The CSIR Spectrum Innovation Eco-system:

From Local Innovation to an International Sustainable Connectivity Player

Dr F. Mekuria & The Smart Spectrum Sharing Team, CSIR.
(fmekuria@csir.co.za)

Context:

The Council for Scientific and Industrial Research (CSIR) in Collaboration with the United Nations Development Programme (UNDP) realize that sustainable digital connectivity and broadband availability are crucial components to achieve the Sustainable Development Goals (SDGs) and promote rapid socio-economic transformation in the context of the digital economy through sustainable connectivity. The CSIR is a leading technology research organization which has been working on R&D and innovations on green ICT technologies to realize affordable broadband connectivity for rural and underserved communities – an effort to achieve aim of "leaving no one behind by 2030" as championed by the United Nations. In line with this agenda, the CSIR has developed ICT technologies for effective management of national radio spectrum resources,[1] including a model based geo-location spectrum database (GLSD) and spectrum sharing radio network technologies, aimed at addressing the glaring broadband demand for the digitally unconnected subscribers in South Africa and beyond. The technology of innovative spectrum sharing radio networks lends itself for country wide beneficiation in the form of the creation of new rural network provider small and medium enterprises (SMEs), as wireless internet service providers (WISPs) which are expected to contribute to sustainable socio-economic development locally.

The United Nations Development Programme (UNDP), being the SDG integrator, as mandated by the United Nations General Assembly, is desirous to make rural internet access a strategy of achieving leaving no one behind, diversifying rural economy and digitally transforming rural areas in Africa. In this regard, UNDP launched the SDG Accelerator Laboratory in 60 countries globally of which South Africa is one. Given that about 45 percent of South Africans do not have internet access, UNDP sees promoting rural access to the internet as a development accelerator and a game changer for the achievement of the SDGs in South Africa.

In partnership with the UNDP, the CSIR will leverage the innovative CSIR spectrum sharing technologies, sustainable digital connectivity and the UNDP Accelerator Laboratory Initiative, for the development of digital SME's, benefitting rural and underserved communities to achieve sustainable socio-economic development and digital inclusion in developing African economies. In this regard, the collaborative initiative will build on existing spectrum innovation eco-system (SIES) developed at the CSIR, and promote harnessing the entrepreneurial potential of young South Africans through the UNDP accelerator program. The long term aim is to spread the CSIR-SIES and UNDP's entrepreneurial acceleration through a digital SME eco-system (DSE) to all regional African countries, as it is shown that the challenges are highly similar in many of the rural communities in Africa.

Objectives:

The CSIR sustainable digital connectivity through spectrum innovation is aimed to primarily promote a universal access to the internet in South Africa – with primary focus on rural internet access. It aims to promote digital inclusion by accelerating the dissemination of the spectrum innovation technology and business eco-system to all South Africans. The overarching goal is to develop a South African wide digital connectivity accelerator program in the short term and

[1] See Annex for the spectrum innovation ecosystem.

to facilitate a continental-wide sustainable digital connectivity and a digital SME ecosystem (DSES) in the long term. Also assess and implement the model for a possible uptake in other regional African Countries and Emerging Economies globally. The specific objectives are to:

1- Support the development of an enabling telecom regulatory environment, including capacity building in networking for sustainability for the national telecom regulators and relevant aspects of spectrum innovation technologies and business eco-systems.

2- Strengthen the spectrum innovation eco-system (SIES) as depicted in figure 1 below, composed of the technologies (a) Reference-GLSD, for enabling national spectrum regulators full dynamic control and monitoring of national spectrum resources; (b) Secondary-GLSD, to monitor Wireless ISPs and network device type approval according to national regulations.(c) Innovative spectrum sharing network planning tool.

3- Integrate the spectrum innovation eco-system with SME accelerator programs, for development of innovative business models for the different layers of the digital connectivity. And support affordable network innovation and deployment for sustainable rural connectivity.

4- Enable broadband network innovation and the concept of networking for sustainability, internetworks powered by green energy technologies, in support and provision of affordable broadband and digital inclusion for rural and underserved population.

5- Develop a network of rural ICT based digital SME ecosystems (DSEs) that would be able to propel national and specifically rural economic transformation and extract benefit from the emerging digital economy in South Africa including piloting 5 regional countries in Africa.

6- Promote a three pronged approach to ensure sustainability, complementing existing networks and address the emergence of new network technologies propelling 4IR and identification of synergetic opportunities of emerging technologies to benefit sustainable digital transformation and development of rural underserved communities.

Methodology

Rural dwellers and specifically the younger population are among the most marginalized on the development spheres and therefore constitute one of the last miles in the achievement of the Sustainable Development Goals (SDGs). One of the important targets of this project is to improve entrepreneurial capacity for young ICT entrepreneurs based on sustainable green technologies and ICT based digital SME ecosystems (DSEs). Rural sustainable connectivity remains one of the tools for socio-economic transformation and sustainable development in South Africa and regional African countries. However, low income and population density contributes to low rate of return on investments, which makes it highly unprofitable for large private-sector network operators to roll out services. However, the low profit case in the context of a larger availability of high-demand wireless spectrum – with strong potential for building universal internet access and ICT based services, including youth entrepreneurship gives an opportunity and potential to change this predicament. The white paper described in this document therefore presents such a sustainable connectivity solution based on spectrum sharing networks and green radio technologies, to address this developmental challenge. The white paper presents a spectrum innovation eco-system, a thinking outside of the box in order to achieve sustainable rural connectivity and digital inclusion in the context of Africa.
The spectrum sharing approach addressed by the CSIR provides an opportunity for a real change that could unleash a rural-oriented, commercially viable, and green telecommunication infrastructure in South Africa. This approach allows lower costs in building the network infrastructure, green energy powering of networks and operational aspects of spectrum sharing radio-networks (SSRN). This does not only promote local small network operators but can also be extended to affordable WiFi for local communities. The spectrum sharing radio technologies, managed by geolocation spectrum databases,

could help identify underutilized spectrum (so called 'white Spaces") that could be used for broadband services in the country. Working with relevant stakeholders, this partnership intends to leverage this emerging opportunity to promote rural connectivity and digital inclusion in South Africa and regionally.

Digital inclusion is the primary goal of this collaborative project concept. Partnering with the major ICT technology and service providers to empower local network operators that would provide services to underserved communities remains critical. This alliance will be anchored on public-private partnership among rural digital ecosystems in South Africa and regionally. Strategic approaches would hinge on innovation and capacitation with specific elements including mapping of relevant stakeholders, de-risking rural digital sub-sector, networking and spectrum regulation for sustainability, platform nurturing, and promotion of developmental changes.

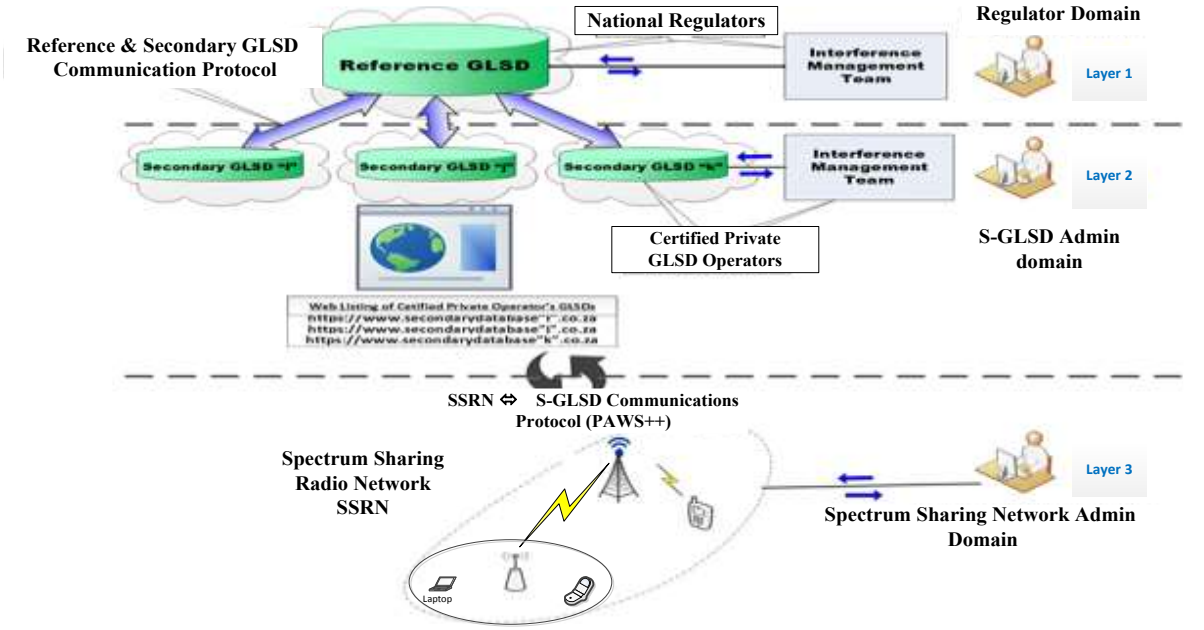
Annex 1: The CSIR Spectrum Innovation Eco System

The CSIR Spectrum Innovation eco-system and associated green network technology offerings are a collection of innovative spectrum management toolboxes which allow countries, national regulatory authorities and industry, SME-WISPs and stake holders of the spectrum innovation eco-system to benefit from efficient utilization of national spectrum resources. The eco-system, is anchored with a national spectrum regulation which CSIR supported with research and 2 proof of concept (POC) networks, and recently enacted by the Independent Communications Authority of South Africa (ICASA): https://www.icasa.org.za/uploads/files/Regulations-on-the-use-of-Television-White-Spaces-2018.pdf. It is also expected that the proposed innovation eco-system will promote new technology manufacturing and service creation potential, to address one of the important national development goals of providing affordable broadband and digital inclusion of under-served communities. Furthermore, future proofing and enabling the concept of networking for sustainability and future wireless 5G+ network deployments are being developed, so that even in a rural low cost environments the goal of "leaving no one behind in the digital economy" of the future is addressed.

Sustainable Connectivity and green network technologies lie at the core of the spectrum innovation eco-system, and hence interaction with technology development partners and sustainable rural deployment of connectivity solutions is guided by the living labs-concept, developed at the CSIR. The living lab concept involves and engages the communities that will be targeted for the proof of concept (POC) test-bed networks followed by digital skills development, so that communities become empowered and aware to take the ownership, protection and sustainability of the network equipment & services. Thereby guaranteeing sustainability.

Data generated during the PoC exercise will be analysed and used to disseminate necessary information to project partners, in the form of study the consequences of connectivity, CO_2 emissions and use of green energy resources, and accelerated deployment of ICT based SME services for sustainable digital inclusion. The CSIR hosts an RD&I Centre for renewable green energy resources development which is keen to partner in developing green energy powering of networks & ICT infrastructure: https://www.csir.co.za/energy-autonomous-campus-mitigating-effects-climate-change

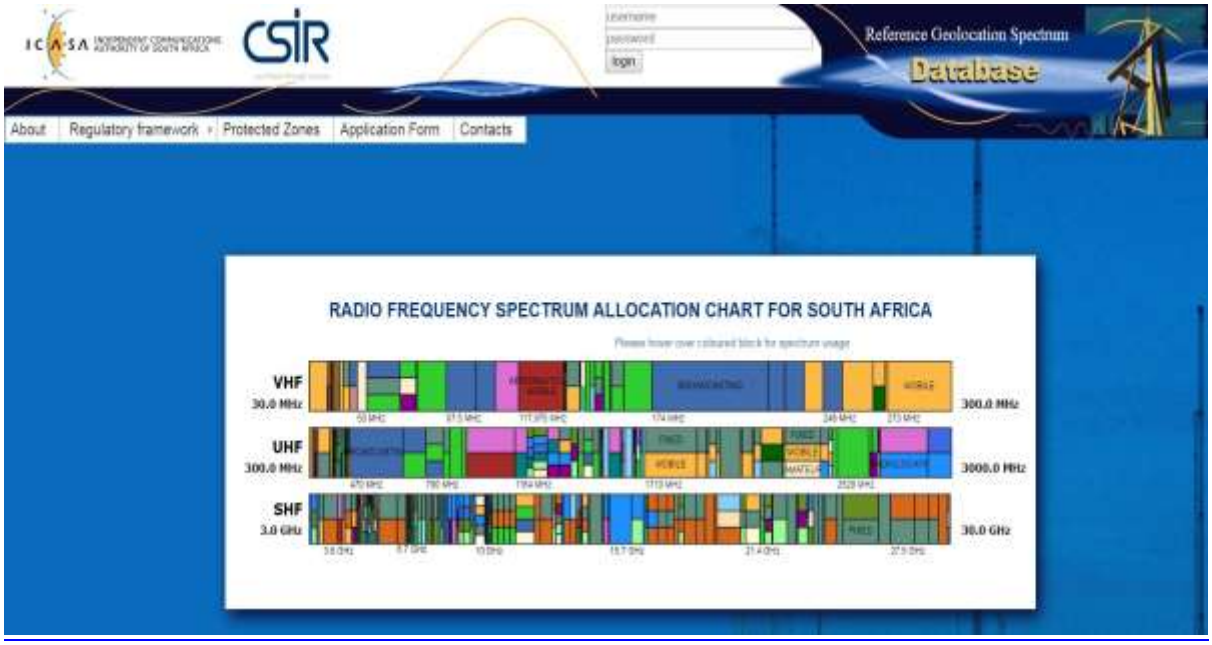
The CSIR Spectrum Innovation Eco-system



Layer 4: (a) Network Technology Roll Out, Alternative Energy Supply.
(b) SME Business creation & Acceleration
(c) ICT Service Creation & Digital skills development

Figure 1, A simplified View of the Spectrum Innovation Eco-system.
More info: https://tvwhitespaces.icasa.org.za
https://whitespaces.csir.co.za/

CSIR Tech 1: The CSIR Reference-GLSD Technology:



The Reference R-GLSD

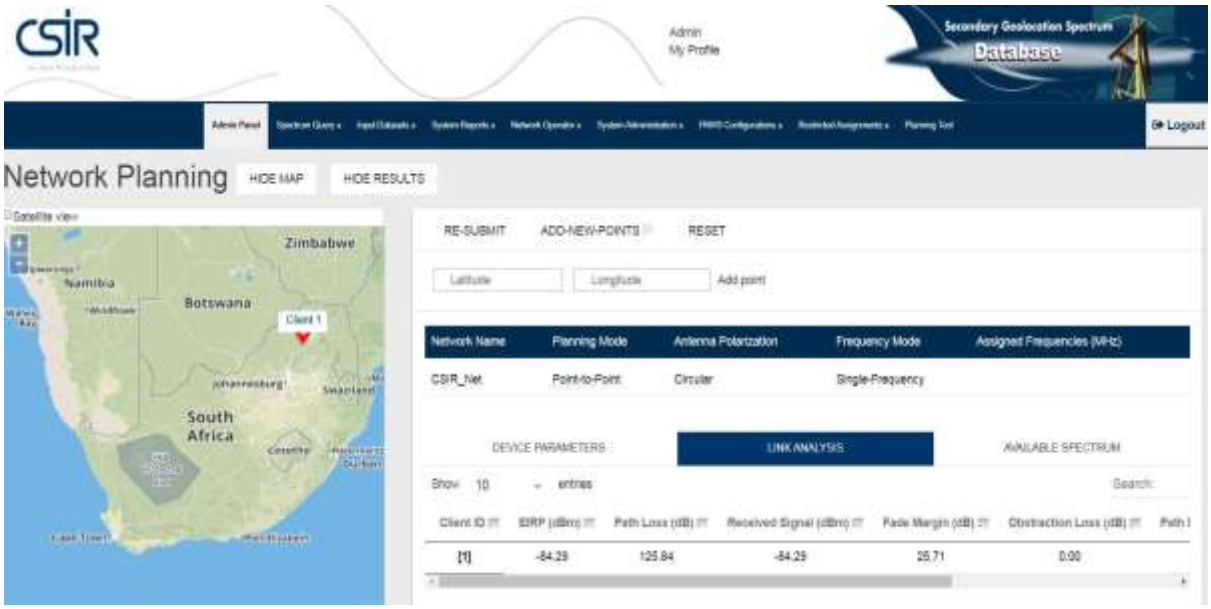
The CSIR developed Reference Geo-location spectrum database (R-GLSD) is full-fledged and market oriented regulatory reference spectrum database. The R-GLSD gives any national spectrum regulator the capability to have full control of the national spectrum resources band per band, and acts as a monitoring tool to guarantee the necessary QoS is achieved through a collaborative spectrum sharing framework. One of the most important functions of the R-GLSD is the qualification of the secondary (S-GLSD) spectrum database tool. The S-GLSD is the dynamic spectrum co-existence manager for the deployment of DSS based wireless broadband networks. The R-GLSD is implemented as a pre-packaged software solution and deployed as a localised cloud implementation including a user friendly graphical user interface. The CSIR also has developed a tutorial and seminar series to introduce and develop dynamic spectrum skills of regulatory organizations to effectively use the R-GLSD platform.

CSIR Tech 2: The CSIR Secondary-GLSD Technology Demonstration:

The S-GLSD

The Secondary Geo-location Spectrum Database (S-GLSD) is the enabling spectrum toolbox for intelligent spectrum allocation & other S-GLSD Services. It interfaces to wireless network service providers (WNSPs), providing intelligent and accurate spectrum availability information, network device parameter selection and reduces interference through accurate modelling of the radio environment based on the Geo-location information and terrain obstruction data obtained from the WNSPs. It also interfaces back to the Reference R-GLSD regulatory database, to obtain security parameters and device authentication according to the national regulation set by the national regulatory authority. The S-GLSD also can provide information on improving quality of service (QoS) and accommodation of high band-width services through efficient and on-demand spectrum allocation.

CSIR-Tech 3: The CSIR Net-Plan Tool Technology Demonstration:



CSIR-Tech 3: Network Planning Tool, NetPlan

In connection with the R-GLSD and S-GLSD operations and services, the CSIR also has developed a network planning tool to support wireless network and internet service providers (WNISPs) to launch commercial TVWS networks at any geo-location in South Africa. The CSIR NetPlan toolbox is implemented as a pre-packaged software solution with interfaces for radio parameter entry and deployed as a localised cloud implementation including a WNISP friendly graphical user interface. The NetPlan also guarantees that the resultant wireless TVWS network is compliant with the national regulation and network device types as specified in the recent TVWS regulations by the national regulator ICASA.

Contact:

Fisseha Mekuria, fmekuria@csir.co.za,
Luzango Mfupe, lmfupe@csir.co.za.

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