terrestrial TV users.
- Part of the academic contribution pertaining to the spectrum measurement exercise was a paper titled, '*Towards Affordable Broadband Communication: A Quantitative Assessment of TV White Space in Tanzania*' published in a Springer journal available at: https://link.springer.com/chapter/10.1007/978-3-319-95153-9_29

The network architecture for the Kondoa CN involved a base station also known as master device co-located to one of the mobile network operator in Kondoa. Customer Premises Equipment (CPE) installed at school premises was connected to the television white space Internet through direction antennae connecting directly to the base station in the backhauling location. End-users were able to access the internet using smartphones and computers. The connectivity provided the necessary speed to enable access to various online services (including educational content) and help bridge the digital divide.

Some of the challenges facing rural broadband include high bandwidth costs and co-location fees, a lack of stable and reliable power solutions, widespread illiteracy among rural populations and the absence of policy and regulations pertaining to the CN model and TVWS.

The initial deployment costs were covered by the University of Dodoma and Internet Society through the Beyond the Net funding making Kondoa Community Network become the first community network to pilot the use of television white space to deliver high-speed Internet in rural Tanzania. Mr. Matogoro (one of the panellist) is working with Mozilla Foundation through its Open Internet Engineering Fellowship to replicate the experience and skills gained from Kondoa Community Network to establish four more community networks in Tanzania aimed to connect more than 20 million users. This includes, Kasulu Community Network Cooperative Society Ltd, Nyasa Community Network Cooperative Society Ltd, Mpimbwe Community Network Cooperative Society Ltd and Tarime Community Network Cooperative Society Ltd.

Mr Jabulani Vilakazi, Soweto Wireless User Group (SOWUG)

SOWUG was established in February 2010 as an NPO with the help of the Internet Society. The organisation seeks to promote information sharing through wireless communication and was inspired by the Johannesburg Wireless User Group (JAWUG) that provided wireless services for internal use only. Founders of SOWUG felt that it was necessary to customise the network to enable internet access for social, education purposes as well as the development of the broader community through providing access to information.

SOWUG started by developing the necessary infrastructure. The initial tower was used for the fibre backhaul to the data centre. By providing infrastructure as a service, fixed wireless internet service providers (WISPs) depend on the line of sight for connectivity. SOWUG has invested in such infrastructure and leases the space to other WISPs. Operating a telecommunication infrastructure requires strategic partnerships in the industry. SOWUG partnered with Njinjicom, its primary internet service provider (ISP). Other ISPs utilise the network for the communities that are in close proximity to the infrastructure.

Currently, SOWUG utilises the unlicensed 5,8 Gigahertz (GHz) frequency for users and backhaul connectivity. It has backhailed capacity of 1 Gigabyte (G), but only utilises 300 Megabytes (MB) of that and anticipates that future demand will exceed the 1 G capacity. In terms of network coverage, the 11 sub-stations are connected to one backhaul and are located in different parts of Soweto connecting over 200 users including businesses, restaurants, homes, student accommodation and clinics, and providing specific solutions for them.

Although a COCN is limited to operate as an NPO, SOWUG registered an entity that was recognised by the Independent Communications Authority of South Africa (ICASA) in order to obtain the requisite license to operate commercially. SOWUG has installed Wi-Fi in informal settlements where there is no electricity and where many people cannot afford connectivity. A single hotspot provides connectivity for between 100 and 150 users. An initial 200 MB are provided at no cost and local entrepreneurs are responsible for sustaining and expanding the hotspots within the informal settlements.

SOWUG lays the infrastructure and allows Small, Medium and Micro Enterprises (SMMEs) to utilise the infrastructure. They find clients and manage and bill them for sustainability purposes. Not a lot of profit is generated from this, but it does create a platform for employment, particularly for young people. SOWUG also trains individuals and SMMEs to do installations.

There are challenges with the kinds of networks utilised and the high concentration of technologies in a given area that cause interference. Other challenges have to do with:

- Access to municipal infrastructure (such as water reservoirs) in order to secure a line of sight for optimal coverage by a wireless network
- Access to Government Broadband Network (GBN) transit. Some schools have fibre, but a lot of transit is under-utilised. COCNs should be allowed to access the transit at cheaper rates and provide it to previously disadvantaged homes through Wi-Fi and at affordable rates.
- Fibre network operators (FNO) in the townships create more competition for WISPs and local WISPs and COCN are currently excluded from participating in the ecosystem due to the financial vetting required by the FNOs. FNOs should be required to engage with local WISPs in local communities.
- Access to licensed spectrum to avoid interference on the unlicensed band.
- Access to funding to allow local entrepreneurs the opportunity to participate in skills development and specialised training in the engineering aspects of the networks that they build.

In terms of governance structures, the COCNs and local WISPs are owned and operated by local entrepreneurs. The WISPs manage and support clients in their communities and they help drive the economy while creating jobs in the local community. The substations are located in specific parts of the township and are managed by people from the local community who also manage the power issues on site. The COCNs engage with the local authorities to inform them about the services they provide and gain their support in terms of the role COCNs play in providing affordable universal access to connectivity.

Ms Duduzile Mkwana, Consultant

Statistics from 2018 show that only 10.4% of households in South Africa have access to the internet in the home. The COVID-19 pandemic exposed the extent of the digital divide in this country and highlighted the role that COCNs could play in helping to bridge this divide.

Apart from seed-funding mechanisms, CNs use a range of funding streams to acquire the initial capital to sustain and scale their networks, including the donation of equipment, services, or funds via corporate social responsibility or research programmes. Project Isizwe, a NPO dedicated to bringing internet access to the populace, received requests from rural communities as well as those in urban areas that cannot afford internet services and started reaching out to private companies operating within these communities (such as mining companies). The companies invested in the upliftment of the communities by providing exposure to digital technologies, partnering with the NPO to roll out Wi-Fi hotspots and utilising the connectivity to bridge the communication gap, as well as by helping them to create their own content, start communicating among themselves and grow small business utilising the CN. Through the initial connection, Isizwe was able to partner with other private companies and NPOs that were looking to utilise technology as an enabler for content or an initiative.

There are also matching fund mechanisms where donors match the amount contributed by the communities. CNs reach out to partners within the telecom space, not to request monetary donations but proposing that the CN be allowed to utilise the company's (redundant) infrastructure to provide connectivity to specific communities.

In building profitable and sustainable CNs, it is important to move away from donor dependency and to create multiple streams of revenue and profits in order to be seen as social entrepreneurs. NPOs and ISPs use different methods such as partnering with content providers and charging them to put their content on the network, and ISPs offer hotspots for small profits or voucher systems as a key source of revenue for CNs. Google and Facebook have been experimenting with various models for providing access around the world. Microsoft, through the Airband initiative, aims to bring internet access to remote areas utilising TVWSs. CNs are well positioned to stand strong and complement global initiatives by providing realistic implementation paths.

The Universal Service and Access Agency of South Africa (USAASA) has funding and has been at the forefront of the government initiative around SA Connect, which aims to deliver widespread broadband access the entire population by 2030. To date,

very little if any progress has been made in this regard. The biggest issue has to do with policy around bridging the digital divide. It is not helpful to recognise CNs on the one hand and on the other hand does not allow for private sector involvement in CNs. The main objective of USAASA should be to support and subsidise the network infrastructure for CNs because they are doing the work. It is necessary to relook at government's grand initiatives to connect South Africa while excluding CNs and only recognising the role of CNs in areas where there is no connectivity.

Ms Mkwanazi recommended that CNs should be at the forefront of the roll out of Phase 2 of the SA Connect initiative and that technical support should be provided to the CNs, possibly through the Universal Service and Access Fund.

Dr David Johnson, University of Cape Town

Dr Johnson's presentation reflected on lessons learnt over the past 14 years that could be of help in building profitable and sustainable CNs.

CNs are built on a foundation of skills, creativity, courage and love, and require good regulation particularly with respect to sharing spectrum. They also need good infrastructure that is nimble, easy to set up and low-cost, as well as good quality spectrum. Unused high-value spectrum should be shared – in a similar way that wayleaves for fibre or tower space is shared amongst multiple operators. It is important to build community-created and -centred content. Currently, large national operators are active in this space, but the right frameworks need to be created so that more CNs can provide solutions for universal connectivity.

Interesting innovations that have been critical in terms of the infrastructure include a small and cheap device dating back to 2006 that could run embedded Linux. Since then, a plethora of low-cost devices that one can build CNs with have become available from companies like Ubiquity and even cellular base stations can be built at low cost. LTE base stations for CNs are available for around \$1500 compared to a typical base station used by a commercial operator costing between \$20 000 and \$50 000. With regard to spectrum sharing, there is talk about a 'spectrum crunch' which refers to urban areas where the cellular and Wi-Fi bands are cluttered, while most of the spectrum in rural areas is unused. However, regulation dating back to the 1930s maintains that the unused spectrum cannot be used. High-value spectrum is full of 'white spaces' and the perceived 'spectrum shortage' is in fact an artefact of the prevailing mode of spectrum management, of granting exclusive-use licenses to particular frequencies. This outdated thinking needs to change.

Thanks to the CSIR database and spectrum sharing platform, TVWS has begun to be deployed. Around 42% of the South African population could benefit from TVWS or any technology under 1 GHz. This model can also be used in White Space Cellular. There is lots of unused spectrum in cellular bands. Localised micro services present a further opportunity for connectivity in communities. Work done in Zambia showed that 60% of the messaging traffic in a certain village was between local users in the village, yet the internet is not designed for locality of interest.

The challenge relating to current locality is that it will cost an artist in a village \$4 to upload a video to You Tube and the fans will spend between \$1 and \$4 to look at the video, while the video should be stored on a micro service. This has inspired a new

project that Dr Johnson is involved in called iNethi, which is a content sharing and services platform for community wireless networks. The idea is to encourage content creation and also to make services available for free and make it easy to share. The real principle behind iNethi is to work with communities to co-design a content sharing and services platform for community wireless networks. Its goal is to build more resilient communities by using information technologies to help them tap into local creativity, innovation, and other resources, with the aim of improving socioeconomic status. iNethi is being trialled in a community owned network in Ocean View, Cape Town. The network is owned by OVCOMM Dynamic – a fully community owned network cooperative that launched at the end of 2018. OVCOMM Dynamic has rolled out a number of Wi-Fi Libremesh access points across the community and during the COVID-19 pandemic, a system was launched that provided education resources that connected school learners with teachers and could be accessed by the whole community. iNethi aimed to have a community owned LTE to provide wide coverage and access to lower bandwidth iNethi services across Ocean View. However, this would require some policy intervention.

The way forward is to have the following:

- Some intention amplifiers for cooperative community owned networks to close the connectivity/affordability gap
- Networking infrastructure that is nimble and low cost (mesh can help)
- Regulation and technology to support spectrum sharing, such as TVWS and new bands such as cellular
- More micro cloud localised service platforms
- Economic systems that create ownership of the network and reward those that put in effort to expand the network
- More skills development through workshops and training programmes

Dr Johnson concluded by asking the following questions:

- Could the Universal Service and Access Fund (or other funds) be used to create a 'new deal' for cooperative-based community owned networks?
- Could operators be incentivised to share spectrum by reducing their USAASA fees or being paid rebates on their license fees for sharing spectrum and allowing community networks to meet their service obligations?
- Is there a lesson to learn from the cooperatives formed to electrify rural America from the 1930s? (In the 1930s, 90% of Americans in cities had access to the electricity grid. Only 10% of rural Americans had access. In 2010, the 75th anniversary of rural electrification, co-ops managed 2.5 million miles – 42% of the nation's distribution lines. Today 100 rural electrical cooperatives are being used to roll out broadband).

Q&A, Discussions and Recommendations

(Question) Mr Keith Pitout, Indigo Broadband South Africa

How can we lobby the major MNO and TOWERCO's to reduce their tower rentals to help lower the cost to host wireless broadband base stations? At present the tower rental costs are so prohibitive.

(Response) Dr Carlos Rey-Moreno, Association for Progressive Communications (APC)

Indeed, Zenzeleni has had to build their own towers because of this... basically building one costed less than 8 months rental for two antennas. Plus, it strengthens the community buy in.

(Question) Mr Ephraim Phalafala, Department of Science and Innovation (DSI)

1. To Dr Carlos, what are the requirements to be a member of the NPC and what are the benefits?
2. In respect to the question above, requirements and benefits of being a member of the APC?

(Response Dr Carlos Rey-Moreno, Association for Progressive Communications (APC))

1. Do you refer to Zenzeleni NPC, or to APC. I've answered to the latter in another question. As for the former, I would advise that anyone interested in joining the NPC, send an email to info@zenzeleni.net.
2. You can find more information on <https://www.apc.org/en/join-apc> or on email karel@apc.org and carlos@apc.org.

(Question) Mr Nathi Mbele, AdNotes Digital

The Independent Communications Authority of South Africa, in terms of regulation 26 of the Regulations on the Use of Television White Spaces, 2018 ("the Regulations"), published in Government Gazette No. 41512 (Notice No. 147) of 23 March 2018, hereby gives notice that the commencement date of the Regulations is 1 April 2021. This is a great news for fixed broadband connectivity. Can the use of TV White Spaces possible enables growth and profitability of rural based community owned connectivity networks?

(Response) Dr Carlos Rey-Moreno, Association for Progressive Communications (APC)

I think this was a great step, and we will see more and more access being provided using TVWS. I believe it is a great technology for the infrastructure component of a CN, as well as the backhaul. For public access in rural and remote areas you need a technology that reaches the handset, and TVWS doesn't allow for that. Hence my request to support Mobile Broadband White Spaces (the UK regulator is already allowing this).

(Question) Giancarlo Groenewald, Pretoria Wireless Internet Service Provider

Where can we sign up to support this effort as an official wireless internet service provider (WISP) and with knowledge share. We are prepared to work with micro and government from a South African perspective.

(Response) Dr Carlos Rey-Moreno, Association for Progressive Communications (APC)

I would suggest you drop an email to info@zenzeleni.net.

(Comment) Mr Coenraad Loubser, WISH

Anyone who wants to duplicate or support this can also contact me on: coenraad@wish.org.za; 0737721223.

(Comment) Mr Jabhera Matogoro, University of Dodoma

We also need you in Tanzania. Hopefully COVID-19 will be over in that time.

(Comment) Dr Carlos Rey-Moreno, Association for Progressive Communications (APC)

We at APC, ISOC would encourage anyone who is interested in building CNs to contact established CN that have been mentioned here for support, in addition to reaching out to us for any assistance and guidance that you may require."

(Comment) Mr Coenraad Loubser, WISH

Yes! The whole point and power of the internet is that we are not bound by geography! Also, no need to settle for less, rural networks can be as fast or better than urban areas and have more to gain!

(Response) Ms Ellen Fischat, Story Room

Unfortunately, most people do not yet know how to navigate the internet for economic opportunities, how to upskill yourself and generate income regardless of where you are!

(Comment) Ms Kgopotso Magoro, Zuri Foundation

You are correct Coenraad, it does not have to be poor quality of service just because it is for rural people.

(Comment) Mr Keith Pitout, Indigo Broadband South Africa

When there are many existing towers, it's not good for the environment to add more towers etc. In many locations, there are many towers around especially the old Telkom DECT towers in the Eastern Cape and KZN. They need to support community networks, even for a profit-based ecosystem they need to drop their tower rental costs as they base it on large ISP or opposition MNO's.

(Response) Dr Carlos Rey-Moreno, Association for Progressive Communications (APC)

Agree. I've tried the same with Eskom to no avail. They don't see the public utility angle to connectivity, they just want to get profit, because they assume you are making profit. There needs to be a change in mindset about non-profit connectivity. If you are going to make profit, I would support they charge you something.

(Question) Ms Thuka Matlhoko, Private

Why do we only involve the community at the delivery stage not during the planning and inception stages (for development and ownership)? We should always have community data base information on skills we have and fully utilise rather than outsourcing.

(Question) Mr Kenosi Ngata, Keneo Solutions

Is there ways you can advise small start-ups on who we can approach if we are interested in building community networks, we want to help and have access to the community, but we don't know who to approach.

We have done research, however equipment is very expensive for us to buy. We have gone to different locations including, (Free State) Botshabelo, Thaba Nchu and (Mpumalanga) Embalenhle and can say the network in the areas are poor.

We have 12 years experience in different IT fields professionally, we are really trying to get our company to be part of the telecommunications industry. We only need advice on who we can approach, we are willing to learn anything we don't know.

(Response) Ms Ellen Fischat, Story Room

You should connect with Ms Dudu Mkhwanazi!

(Question) Giancarlo Groenewald, Pretoria Wireless Internet Service Provider

Can we setup a Discord server or something so we smaller WISPs can discuss and work together and grow micro access?

(Response) Dr Carlos Rey-Moreno, Association for Progressive Communications (APC)

There is already one: <https://communitynetworks.group>.

(Question) Mr Jacob Munodawafa, Southern Africa Telecommunications Association (SATA)

This discussion for lobbying MNOs (telecom operators) requires all stakeholders - regulators and operators to engage and support the roll out of community networks. I am from SATA, <https://sata-sec.net>, <https://sataconnect.net>, jacob.munodawafa@sata-sec.net

(Response) Dr Carlos Rey-Moreno, Association for Progressive Communications (APC)

I'll definitely follow-up on this.

(Comment) Prof Shaun Pather, University of the Western Cape (UWC)

I would also like to engage with you Jacob. We could use Zenzeleni as a case with SATA to see how SATA could support the lobbying of stakeholders - including regulators.

(Question) Mr Eric Nitschke, Wakoma

1. To Carlos or Michuki, how can we develop meso level partnerships between CNs and non-CN's? i.e. "community-based connectivity initiatives" and WISPs that aren't entirely community-owned but still deeply rooted in local social/tech/economic development.
2. How can CN 'club' be more inclusive to share/grow resources and capacity, and help other networks look beyond revenue-generation motives while remaining sustainable?

(Response) Dr Carlos Rey-Moreno, Association for Progressive Communications (APC)

I would love to explore that; I must say I have mixed feelings. My attempts so far is that most WISPs are very deep into revenue-generation motives, and that is at odds with the more collective local rural development behind CNs, whereby they see the CN 'club' opening a new markets that was not previously available.

(Comment) Mr Fred Mweetwa, MachaWorks

I think community networks need to focus more on content generation by developing local apps that suit each community. decolonising content should be a top agenda CN forums because that is how we sustain CNs.

(Comment) Mr Nathi Mbele, AdNotes Digital

I absolutely agree with you Dr Rey-Moreno on the backhaul and the infrastructure component of a CN. I am not sure about Mobile Broadband White Spaces looking at The Commission Data Services Market Inquiry released on the 2 December 2019. Mobile Broadband in South Africa cannot form part of any alternative solutions, considering that efforts to extend the reach of alternative infrastructure such as fixed line or fixed wireless into poorer areas, even if only in the form of public Wi-Fi, remains an important solution to high data prices now and in the future.

(Response) Dr Carlos Rey-Moreno, Association for Progressive Communications (APC)

Paragraph 55.3 of this report below states that: "ICASA considers models and regulatory changes to allow at least non-profit community networks, and possibly small commercial enterprises to access licensed spectrum not used by mobile operators in rural areas in a similar manner to television white space." <http://www.compcom.co.za/wp-content/uploads/2019/12/DSMI-Non-Confidential-Report-002.pdf>

(Comment) Mr Nathi Mbele, AdNotes Digital

I previously interpreted paragraph 55.3 as a way ICASA was proposing WOAN as a complementary solution for rural communities just like the TVWS. While the SA government is adamant on its plans to establish a WOAN, the jury is still out about the feasibility of such a model in South Africa, but Mobile Operators in South Africa don't seem to fully support WOAN.

(Question) Dr Fisseha Mekuria, Council for Scientific and Industrial Research (CSIR)

What is the status of the TVWS regulation in Tanzania?

(Response) Mr Jabhera Matogoro, University of Dodoma

The Ministry of Works, Transport and Communication is giving out a green light on the possibility of getting the required support to help put the policy in place. We have hope that the green light will come out as we are working on the scalability phase and bringing more partners onboard.

(Question) Ms Thuka Matlhoko, Private

1. Do different countries in Africa use different Spectrum, if so, why is that so?
2. What are the advantages and challenges?
3. Are African countries interdependent or independent?
4. Around Africa how many regulators do we have?

(Response) Dr Carlos Rey-Moreno, Association for Progressive Communications (APC)

Every country tends to have a regulator that is independent from the Communications Ministry, although in some countries it's still embedded. Radio-electromagnetic Spectrum is quite a broad topic. There are different parts of the spectrum that are used for different services (GPS, radio, television), each part having different characteristics. I would recommend you have a look at this resource:

<https://www.internetsociety.org/resources/doc/2019/innovations-in-spectrum-management>

(Comment) Mr Maokane Manala, Air Traffic and Navigation Services (ATNS)

I live in Johannesburg, South Africa. However, my passion is in developing an enabling environment for village kids. I want to build a connectivity network for the kids to access the vast educational content that the internet provides. How do I go about achieving this? I believe this is the solution to "free education for all". The Fourth Industrial Revolution presents the possibility of uprooting talents from anywhere, regardless of background.

(Question) Prof Shaun Pather, University of the Western Cape (UWC)

Mr Vilakazi, what is the approximate user-number per hotspot and how does the entrepreneur who manages each hotspot derive income?

(Response) Mr Jabulani Vilakazi, Soweto Wireless User Groups (SOWUG)

Users vary from 10- 50 users per hotspot. They charge clients and make a bit of a mark-up.

(Question) Prof Shaun Pather, University of the Western Cape (UWC)

There is a case to be made for government to share spare capacity on its fibre network for schools and other government site (or even resell it at cost) to COCNs to provide community service. Have you engaged with government?

(Response) Mr Jabulani Vilakazi, Soweto Wireless User Groups (SOWUG)

It would be great to have a contact on who to speak to from the government. The last time we spoke to the e-Government and we were not successful.

(Question) Ms Zainoenisa Allie, University of the Western Cape (UWC)

To all the panellists. How do you address the environmental impact of the wireless communication networks, especially in rural areas?

(Response) Dr Carlos Rey-Moreno, Association for Progressive Communications (APC)

Environmental impact is theme. At APC we are looking that in depth looking at the different methodologies to first create a benchmark, and then measure against it with the CNs that we work with. But looking at the carbon footprint from the telecoms industry is indeed something to look at it, and CNs are really a drop in the ocean.

(Question) Giancarlo Groenewald, Pretoria Wireless Internet Service Provider

Can we get Ms Duduzile contact information? Love to work with her.

(Response) Ms Duduzile Mkhwanazi, Private

dudu@zinathitechnicalconsulting.com

(Question) Mr Keketso Marishane, Marishane Youth Forum

34,"1. How do grassroots initiatives - community networks located in dysfunctional places (rural South Africa) make use of these high-level presentations? 2. For community networks with global visibility, how do they reach out for help to these global initiatives for public benefit?

(Response) Dr Carlos Rey-Moreno, Association for Progressive Communications (APC)

Dear Keketso, there are national initiatives that are supporting this "dysfunctional" places to set up their own connectivity initiatives in a more practical way. I would recommend you reach out to info@zenzeleni.net

(Comment) Mr Coenraad Loubser, WISH

That is true, but the returns on good connectivity compounds - Zenzeleni has showed us how quickly - if there is good connectivity, then it is easier those whose are unskilled, locally, to do video calling and show what they are struggling with, and for an expert anywhere else in the world to be able to assist them. The key is to be able to tap into underutilized capacity on existing infrastructure. What I would like to learn more about in future is that once there is a good connection, what additional measures can be taken and who can help to help with additional social development using the connectivity.

Closing Remarks and Way Forward

Ms Mkhize thanked everyone for the interesting discussion and noted the appreciation for the fact that CNs were not only about access but also about how they enable community owned networks to be providers of internet services. It is recognised that although progress has been towards building sustainable CNs, several gaps still exist.

The presentations as well as the report emanating from this webinar would be shared with all participants. This engagement would be used as part of the DSI's continued discussions with the Department of Communication and Digital Technologies.

Prof. Soodyall thanked everyone who was involved in the webinar including the presenters, the participants and the facilitator. The conversations in the Zoom chats and Q&A section provided insightful connections and inputs.

The engagement brought to the fore what is possible through government, business, community and academic partnerships. The IID seminar series is about connecting the dots. In engaging all stakeholders, the Academy plays a unique role as a neutral broker by bringing together the various conversations under one umbrella so that the nation can grow in achieving that collective evidence-based use of science in the service of society. This webinar brought that sort of dialogue to the fore and was definitely a knowledge growing experience.



Annexure A: Acronyms

APC	Association for Progressive Communications
ASSAf	Academy of Science of South Africa
ATNS	Air Traffic and Navigation Services
Capex	Capital expenditure
CN	Community network
COCN	Community owned connectivity network
COVID-19	Coronavirus disease
CSIR	Council for Scientific and Industrial Research
DSI	Department of Science and Innovation
FNO	Fibre network operator
G	Gigabyte
Gbps	Gigabyte per second
GHz	Gigahertz
GSM	Global System for Mobile Communications
ICASA	Independent Communications Authority of South Africa
ICT	Information and Communication Technology
IID	Innovation for Inclusive Development
ISP	internet service provider
ITU	International Telecommunication Union
LTE	Long-Term Evolution
MB	Megabytes
MHz	Megahertz
MNO	Mobile network Operator
NGO	Non-governmental organisation
NPC	Not-for profit company
NPO	Non-Profit Organisation
Opex	Operating expenditure
SATA	Southern Africa Telecommunications Association
SMME	Small, Medium and Micro Enterprises
SOWUG	Soweto Wireless User Group
STI	Science, Technology and Innovation
TVWS	Television White Space
UFH	Ultra-High Frequency

USAASA	Universal Service and Access Agency of South Africa
UWC	University of the Western Cape
WISP	Wireless Internet Service Provider
WOAN	Wholesale Open Access Network



Annexure B: Participants

Title	Name	Surname	Organisation
Ms	Lillian	Achom	AfChix
Mr	Herman	Ackermann	Talmar Impact Investments and Developments
Dr	George	Ah-Thew	Southern African Development Community
Ms	Zainoenisa	Allie	University of the Western Cape (UWC)
Mr	Roderick	Arendse	Western Cape Education Department (WCED)
Dr	Dawit	Bekele	Internet Society
Mr	Jarryd	Bekker	Riot Network
Dr	Sarbini	Belur	Indian Institute of Technology Bombay, India
Dr	Siyavuya	Bulani	Academy of Science of South Africa (ASSAf)
Prof	Stephanie	Burton	University of Pretoria (UP)
Dr	Ana	Casanueva-Gonzalez	UWC
Dr	Josiah	Chavula	University of Cape Town (UCT)
Mr	Walter	Claassen	Private
Mr	Justin	Colyn	Comsol Networks
Mr	Jonathan	D	Concept Afrika
Mr	Daniel	de Kock	Riot Network
Ms	Sol Luca	de Tena	Zenzeleni Networks
Ms	Kathleen	Diga	Association for Progressive Communications (APC)
Ms	Mariam	Edwards	First Iqra Comprehensive School
Ms	Cynthia	el Khoury	APC
Ms	Ellen	Fischat	Story Room
Ms	Zukiswa	Gala	WCED
Ms	Sue	George	International Association for Impact Assessment South Africa (IAIAsa)
Mr	Mark	Gray	Easttel - Amatole Telecommunications
Mr	Christo	Greeff	Witel Service Provider
Ms	Dwyn	Griesel	Kronendal Music Academy
Mr	Giancarlo	Groenewald	Pretoria Wireless Internet Service Provider
Mr	Ian	Guest	Riot Network
Dr	Senka	Hadzic	Research ICT Africa

Title	Name	Surname	Organisation
Ms	Monique	Heystek	UWC
Mr	Dion	Jerling	Connect Earth
Dr	David Lloyd	Johnson	UCT
Mr	Zvidzai Malvin	Kanengoni	Internet Society-Zimbabwe
Mr	Nyadzani	Khorommbi	Dido Digital Document
Mr	Ikbal	Kolia	Ma Kolia and Associates
Mr	Marnus	Kruger	Think WIFI Pty Ltd
Ms	Immaculate	Laker	Makerere University
Mr	Edgar	Lebepe	Limpopo Connexion
Ms	Mapule	Letshwene	South African Local Government Association (SALGA)
Ms	Nahungu	Lionjanga	Research Institute for Innovation and Sustainability (RIIS)
Mr	Coenraad	Loubser	WISH
Dr	Albert	Lysko	Council for Scientific and Industrial Research (CSIR)
Mr	Verengai	Mabika	Internet Society
Dr	Tebogo	Mabotha	ASSAf
Ms	Kgopotso	Magoro	Zuri Foundation
Ms	Aisha	Mahomed Ali	UWC
Ms	Angie	Maloka	MTN SA
Mr	Maokane	Manala	ATNS
Mr	Ganief	Manuel	OVCOMM Dynamic
Mr	Stanley	Maphosa	ASSAf
Ms	Tsakane	Maqayiya	Limpopo Connexion
Mr	Johnson	Marema	South African Bureau of Standards (SABS)
Mr	Koketso	Marishane	Marishane Youth Forum
Ms	Nthabiseng	Maseko	North-West University (NWU)
Dr	Nqobile	Masondo	Stellenbosch University
Dr	Matshidiso	Matabane	South African Council for Natural Scientific Professions (SACNSP)
Ms	Thuka	Matlhoko	Private
Mr	Jabhera	Matogoro	University of Dodoma
Ms	Louise	Matschke	Cape Town Environmental Education Trust

Title	Name	Surname	Organisation
Ms	Mavis	Maunganidze	Postal and Telecommunications Regulatory Authority of Zimbabwe
Dr	Uche	Mbanaso	Centre for Cyberspace Studies
Mr	Nathi	Mbele	AdNotes Digital
Mr	Enock	Mbewe	UCT
Ms	Hayley	McKuur	National Department of Human Settlements
Dr	Fisseha	Mekuria	CSIR
Ms	Josephine	Miliza	APC
Ms	Nonhlanhla	Mkhize	Department of Science and Innovation (DSI)
Ms	Duduzile	Mkhwanazi	Private
Ms	Dannielle	Moore	Stellenbosch University
Ms	Thato	Morokong	ASSAf
Mr	Segopotso	Moshapo	Private
Mr	Tshepang	Mosiea	DSI
Ms	Mahali	Motsoeneng	ATNS
Mr	Paul	Muller	Connect Earth
Mr	Jacob	Munodawafa	Southern Africa Telecommunications Association (SATA)
Dr	Val	Munsami	South African National Space Agency (SANSA)
Ms	Jeeva	Munsamy	Central University of Technology
Mr	Michuki	Mwangi	Internet Society
Mr	Fred	Mweetwa	MachaWorks: Chief Executive Officer
Mr	Kenosi	Ngatau	Keneo Solutions
	Belmira	Nhabangue	SATA
Mr	Eric	Nitschke	Wakoma
Mr	Lwando	Nkamisa	Talmar Impact Investments and Developments
Dr	Thobela	Nkukwana	UP
Ms	Jacqueline	Nyambira	Postal and Telecommunications Regulatory Authority of Zimbabwe
Mr	Bernd	Oellermann	Department of Trade, Industry and Competition (the dtic)
Mr	Abdulrasaq	Oyedeji	The Federal Polytechnic, Ilaro, Nigeria
Ms	Yumna	Panday	APC
Prof	Shaun	Pather	UWC

Title	Name	Surname	Organisation
Mr	Ephraim	Phalafala	DSI
Ms	Tankiso	Phidza	Gemini GIS and Environmental Services
Mr	Keith	Pitout	Indigo Broadband South Africa
Mr	Bruce	Pitso	Afrovation
Dr	Paul	Plantinga	Human Sciences Research Council of South Africa (HSRC)
Mr	Zuko Leonard	Rabotapi	Voimar COO
Ms	Sibongile	Radebe	Technology Innovation Agency (TIA)
Dr	Pradish	Rampersadh	SACNSP
Dr	Carlos	Rey-Moreno	APC
Mr	Thato Tshepang	Sekgoele	University of Johannesburg (UJ)
Mr	Tim	Shete	Morai Solutions
Mr	Steve	Song	Mozilla Foundation
Prof	Himla	Soodyall	ASSAf
Dr	Lardo	Stander	City of Tshwane
Ms	Khuthala Faith	Swanepoel	Department of Environmental Affairs and Development Planning
Prof	Leslie	Swartz	Stellenbosch University
Mr	Stefan	Szewczuk	Private
Mr	Khaya	Tantsi	Khula Tech Solutions
Mr	Eric	Thwala	Wireless Access Provider's Association
Ms	Nolundi	Tiya	BNPN Properties
Mr	Joleen	van Aardt	OED (SA: Physical Science)
Ms	Coralie	van Reenen	CSIR
Dr	Gertjan	van Stam	Private
Ms	Renate	Venier	ASSAf
Prof	Marius	Venter	UJ
Ms	Portia	Vilakazi	Duzi uMngeni Conservation Trust
Mr	Jabulani	Vilakazi	Soweto Wireless User Group (SOWUG)
Ms	Jacqueline	Willems	Pro-Novium
Dr	Spiwo	Xapile	The Platform for the Construction of Preferred Futures
Mr	Eckart	Zollner	The Right Choice

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Building Profitable and Sustainable Community Owned Connectivity Networks

Academy of Science of South Africa (ASSAf)

Academy of Science of South Africa (ASSAf)

Academy of Science of South Africa (ASSAf), (2019). Building Profitable and Sustainable
Community Owned Connectivity Networks. DOI 10.17159/assaf.2019/0065

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