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White Space Device

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ABSTRACT

Background/Objectives: This study dealt with providing a wireless broad band connection using TV White Spaces. This could be implemented with the help of AWR device which providing an access of about of 10 km existing in U.S. and South Africa. **Methods/Statistical Analysis**: In this paper, a high IF transceiver, UHF antenna and UHF low pass filter are considered. The low pass filter is designed and it is based on the type of antenna and the LNAs input network matching. **Findings:** Four layers of PCB with the RF signals, ground plane, routing and digital signals forming is used and worked with 12 v peripheral power supply with the current consumption is 800 mA. **Applications/Improvements:** This technology provides broad band connection in rural areas.

Keywords: Agility White Space Radio (AWR), Low Noise Amplifier (LNA), Ultra High Frequency (UHF),

1. Introduction

The government authorizes certain frequencies to certain organizations. But the frequencies will not be allotted continuously, as there may occur some interference. To avoid such interferences some range of frequencies between these licensed frequencies are left unused. These unlicensed frequencies can be used for providing broadband connection in rural areas. Nowadays, spectrum sharing type in TV White Spaces was promoted with IEEE802.11af and IEEE802.22 technical specifications, was implemented in international standardization activities. This international standardization system are tending to secure more frequency channels on existing systems by converting from native frequency band to TV White Spaces. White Space used in tablets, phones and computers is shown in Figure 1. Generally, White Space spectrum ranges from 470 MHz to 790 Mhz, but it may varies from region to region. Maximum antenna tower height ranges from 30 m to 100 m[1].

2. White Spaces

Television is available at each and every home. The television will receive the signals separately without any interference[2]. Thus the spaces which are left between them will be called as White Spaces as shown in Figure 2. White Space is referring to portion of licensed radio spectrum. Several unlicensed regulators in the world are available to gather these frequencies, on par with the licensed transmitters[3].

2.1 Function of White Space Device

The database will allow devices to use vacant TV signals in particular area. The fixed device's user will register with the database. Similarly, the AWR device which is fixed will authenticate with the database as shown in Figures 3 and 4. The device will determine its GPS location and will ask for the available channel list to the database as shown in Figures 5 and 6.

The database analyses the location coordinates and it looks for occupied channels to determine the unused

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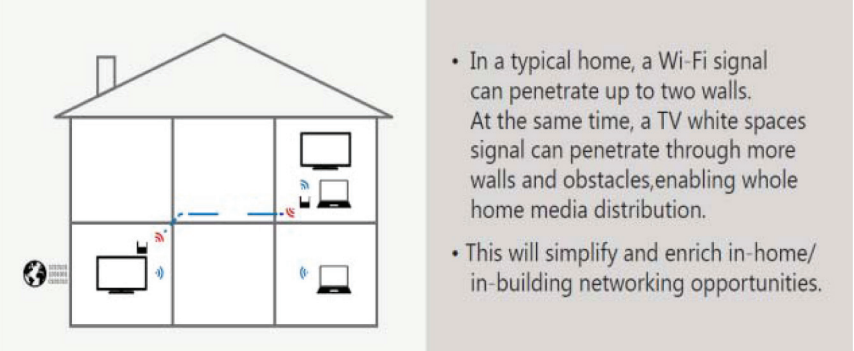

Figure 1. Typical home.

Figure 2. Frequencies used by televisions.

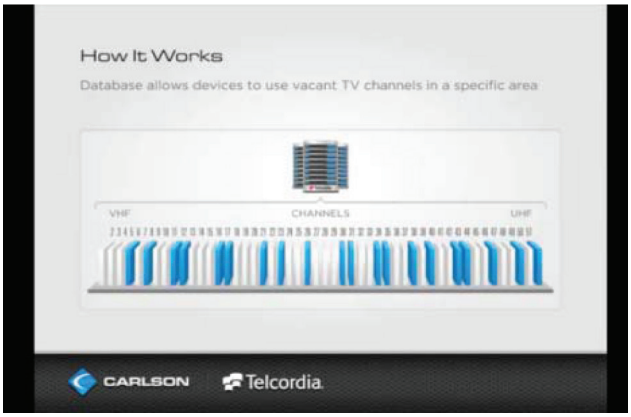

Figure 3. Detection of available channels.

available channels as shown in Figures 7 and 8. Then the database will send the channel list to the device. Now the device uses the available channels for wireless broadband as shown in Figure 9.

2.2 Fixed White Space Devices

Fixed TV White Space devices are operating at high power and can provide multi-kilometer wide area connectivity to current 3G/4G wireless networks. The fixed TV White Space devices operate efficiently, that can be observed through conducting the performance test in

Figure 4. Fixed device registers with database.

Figure 5. Authentication.

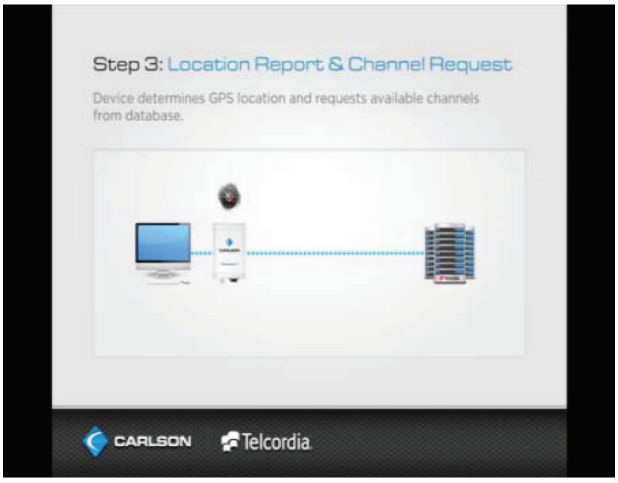

Figure 6. Request for channel.

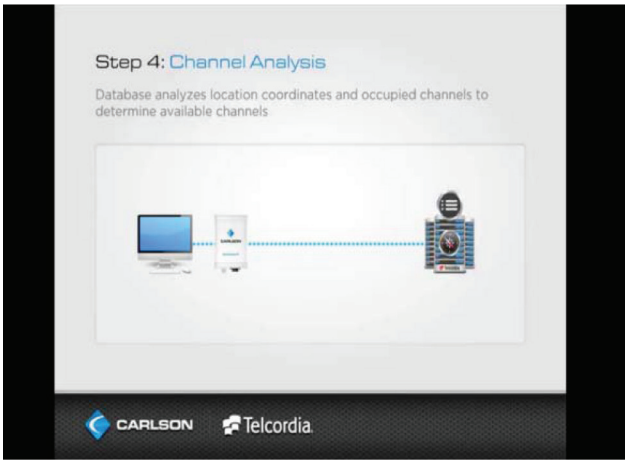

Figure 7. Analysis of channel.

Figure 8. List of channels is sent.

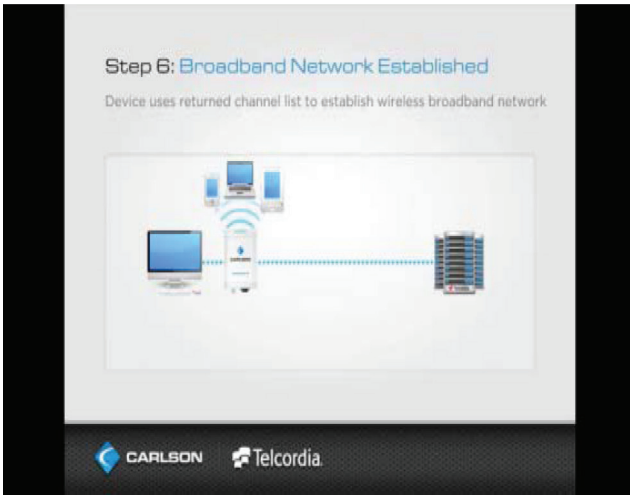

Figure 9. Network is established.

current generation devices. Further, the performance may be compared with other competing wireless technologies. The addition benefits are:

- Variable broadband data rates up to 3.25 Mbps.
- Supports UHF and unlicensed 900 MHz frequencies.

2.3 Portable White Space Devices

Portable White Space devices must check database for permissible channels. Portable devices obtain location/channel from fixed devices. Portable device has its own geolocation/database access capability.

2.4 Conditions

- Portable White Space devices use the concept of TV White Space channels database.
- Devices are used for rechecking the database based on the list of available channels.
- Devices are accessing to the channels occupied by the incumbent operators.
- Devices are used for maintaining up to date information in a database.

3. Design of White Space Device

The design of this White Space device is similar to the cognitive radio design, as there is a requirement for the detection of vacant unoccupied signals. The design of this device is similar to part of White Space converter design which is connected to the WLAN devices.

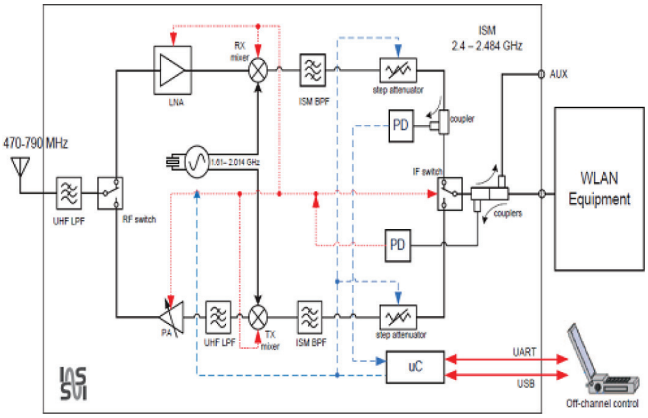

Figure 10. Design of WSD.

The architecture consists of a high IF transceiver. The separate transmitter and receiver paths are available in the transceiver. These two paths viz., transmitter and receiver paths are separated by two SPDT switches (RF and IF switches). These RF and IF switches are reunion signal paths, that allows the operation of single UHF antenna. Further, antenna port and RF switch is connected UHF low pass filter. It is designed based on the mode of the antenna and the LNAs input matching network. The LNA forms the band pass network which reduced the unwanted signal interference[4].

A less portion of signal transmit is available in the middle of RF and IF switches, is fed into the RF power detector for controlling RF switches. Further, a small lot of the received signal is fed into supporting RF connector in Figure 10 for additional measurement requirement.

3.1 Transmit Path

Transmit begins after separation of RX and TX paths. The digital attenuator in the transmit path has different signal strength settings and microcontroller interface used for getting low power.

Highly linear down conversion mixer translates the signal in UHF band with the help of local oscillator signal. The amplified signal is placed in the 470-790 Mhz UHF band region and fed into the antenna through RF switch. Single ended transmission system is used for whole signal processing[5].

3.2 Receive Path

The first stage in the LNA offers superior noise rejection and then converts the required frequencies into the ISM band. Additionally, the ISM band pass filter is removing the unwanted frequency components generated by the mixer, since, the bandwidth of this BPF is only 80 Mhz. This signal is then fed to the attenuator and then to the power detector. Receive signal path is also single ended.

3.3 Synthesizers

The local oscillator comprises of a wideband synthesizer chip, used to obtain the carrier signal of desired phase noise performance.

3.4 TX/RX External Switching and External Control

The transmit signal is now fed into power detector as controller mode. If input power is reaching the predefined threshold level, automatically, it switches to transmit mode and if the power of the signal is falling below predefined specified threshold level, then automatically it returns to receive mode.

The unused blocks in the other signal path are transferred for conserving power and reducing the local intrusion. Microcontroller ATmega32 is used the off channel control mechanism. It controls the settings of transmit and receive paths. The voltage from RF power detector is observed by microcontroller.

4. Hardware Implementation

4 layer PCB with the RF signals, ground plane, routing and digital signals forming the layer stackup helped for implementing the hardware system. An electromagnetic

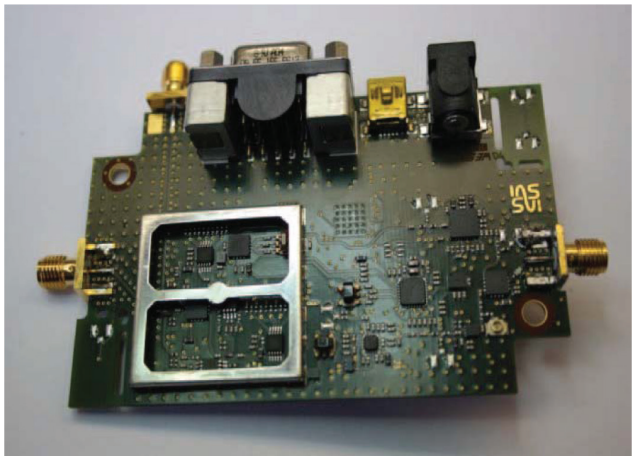

Figure 11. Hardware implementation.

shielding is given to prevent the degradation during the performance of RF switch. The layer stackup is operating with 12 v external power supply with the current consumption of 800 mA (Figure 11).

4.1 Efficiencies

The longer and wider range in the system helps to deliver more bandwidth and more consumer benefits at lower network costs and power consumption. As a result, the consumer accesses the internet using this bandwidth appetites and hence, indirectly internet providers will have more consumers.

This technology is gives a greater network capacity and greater number of users in a given area by protecting television reception from interference. The consumer may not know the intelligent of broadband connectivity, but it does the consumer requirements.

4.2 Benefits

Wherever, the existing technologies failed, this technology come into picture to solve.

4.3 Advantages

- Low cost and rural broadband.
- No interference and better coverage (10 kms) than Wi-Fi (100 m) as displayed in Figure 12.
- Simple to deploy, eco-friendly.
- High speed of 4 Mbps.
- Solar panels can be used to power the White Space power stations.
- Non line of sight performance can be achieved.

5. Conclusion

This study discussed the wireless broad band connection using TV White Spaces. A high IF transceiver, UHF antenna and UHF low pass filter are considered for connecting TV White Spaces with wireless broad band. The mode of the antenna and LNAs input matching network were used for designing the low pass filter. A 4 layer PCB with the RF signals, ground plane, routing and digital signals forming the layer stack up operated with 12 v external power supply with the overall current consumption of 800 mA. Finally, this study concluded that White Space technology provides broad band connection in rural areas.

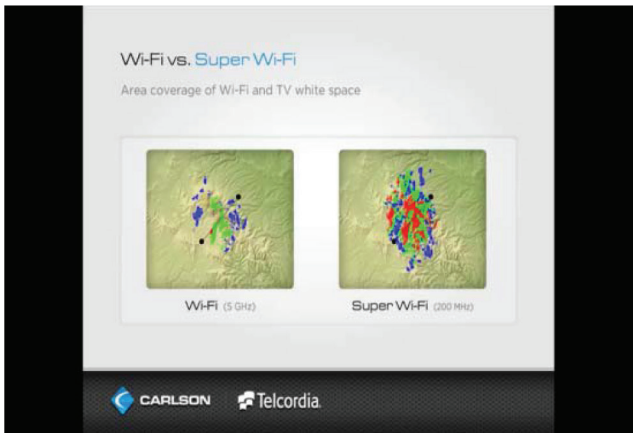

Figure 12. Range of Wi-Fi and super Wi-Fi.

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