

Frequently Asked Questions (FAQs)
On
The use of TV White Spaces (TVWS) in Kenya



February 2022

Overview

1. What are “White Spaces”?

This refers to unused but assigned spectrum (often referred to as idle spectrum) in a particular location or locations at a particular time.

2. What is TV White Space (TVWS) Technology?

Television White Spaces (TVWS) refers to the portion of the frequencies that are unused by the licensed TV services in the ultra-high frequency (UHF) band **470-694** MHz. With the assignment of channels to TV broadcasters varying by geographic location, not all allocated channels assigned are used, giving rise to “white spaces” in which a channel that is not assigned for broadcasting services may be available for other wireless services. Similar to other regulators, the Communications Authority of Kenya (CA) has developed a framework to allow service providers that offer Internet services to obtain access to the “white spaces” while ensuring that they do not cause harmful interference to the licensed services in the TV band. TVWS availability can change based on geographic location and time.

3. What is spectrum sharing?

The spectrum sharing approach to spectrum management is designed to allow radio frequency (RF) spectrum to be used by another entity when it is not being utilised or is not being made use of at particular times and locations by the incumbent user(s). An example of this might be an agency that does not require RF transmission at specific times as well as specific locations. In such a case, those broadband frequencies can be utilised for alternative purposes during those specific period(s) and specific location(s). This form of dynamic access to broadband offers multiple users the ability to share available “White Spaces” in different radio bands and eliminate scarcity while increasing the potential of maximum exploitation of the RF spectrum.

4. Does TV White Spaces activations affect licensed operations?

No. Trials and commercial pilots that have already been conducted in many countries around the world including Kenya show that licensed operations are not affected by TVWS activation. The tests have proven that TV band White Space Devices (WSDs) operate with no interference to existing licensees entitled to interference protection.

5. What Use Cases are best for TVWS?

TVWS can be used to provide cost-effective broadband connectivity and telemetry for Internet of Things (IoT) solutions. Since the TVWS spectrum in both the VHF and UHF bands is below 1 GHz, it provides better radio frequency (RF) propagation, allowing for reliable, cost-effective and better coverage in rural areas. TVWS has been identified as the most efficient solution for broadband access for a large fraction of the rural areas in most countries. Wireless Internet Service Providers (WISPs) and other types of ISPs use 5 GHz deployments in low-density areas, hence, TVWS can be deployed in conjunction with the 5 GHz and other mid-band spectrum to increase the coverage area and enable coverage in areas of non-line-of-sight (NLOS) and distance limitations. TVWS technology also provides reliable long-range connectivity to reach the sensors, devices and machines for the Internet of Things (IoT).

6. What is the difference between Licensed and Unlicensed Users?

Licensed bands are exclusively assigned to operators by the Communications Authority of Kenya (CA). A licence is given to an entity for its exclusive use of a channel in a specific area or location and protected from interference. Unlicensed bands of spectrum are used on a shared non-exclusive basis subject to compliance to the technical standards or guidelines set by the regulator. For example, anyone can use a compliant Wi-Fi router and transmit without a licence, using the 2.4 GHz and 5 GHz bands within a home, building or campus. In the context of “white spaces” which are often considered available for unlicensed use, the users of such an “unlicensed” spectrum must be regulated to avoid harmful interference to any licensed services assigned the access to the band where these white spaces occur.

7. What are the primary services in the authorised UHF band for TVWS?

The UHF band 470-694 MHz is allocated, on a primary basis, to the broadcasting services for Digital Terrestrial Television (DTT or DTV).

White Spaces and Regulation

8. What agency regulates spectrum in Kenya?

The Communications Authority of Kenya (CA) is the regulatory authority for the communications sector in Kenya. It is therefore mandated to regulate access to spectrum in Kenya. CA was established in 1999 by the Kenya Information and Communications Act, 1998, with the responsibility of facilitating the development of the information and communications sector including; broadcasting, cybersecurity, multimedia, telecommunications commerce, postal and courier services.

9. What are permissible channels of operation?

Permissible channels of operation are available channels of operation for users that do not interfere with the operation of the protected TV band operators, as determined by the regulatory rules of making use of TV White Spaces.

10. What is an available channel?

As applied to the UHF Band 470 - 694 MHz, an available channel is an 8-MHz wide frequency slot which is not being used by an authorised service at or near the same geographic location, and is acceptable for use by a secondary application like TVWS.

11. What frequency bands have been authorised in Kenya for TVWS use?

Kenya has authorised lightly licensed operation of TVWS in the UHF band 470 – 694 MHz.

12. Why don't White Spaces Devices (WSDs) interfere with regular TV broadcasting?

WSDs only use managed access to unused TV channels. Using their exact location in an authorised database-assisted service, channel lists are utilised (with other operating parameters, such as power, duration, and geographic boundaries). White Space devices (WSDs) only use those authorised channels. If no channels are returned, the WSD will not transmit on the TV band spectrum, hence guaranteeing protection to the incumbent regular broadcasting service(s).

13. What does it mean by “Lightly Licensed”?

This is the licensing regime whereby the users of a band are allowed to utilise spectrum on a shared basis at a nominal fee. There may be further obligations associated with the general authorisation such as the

need to register the location of any transmitters and possibly coordinate their deployment with other registered users. This type of licensing regime is the one adopted for TVWS in Kenya. It is largely similar to the licence-exempt regime adopted in many countries with the WSDs being managed by the geolocation databases, only that a nominal fee is attached to it.

14. Will TVWS Operation in the country affect licensed operations?

TVWS operation will not affect the licensed operations in the authorised frequency band. The White Space Devices (WSDs), will require type approval from the CA to meet the stipulated technical specifications provided in the framework before being accepted for deployment. Further, WSDs shall only be authorised to operate under the control of a geolocation database.

15. What is the architecture of a typical TVWS Network?

A typical TVWS network comprises a base station (Master device) infrastructure and customer premises equipment (CPE) or end-point clients. Figures 1 and 2 illustrate a typical TVWS network architecture. Base station infrastructure sites require a vertical asset such as a tower or building to install base station radios and antennas. Vertical assets can be either owned or leased. A typical site in Kenya should have TVWS base station antennas mounted between 1.5 to 50 m with 50 m being the maximum height above ground level providing longer range coverage when desired. In addition to sufficient height above ground level, the base station must be provisioned with power and backhaul. The client WSDs or CPEs consist of an outdoor TVWS radio and directional antenna pointed back towards the serving base station. Typically, the CPE is to be installed at a high point or near the roofline. This installation is done along with an indoor Wi-Fi access point which in turn provides wireless connectivity to end user devices such as laptops, PCs, mobile phones as well as IoT devices.

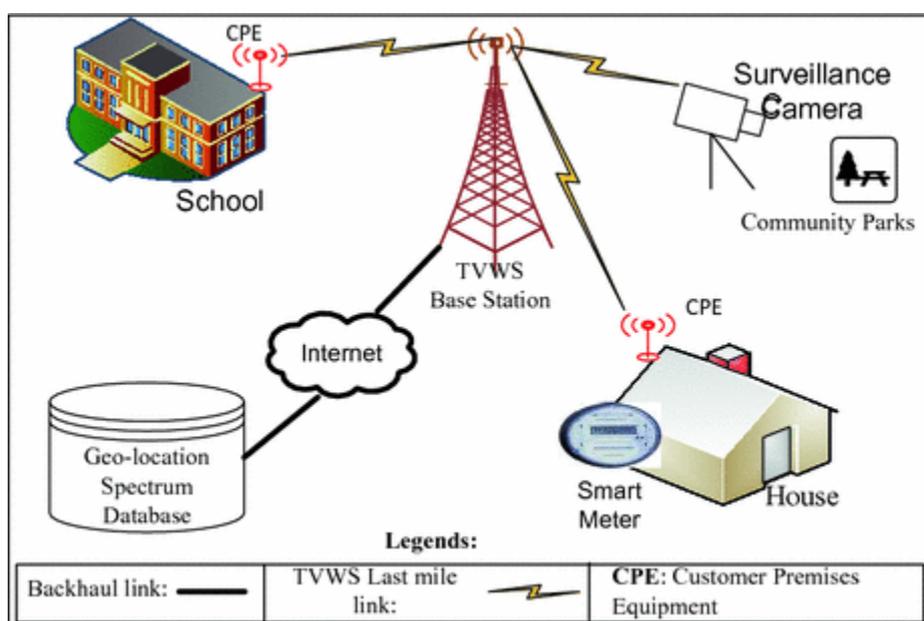


Figure 1: TVWS Network Architecture - Source: TV white space networks deployment: a case study of Mankweng Township in South Africa (<https://researchspace.csir.co.za/dspace/handle/10204/9094>)

16. What is a Geolocation Database (GDB)?

A Geolocation Database (GDB) is a database listing the frequencies allowed for TVWS use at any time and location. The intention of such a database is to enable the WSDs to opportunistically exploit the white space spectrum without interfering with the primary services. The GDB, therefore, takes the responsibility of

intensive data processing e.g. identifying the white space spectrum and computing the allowable transmission parameters as well as the period of validity of the parameters for the WSDs. The WSDs need to provide their location information to the GDBs for the frequencies of use and the transmission requirements to be provided by the GDB. Figure 3 shows A TVWS network with a GDB.

17. Are there any TVWS deployments that have been done in Kenya?

Commercial deployments are planned for 2022, earlier on multiple tests and trials were authorised. The first trial was conducted between 2013 and 2015 under the Mawingu project that was led by Microsoft East Africa through the Microsoft 4Afrika initiative. CA issued Microsoft East Africa Limited a trial authorisation at the time on the 19th of August 2013 to test the technology together with Indigo Telecom for one year. The Mawingu project which eventually led to the establishment of Mawingu Networks as an ISP, was provided an extension for another year between November 2014 to December 2015. On the other hand, In November 2016, CA also permitted another TVWS trial countrywide by the Broadcast Signal Distributors – Signet and PANG were allowed to collaborate with telcos in Kenya and pilot TVWS networks. Mawingu Networks also piloted TVWS networks further in 2018-2019 in Embu as well as in 2020 in Nanyuki during the validation of the draft framework for TVWS.

18. What are some of the findings of the Trial Deployments?

All pilots conducted in the country (until 2020) have all been successful and did not cause any interference to the incumbents (primary services). Although all the trials before 2018 did not make use of geolocation databases, they still did not cause interference to the DTT services. Successfully, the Mawingu project connected some schools, hospitals, a library and the Red Cross leveraging TVWS technology in the rural Laikipia and Nyeri counties. The TVWS network was implemented in a point-to-multipoint (PtMP) fashion and leveraged solar energy to power the base stations. Hence, the pilots have demonstrated technical viability of TVWS with the PtMP coverage of about 14-20 km achievable with TVWS base stations transmitting at 2.5 Watts (34 dBm). The allowed transmission power in the regulations is 42 dBm (4W) which can practically cover a range of 30 km with a reasonable CPE antenna gain of about 11dB. The Internet speeds released from the network range from 16 – 20 Mbps on a single 8 MHz channel.

19. Who is allowed to deploy TVWS in Kenya?

According to the regulatory framework, interested service providers who hold an infrastructure licence, either a Network Facilities Provider Licence (Tiers 1, 2 or 3), a Broadcasting Signal Distributor Licence, a Self-Provisioning Broadcasting Licence or a Community Network Service Provider can deploy TVWS networks.

20. Are TVWS radios from different manufacturers interoperable?

Not yet. All vendors use proprietary technology, hence not interoperable at the moment. Some of the manufacturers such as Adaptrum are producing a baseband chip based on the 802.11af standard. It is envisioned that, since many countries have embraced the 802.11af standard, most radio and hardware vendors will implement radios that can be interoperable.

21. What is the difference between fixed and portable devices?

Fixed white space devices operated from a specified fixed, or non-moving location. As such, they have more applications for things like commercial Wi-Fi hotspots, rural broadband distribution, or cellular-style installations. They typically operate at relatively higher power and use antennas mounted on higher buildings or a mast. This type of installation will have a stronger signal and reach greater broadcast

distances than the signals sent by personal devices, so the regulations are stricter for them on location and hours of operation.

Comparatively, portable white space devices operate over shorter distances and utilise lower power levels (think laptops and smartphones). Since these devices generate a relatively small bandwidth or "footprint", they are permitted to have greater operating freedom in different locations and can use a larger number of frequencies.

22. What is the status of TVWS in regards to mobility support?

Presently, most TVWS devices are for fixed connection based on the experience from the pilot trials. Although the regulatory framework authorises the operation of personal/portable WSDs, no deployments/tests have been carried out so far on such WSDs. Nevertheless, if manufacturers introduce the personal/portable WSDs in the Kenyan market, they would still be allowed provided they still adhere to the framework provisions.

Devices and Geolocation Databases

23. Who are the TVWS Equipment Vendors?

There are many vendors of TVWS. Major vendors include Adaptrum, 6Harmonics, Carlson Wireless and Radwin. Their website links are included here:

1. Adaptrum - <https://www.adaptrum.com/>
2. 6Harmonics - <https://6harmonics.com/>
3. Carlson Wireless - <https://carlsonwireless.com/>
4. Radwin - <https://www.radwin.com/radwin-outland/>
5. Redline - <https://rdlcom.com/uhf-tv-white-space/>

24. What is the stand on Type-approval requirements for the TVWS Equipment?

Similar to the type-approval requirements for telecommunications equipment stipulated by the CA, duly licensed vendors and contractors of the equipment will be authorised to provide the TVWS equipment and they will be required to obtain type-approval for each model of the equipment. All the entities wishing to use telecommunication equipment for their networks will require authority to operate the network under article 3 of the Kenya Information and Communications Regulations 2010 (Importation, Type Approval and Distribution of Communications Equipment).

25. Who are the Geolocation Database (GDB) Service Providers?

Presently, there are several geolocation database service providers globally. Based on the procedure for Qualification of Geolocation Databases for Kenya, only Fairspectrum has been approved at the moment to operate in Kenya. CA shall qualify other GDB providers who can demonstrate that their database solution meets the minimum requirements to reliably provide information on the availability of TVWS to the WSDs. CA will monitor the performance of the GDBs to determine possible ways of improving the framework.

26. How does the Geolocation Database Work?

To access the TVWS spectrum, a master WSD will provide its location and operational characteristics to a geolocation database (GDB) over the Internet and request a list of channels at its specified location (as determined through geolocation capabilities - global positioning system). Depending on their operating

characteristics and intended uses, CA will designate the master WSD devices that directly contact the GDB as either ‘fixed devices’ or ‘portable devices.’

The GDB will then use the information from the master WSD to perform calculations for the location and technical characteristics and communicate the available channels and powers that the master WSD can use to initiate transmission at its location. The client WSDs (also called Customer Premises Equipment - CPE) will operate under the control of the master WSD(s). The CPEs will operate in listen mode only and will only begin transmissions upon hearing an enablement signal from the master WSD(s).

The master WSDs will be required to re-contact the GDB at specified time intervals (24 hours) to obtain a new list of channels for TVWS use. In scenarios where the master WSD is unable to contact the GDB due to external causes (e.g. database downtime, Internet unavailability) may continue to operate with its current available frequencies and maximum powers until 24 hours elapses or the current period of validity expires, or one polling interval after contacting the GDB is re-established – whichever occurs sooner.

The entire process of GDB communication is invisible to the user and requires no action by the consumer. The figure below illustrates the Kenyan regulatory framework for TVWS.

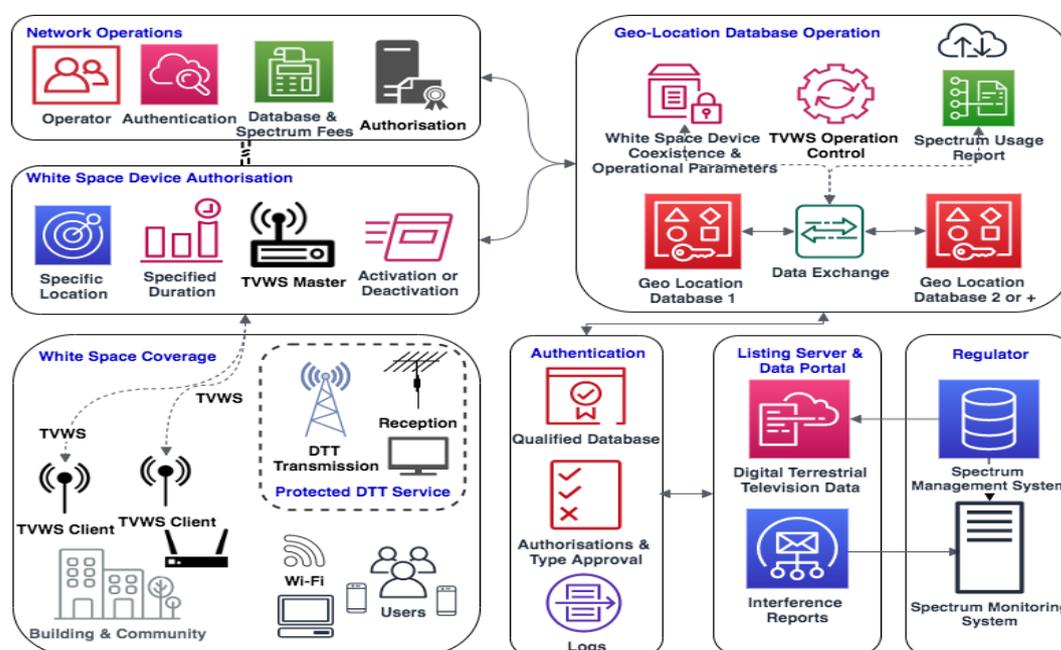


Figure 2: Illustration of TVWS Framework for Kenya

Source: Communications Authority of Kenya

Applicable Fees

27. What is the estimated cost of TVWS equipment?

The different vendors have different pricing models. Hence, to obtain the pricing, please contact the different vendors directly.

28. Is there a fee for use of TVWS Spectrum?

CA has adopted an administrative fee for master devices only, in line with the frequency fee schedule and the Kenya Information and Communications (Radio Communications and Frequency Spectrum Regulations 2010). Each authorised master WSD will be subjected to an annual fee of KES. 10,000.

Benefits of TVWS Technology

29. How do consumers benefit from White Spaces technology?

Higher bandwidth and/or more widely available network access, for starters. That will enable everyone to enjoy the growing number of online services in the ever-expanding technological future enabled by emerging technologies.

30. Do White Spaces transmissions travel further? What about indoors?

Traditional Wi-Fi signals fade after about 100 metres from a base station, while those of TV White Spaces can have outdoor ranges measured in kilometres. Indoors, White Spaces WiFi achieved approximately four times the range of a 2.4 GHz standard Wi-Fi channel with the same transmission power and receiver sensitivity (think home network here), with less noise and better propagation through walls and obstructions.

31. What is the range of White Space transmission? How is White Space better for rural areas?

Transmission range is dependent upon several potential factors, which is true of any transmission network. However, the maximum range of White Spaces transmission could be up to 20 kilometres, as UHF frequencies can boost the effective outdoor range as high as 5 to 10 times more than that for 2.4 GHz.

Technical Parameters

32. What is the difference between Device parameters, Operational parameters and Channel Usage parameters?

Device parameters are the details of the devices such as the category of the device (i.e. either master or client), device type (either fixed or portable), unique identifier (ID recognised by the Geolocation Database (GDB)), device emission class, antenna information (location together with uncertainty), spectral mask details as well as other device details that are to be used by the GDB(s) to determine the for appropriate operational parameters.

Operational parameters are the parameters generated by a GDB and provide operational instructions to a WSD, including the frequencies and powers that a WSD must use. Such parameters include – the lower and upper frequency boundaries within which a WSD may transmit; the maximum permitted EIRP spectral density; limits on the maximum total number of DTT channels that may be used; the period of validity of the parameters; the geographical area of validity and the period of rechecking the validity by the master WSD. Operational parameters for client WSDs from the geolocation database are communicated via the serving master WSD. These parameters may be communicated to the client WSD as a single set of parameters or a series of sets of parameters.

Channel Usage parameters are the parameters reported by the WSD to the GDB which includes the actual operating frequencies and powers. Other parameters include the operational parameters in actual use provided by the GDB such as the location, lower and upper frequency boundaries and the maximum in-block EIRP spectral density.

33. What are the power limits?

A power limit in a given channel constrains the WSD's intentional emissions in that channel and is specified as a limit in dBm over the full width of the 8 MHz channel. For Master/Fixed WSDs, the maximum power radiated shall not exceed 42 dBm per 8 megahertz of bandwidth on which the device operates.

34. What are the TVWS antenna requirements?

All transmit and receive antennas of personal or portable devices shall be permanently attached to the device. The transmit antenna used with fixed devices may not be more than 30 meters above the ground.

35. What kind of data is collected by the Geolocation Database?

A qualified geolocation database will collect the following information from network facilities providers deploying TVWS devices.

Table 1: Device Parameters

Parameter Name	Description
Antenna location	Latitude and longitude coordinates and altitude, e.g. in WGS84 format.
Antenna location uncertainty	Latitude, longitude, and altitude uncertainties specified as $\pm\ddot{A}x$, $\pm\ddot{A}y$ and $\pm\ddot{A}z$ metres respectively, corresponding to a 95 % confidence level.
Device type	Type A or Type B.
Device category	Master or client.
Unique device identifier - Manufacturer identifier	A set of characters representing the IEEE™ Organisationally Unique Identifier (OUI) of the manufacturer, or the Universally Unique Identifier (UUID).
Unique device identifier - Model identifier	A set of characters representing the manufacturer's model number or some identifier to identify the product family.
Unique device identifier - Serial number	A set of characters representing an identifier unique to a device from a specific manufacturer.
Technology identifier	A set of characters that uniquely identifies the technology including: <ul style="list-style-type: none"> • the organisation responsible for technical specifications; • specification number, version and issue date.
Device Emission class	Class 1, Class 2, Class 3, Class 4 or Class 5. The device emission class number reported by the WSD to the geolocation database is the Class with which the device complies as specified in Table 5.1.

Spectral mask improvement	<p>Improvement, $\Delta\text{ACLR}(n_{\text{IB}}, n_{\text{OOB}}) \geq 0$ dB, in adjacent channel leakage ratio, as a function of the out-of-block DTT channel index, n_{OOB} (21 to 48), and the nearest in-block DTT channel index, n_{IB} (21 to 48). The improvement is in relation to the ACLR of the device emission class reported by the WSD.</p> <p>Where ΔACLR is not reported for a certain $(n_{\text{IB}}, n_{\text{OOB}})$ combination, the geolocation database will assume that $\Delta\text{ACLR} = 0$ dB.</p> <p>Note that the ACLRs cannot be smaller than the values specified for the most relaxed device emission class.</p>
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36. What are some of the useful links that one can access on TVWS in Kenya?

We list the useful links on TVWS in Kenya here:

- Dynamic Spectrum Access Framework for Authorisation of the Use of TV White Spaces: <https://www.ca.go.ke/wp-content/uploads/2021/05/Dynamic-Spectrum-Access-Framework-for-Authorisation-of-the-use-of-TV-White-Spaces-May-2021.pdf>
- Procedure for Qualification of Geolocation Databases: <https://www.ca.go.ke/wp-content/uploads/2021/05/Procedure-for-Qualification-of-Geolocation-Databases-May-2021.docx-1.pdf>
- Fee Schedule - <https://www.ca.go.ke/wp-content/uploads/2018/02/Frequency-Fee-Schedule-Effective-1st-July-2018-.pdf>
- Summary of the Regulatory Framework for TV White Spaces in Kenya: <http://www.ilabafrika.ac.ke/wp-content/uploads/2021/06/Summary-of-the-Draft-Regulatory-Framework-for-TV-White-Spaces- -April 25 2021 .pdf>