

SANReN Connect Proof of Concept – keeping the research community connected

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Abstract: SANReN Connect Proof of Concept (POC) is a new VPN-based solution designed to provide students with zero-cost internet access. It creates a great opportunity for South African mobile network providers and the South African NREN to extend internet connectivity reach to the South African research and education community. The service is intended to reroute student traffic destined for the internet through zero-rated SANReN Connect IP addresses, using reversed billing services funded by SANReN. Multiple IP addresses and ports selected for load balancing, represent Virtual Private Networks for a university which have been zero rated and are used to connect to the internet. Students are authenticated via the Identity Federation for the South African research and higher education community, SAFIRE. The SANReN Connect POC service leverages a national mobile provider's (in this case, Telkom's) national network coverage so that it provides access to the internet throughout the country without having to be at a specific institution or hotspot location. This paper documents the progress of the implementation of the service. It is envisioned that the service may be of interest for other NRENs to consider as a way of extending their network connectivity reach. The POC service will be launched at the national Centre for High Performance Computing (CHPC) conference in December 2025. Results from initial testing have been positive - showing that the solution is viable, however more exposure is required to the intended target market to determine whether the service should be taken to production.

Keywords: mobile data, reversed billing, network connectivity, data for higher education and research, student data

1. Introduction

In South Africa, The National Integrated Cyberinfrastructure System (NICIS) is tasked by the Department of Science and Innovation (DSI) to connect all research and higher education institutions to the South African National Research Network (SANReN) high speed network. As part of this mandate, SANReN's Services Development and Innovation (SDI) team develops value-added services for the South African research community.

One such service proposal is the SANReN Connect Proof of Concept (POC) service which has been designed to extend the reach of the SANReN network, overcoming user mobility limitations of traditional campus-based connectivity solutions i.e. This service will provide access to the SANReN network for users on their existing devices away from the university network and eduroam hotspots. It offers students access to online content at no cost, ensuring that even those who are off-campus or engaged in distance learning are not disadvantaged by a lack of internet access.

The SANReN team developed the core functionality of the SANReN Connect Proof-of-Concept (PoC), which has been tested with an initial small group of users who provided technical feedback on the service.

The Proof of Concept service (POC) will be launched at the national Centre for High Performance Computing (CHPC) conference in December 2025 and will end in March 2026. The pilot project is being run with data procured through a South African national mobile network operator, Telkom, through a reversed billing process, leveraging SANReN's infrastructure to ensure seamless and subsidized internet access for students.

In the African context, innovative solutions like these are imperative to help to bridge the digital divide. According [1], it is important to design and make content available with inclusion in mind i.e. accessible and useful content that is “lite”, that can be automated easily and scale, access should be an entry-level condition but usage, uptake and impact the goal and there is also a need for improved digital literacy. The SANReN connect proof of concept aims to achieve this.

1.1 Existing Internet solutions for the Higher Education community

1.1.1 SANReN network

The roles and responsibilities of the de facto South African NREN (SA NREN) are distributed between the South African National Research Network (SANReN) group at the Council for Scientific and Industrial Research (CSIR) and the Tertiary Education and Research Network of South Africa (TENET) [2].

The SA NREN provides support in the form of wired connectivity and advanced services to Science, Research, Education and Innovation entities based on TENET’s connection policy.

The SANReN (network) comprises of the following infrastructure:

- a core national dark fibre backbone with several managed bandwidth backbone links at 100Gbps (in progress),
- backbone extensions (regional links) – typically at 10Gbps,
- back-hauling from the submarine cable landing stations at Yzerfontein and Mtunzini,
- capacity on five undersea cables, and
- several metropolitan area networks.

SANReN is managed and implemented by the CSIR’s Next Generation Enterprises and Institutions (NGEI) cluster and is a key component of the National Integrated Cyberinfrastructure System (NICIS), alongside the Centre for High Performance Computing (CHPC) and the Data Intensive Research Initiative of South Africa (DIRISA).

1.1.2 eduroam

eduroam (education roaming) is a secure, world-wide roaming access service developed for the international research and education community. It allows students, researchers and staff from participating institutions to obtain Internet connectivity across campus and when visiting other participating institutions through their devices [3]. Access to eduroam extends internet access reach and addresses convenience, security, scalability, and interoperability in network access, specifically tailored for the academic and research community by addressing the following problems:

1. Lack of Seamless Internet Access for Traveling Academics and Students
2. Security Risks with Public and Guest Networks
3. Burden on IT Departments for Guest Access Management
4. Fragmented Network Access Policies and User Experiences
6. Lack of Accountability and Logging in Open Networks

eduroam separates the concepts of authentication (identity providers) and hotspots (service providers (SPs)) allowing public, commercial or city wifi initiatives to offer eduroam in addition to research and education institutions. Its implementation has evolved significantly, extending beyond universities to include libraries, leisure centers and parks, hospitals, railway stations and restaurants in countries such as Norway, Sweden, Croatia, UK, Germany, Finland, Austria to name a few. TENET welcomed eduroam rollouts in airports [3] and Wits University (WITS) has recently enabled free Wi-Fi at public libraries in Johannesburg [4]. However, access is still limited as it is dependent on being within range of

an operating eduroam SP hotspot, which is where the SANReN Connect POC service is superior in keeping one connected.

1.1.3 Network providers (Reverse billing, provision of student data, zero-rating of specific websites)

While there are no current blanket "free data" programs for all students, major South African network providers like Vodacom, MTN, Cell C, and Telkom do provide zero-rated access to university websites and learning platforms for registered students. Some universities also offer specific data bundles, such as Wits University's 10GB Anytime + 20GB Night-time data package for non-residence students. Students can contact their university and network provider for applicable offers. In many cases, the "free" access is for specific university-approved websites and learning platforms, meaning the data consumed when visiting these sites does not come out of the student's personal data allowance. The limitation of this is that free or subsidized data programs are often set up by individual universities to support their students - there is no co-ordination on a national level. Free access often applies to zero-rated websites, and often not to general online learning or internet access [5], [6], [7], [8], [9], [10]. Furthermore, eligibility for free data or bundles may depend on your residence status, whether you are a full-time or occasional student, and your location.

1.1.4 Buying and using personal data

This option is currently the most expensive to the user. Data costs in South Africa have historically been known to be higher than other parts of the world [11]. While prepaid mobile data bundle prices have decreased since 2020, this change has stagnated over the past few years [12].

1.1.5 Leveraging smartphone usage

Smartphone usage in South Africa is here to stay. According to [13], The 2023 General Household Survey (GHS) [14] shows that 96.1% of South African households owned at least one mobile phone and 91.2% of South African households exclusively used cellular phones in 2023.

According to the Statista Research Department (2025) [15], the number of smartphone users in South Africa was forecast to continuously increase between 2024 and 2029 by 12 million users (+86.83 percent). After the ninth consecutive increasing year, the smartphone user base is estimated to reach 25.83 million users and therefore a new peak in 2029.

Table 1: Multiple network connectivity solutions vs the SANReN Connect POC solution

	Wireless	Smartphone compatibility	Network reach	Mobile network provider specific	Access requirements
SANReN site connectivity	No	No	Limited to connected site	N/A	South Africa university or research institution beneficiary
eduroam	yes	yes	Limited to eduroam service provider sites	no	Must be associated with a participating eduroam identity provider institution
Network provider data deals/reversed billing services	yes	yes	National reach	yes	Often requirements of association with a specific research institution
Personal data	yes	yes	National reach	yes	No
SANReN Connect POC	yes	yes	National reach	Yes, currently limited to a single network provider but with the opportunity to engage more network providers	Must be associated with a university registered to the South African Identity federation, SAFIRE*

* To see a list of institutions registered to SAFIRE, visit [16]

1.2 Objectives

A key objective of the SANReN Connect POC is to leverage the increasing smartphone penetration trends for internet access at a cheaper or no cost to user solution.

A solution like SANReN Connect addressed the geographical gap in network connectivity currently at zero cost to the user. By conducting this PoC, SANReN aims to gather critical data on usage patterns, which will inform decisions on scaling the service to a broader student base and support South African families with students in Higher Education. The successful implementation of SANReN Connect will enhance the network's footprint, support national education initiatives.

This pilot serves as a PoC to validate the feasibility of the solution and to refine its functionality based on practical use. Leveraging existing SANReN hardware resources and open-source software, the PoC will not only test the service's performance under load conditions but also assess its ability to provide zero-rated traffic and seamless connectivity for students, regardless of their location.

Future benefits for higher education community could include SANReN negotiating costs with mobile providers, leveraging economies-of-scale by purchasing a large quantity of data

(at a lower price) that is shared by the national R&E community. This should offer more flexibility for institutions such as no contractual obligations based on the number of students.

The solution aims to offer more control to participating institutions, such as allowing universities IT staff the ability to monitor statistics, activate and suspend students, manage data limits, manage login frequency for verification of affiliation, manage bandwidth limits e.g. premium and standard settings and the ability to supplement their allocated free data offering.

2. Methodology

In South Africa, National Treasury has, on behalf of government, entered a five-year transversal contract for mobile communication services, with effect from 1 April 2021 to 31 March 2026. As National Treasury has already negotiated preferential rates, terms and conditions with multiple mobile service providers for various services, the most effective way to run a PoC for the SANReN Connect service would be to leverage the reversed billing rates and terms negotiated in the latest RT15 contract.

Feedback will be gathered using a user feedback survey which is available on the SANReN Connect website but that will also be sent out to user at specific intervals of use e.g. after approximately 50% of their data has been used for the month. The POC will start by limiting users to 10G per month.

3. Technology Description

Figure 1 depicts the technical implementation of the SANReN POC service. The figure is divided down the middle, on the left shows the components that are available publicly, while the right shows components that are available via private LAN/VPN access.

Multiple IP addresses and ports are represented by Open Virtual Private Networks (VPN) servers for a university, for load balancing, which have been zero rated and are used to connect to the internet. Students are authenticated via the Identity Federation for the South African research and higher education community, SAFIRE.

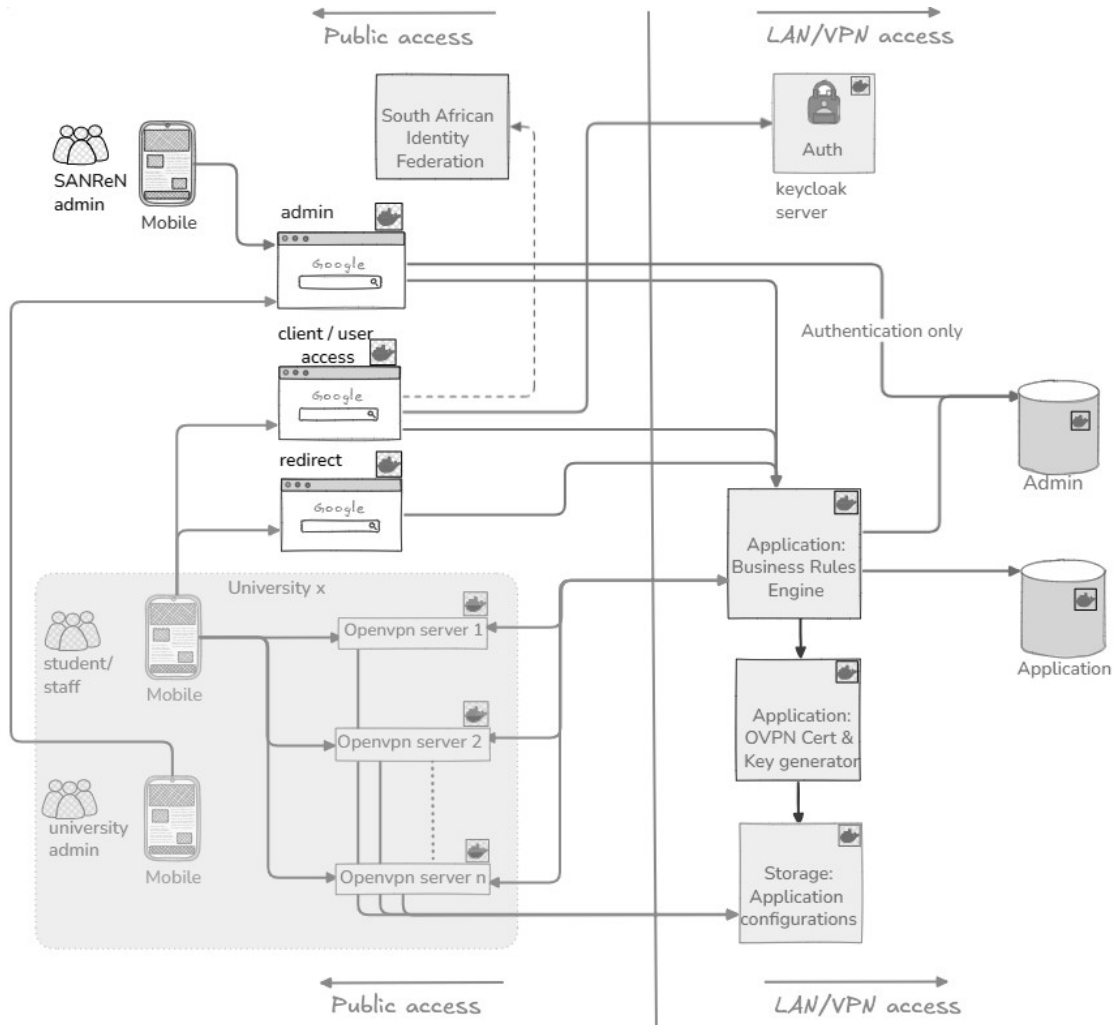
A user would authenticate to the service via their device (e.g. mobile phone or laptop), once authenticated the user will either gain access to the SANReN Connect POC service or be redirected.

The backend of the applications functionality is managed in multiple docker containers. Authentication via SAFIRE interfaces to the service is done via a keycloak application. Functionality includes the Business Rules Engine (BRE), OVPN Certificate and Key generator and Application Configurations. Admin users can also gain and set additional functionality to the BRE.

4. Developments

The service works has been tested with the initial set of internal NICIS users. The service is now in a state where we are ready to test it wider with the university community. The POC will be officially launched at the CHPC conference to be held at Century City where it will be made available to South African universities affiliates.

Figure 1: Technical Implementation of the SANReN Connect POC service



5. Initial Results and modifications

Internal testing of the SANReN POC service showed positive results, as the service works as expected. Most of the issues encountered related to ease of initial setup, for example the outdated version of OpenVPN resulted in the service not working as expected, downloading and installing the VPN file was not as intuitive for some users and non-Telkom network IP addresses could still connect to the service resulting in users' personal data being used. Furthermore, when a user's data was depleted, there was no clear redirect message. These issues were addressed in the following ways by updating the SANReN Connect application, providing more information to the intended users by updating user guides, marketing flyers and content on the service website [17]. Figure 2 is a screenshot of the homepage of the SANReN Connect website. Figure 3 is a screenshot of a user's balance page.

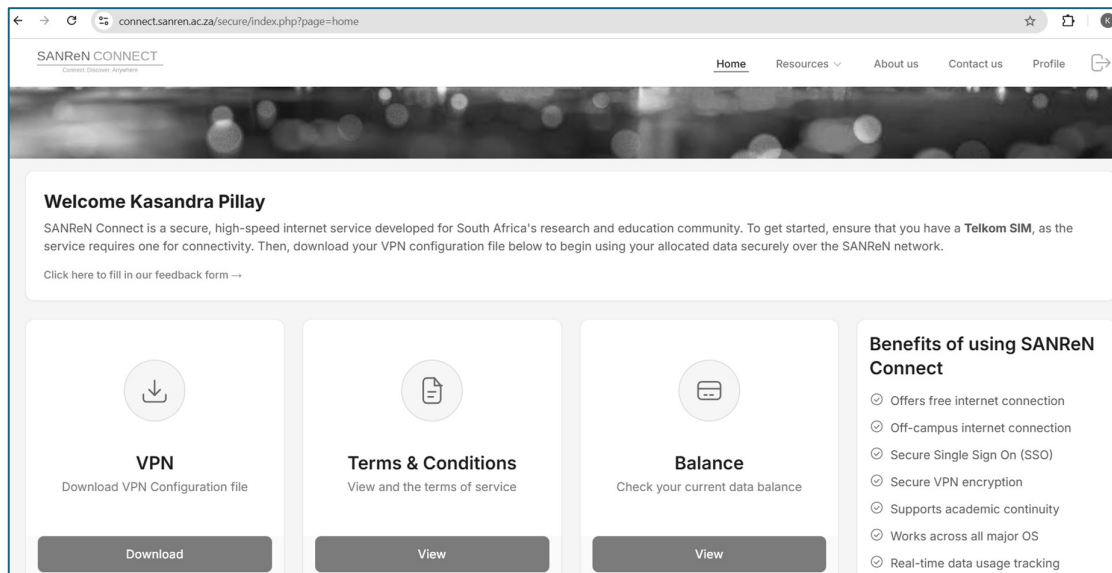


Figure 2: Homepage of the SANReN Connect website

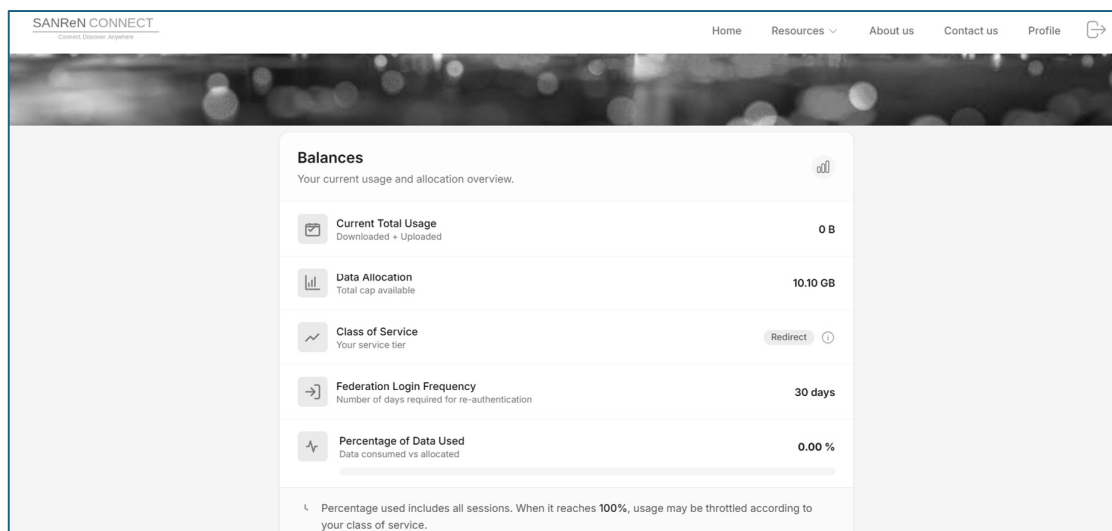


Figure 3: User's balance page of the SANReN Connect website

6. Benefits and next steps

The SANReN POC will be officially launched at the Centre for High Performance computing conference to be held at Century City Convention centre in Cape Town [18] from 30 November 2025 to 3 December 2025 where it will be made available to the universities registered with South African universities, the Council for Scientific and Industrial Research [19] and TENET [20] users for testing. The front page of the marketing flyer distributed at the event is shown in Figure 4.

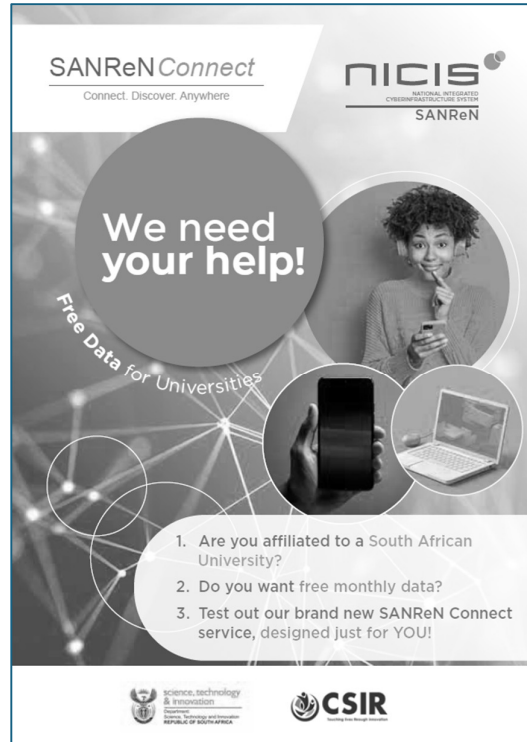


Figure 4: Front of SANReN Connect POC flyer distributed at the launch of the service at the CHPC national conference in December 2025

6.1 Recognition for the mobile networks

The SANReN Connect service provides benefit to the participating mobile network provider by assisting the mobile network provider to fulfil its social responsibility to their community. Furthermore, their participation in the SANReN Connect service enhances its brand reputation and deepens the network providers engagement with the NREN and academic sector.

7. Conclusions

The SANReN Connect POC creates a great opportunity for South African mobile network providers and the South African NREN to extend internet connectivity reach to the South African research and education community. The service will be officially launched at the CHPC conference to be held at Century City Convention centre in Cape Town [18] from 30 November 2025 to 3 December 2025 where it will be made available to the universities registered with South African universities, the Council for Scientific and Industrial Research [19] and TENET [20] users for testing. The POC will run until the end of March 2026, after which time, SANReN will make a decision of whether to pursue the full implementation of the service and offer it as a production service

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