TV White Space for Internet Access in the Developing World

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Abstract

In 2013, the University of Strathclyde began working with Microsoft's 4Afrika programme to create a data communications network in Kenya, providing connectivity and Internet access to a number of rural locations, including schools and health clinics in remote villages. This project has led to the development of Mawingu Networks, a fully licensed internet service provider using "White Space" radio frequencies to enable low cost internet access via renewable powered base stations. Since going live in 2016, the network now has more than 27,000 unique users across a wide geographical area.

Despite the fact that universal Internet access is part of the UN's sustainable development goals, and has been shown to spur social and economic development, a large percentage of people in developing countries do not yet have access. This is often due to a lack of infrastructure, large distances and dispersed populations. This poster presents an overview of TV White Space technologies, with emphasis on our 4Afrika collaboration with Microsoft and Mawingu Networks. In addition, an insight into some recent developments in other African countries (Malawi, Zambia, and Ghana) is presented.

What is TV White Space?

Wireless communication is transmitted using radio spectrum. 'White Spaces' are portions of radio spectrum which are not used by existing licensees at all times or in all locations, as shown in Figure 1. Exploitation of white space means more efficient use of radio spectrum. White Spaces in the UHF band, between 470 and 780 MHz, are commonly referred to as TV White Spaces (TVWS).

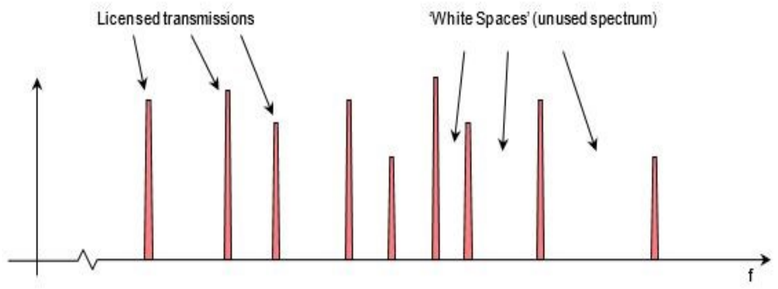

Figure 1: *Graphic illustration of 'white spaces' between licensed transmissions*

Radio signals in the UHF TV band can cover larger areas than Wi-Fi signals for the same power. These signals are also better at penetrating obstacles such as foliage and walls. Rural areas in developing countries are likely to have an abundance of TVWS spectrum because TV service utilization is low.

TVWS Broadband Internet Facilitates Development

In Kenya, five use cases demonstrated the potential of TVWS to facilitate development in remote communities in Africa. These were education, health care, government offices, humanitarian and internet hotspots. Network performance results from a single point-to-multipoint TVWS base station are shown in Table 1 [1].

Transmitter Power	Network Speed	Coverage Range
2.5 Watts	Up to 16 Mbps	Up to 16 Km

Table 1: *Network Performance Results*

Recent Developments: Regulations and Standards

Regulators in Africa are, or will be, drafting regulations to ensure co-existence between licensed primary users and licence-exempt secondary users. In addition, geolocation spectrum databases for dynamic assignment of TVWS frequencies to secondary users will be developed.

International standardisation bodies have released technology standards for different systems and applications operating in TVWS. These standards conform to regulatory requirements of different countries and also specify measures to minimise interference among TVWS devices themselves.

Pictorial Focus of Mawingu Networks

Figure 2: *Pictures of Mawingu Networks*

TVWS Network Architecture Evolution

TVWS standards and regulations have transformed the TVWS network architecture. In current network deployments in Africa, TVWS wireless links provide for backbone connections while IEEE 802.11b/b/n Wi-Fi and IEEE 802.3 Ethernet provide for expansion of the service area. Static TVWS channel assignment is being used at present. Future TVWS system architectures are envisioned to include IEEE 802.22 backbone links and IEEE802.11af access inks operating in the UHF frequency band, and geolocation spectrum databases for automatic assignment of available TVWS channels. TVWS Wi-Fi can cover 4 times the radius of a normal Wi-Fi AP at the same power level and can reach several kilometres with higher power [1].

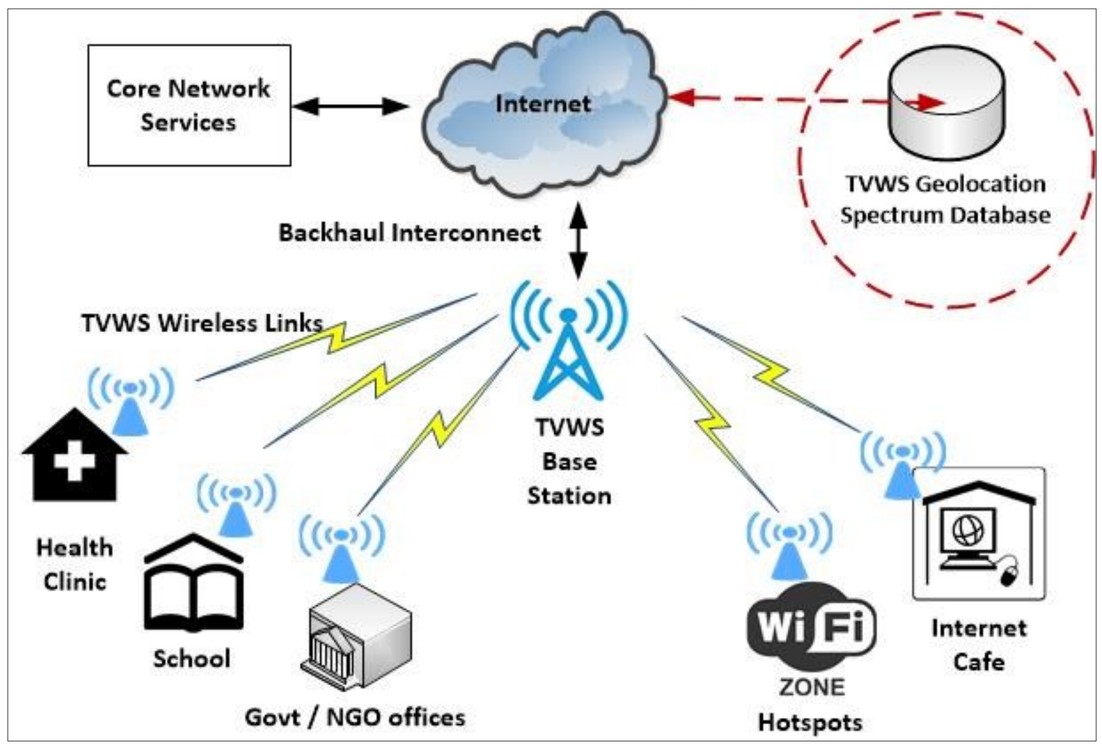

Figure 3: *TVWS Network Deployment and Scenario in Africa (TVWS Spectrum Databases are mostly yet to be developed)*

Future Work: Enabling Affordable Internet Access

The next ESPRC-funded project that the University of Strathclyde will launch in partnership with industry, regulators and universities in Ghana, Kenya, Malawi, and Zambia will focus on dynamic spectrum management, TVWS wireless network planning tools and software defined radio (SDR) implementation of TVWS radio hardware that fully meets technology standards as well as regulatory requirements. The full list and categories of partners is given in Figure 4.

The research will also pilot TVWS connectivity for real-time data transmission and analysis of child nutrition surveillance data in Malawi to improve policy and programme planning for combatting child malnutrition, which has been Malawi's silent emergency for the past 25 years.

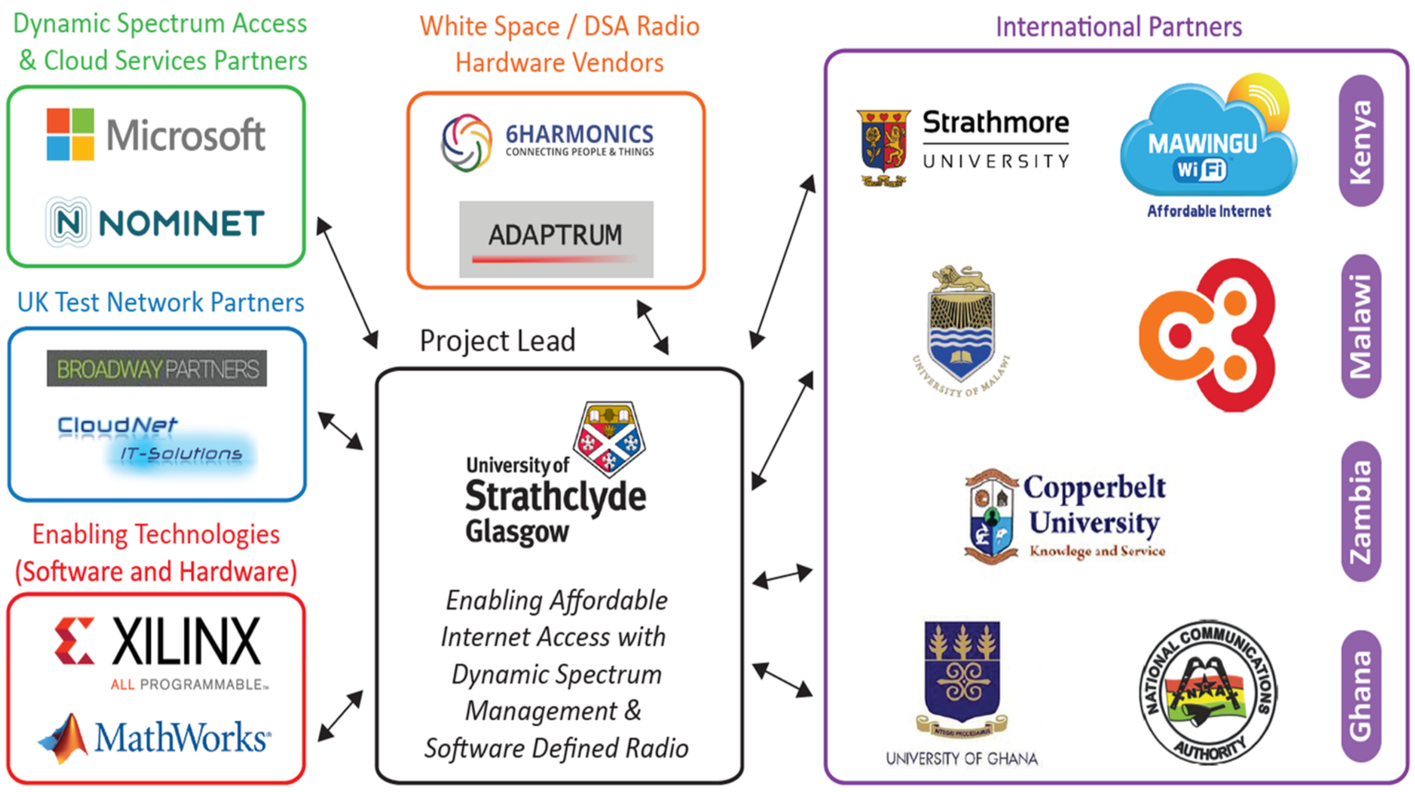

Figure 4: *International Academic and Industry Project Partners*

Conclusions

In this work, TVWS has been discussed as a viable rural broadband technology. Use cases for commercial and socio-economic development have been presented.

Our future research will focus on conformance of TVWS radios to standards and regulations, scalability and sustainability of TVWS networks as well as demonstration of promising use cases for socio-economic progress of rural communities in the developing world.

[1] S. Roberts, P. Garnett, R. Chandra, "Connecting Africa using the TV white spaces: from research to real world deployments", The 21st IEEE International Workshop on Local and Metropolitan Area Networks, Beijing, 2015

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For further information:

www.wirelesswhitespace.org

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