# Using 2.4 GHz ISM Band for Development in Rural Zimbabwe, a case for the Binga District.

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## 1.0 Abstract

Research has shown that telecommunications and the internet contribute immensely in the economic and social development of people and nations in today's networked and information driven society. It can then be concluded that the ISM band and the low cost wireless technologies that operate within it could be of great value to low-income countries with non-existent or poor telecommunications and Internet infrastructures. In Zimbabwe use of the ISM band for internet and telecommunications is illegal. The ISM band is a band of frequencies defined by the ITU for Industrial, Scientific and Medical use however the use of these bands for license-exempt internet and telecommunication purposes is regulated by country regulators, Postal and Telecommunications Regulatory Authority of Zimbabwe (Potraz) in Zimbabwe. This paper seeks to identify the ISM band in Zimbabwe and highlight the benefits that are accrued to remote rural communities if the ban of its use is systematically lifted Potraz. A case for the remote Binga District of Zimbabwe is discussed. Strategies that can be employed to manage interference are also discussed.

## 2.0 Introduction

The use of radio spectrum has become an integral part of society's infrastructure, e.g. phenomenal growth in personal mobile communications has turned wireless access via mobile phones from a luxury to a necessity for many people and also the birth and growth of wireless broadband internet links in Zimbabwean cities.

The value to urban individuals, businesses and the public sector of access to radio spectrum is undoubtedly increasing. Radio spectrum has the potential to make a substantial and increasing contribution to the Zimbabwean economy. Cave, 2002, from studies by the Radio communications Agency of UK, states that even for selected sectors of the economy, the value of radio spectrum use to the economy as a whole exceeds £20 billion per annum, over two per cent of the United Kingdom output. Success in managing access to radio spectrum should thus boost the performance of the Zimbabwean economy.

The ISM (Industrial, Scientific and Medical) Band is a section of the spectrum of radio communication frequencies. A band is a small segment of the spectrum. The International Telecommunication Union (ITU) designated certain frequency bands for industrial, scientific and medical applications. The position of the ISM band on the spectrum is shown in Fig 1.0 below.

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# 3.0 ISM and the Electromagnetic Spectrum

## *3.1 Electromagnetic Spectrum*

The electromagnetic spectrum illustrated in Fig 1.0 (also referred in this paper as the spectrum) is the complete range of electromagnetic waves on a continuous distribution from a very low range of frequencies and energy levels, with a correspondingly long wavelength [measured in meters (m)], to a very high range of frequencies [measured in Hetz (Hz)], and energy levels, with a correspondingly short wavelength. Included on the electromagnetic spectrum are radio waves and microwaves; infrared, visible, and ultraviolet light; x rays, and gamma rays (wikipedia, 2007).

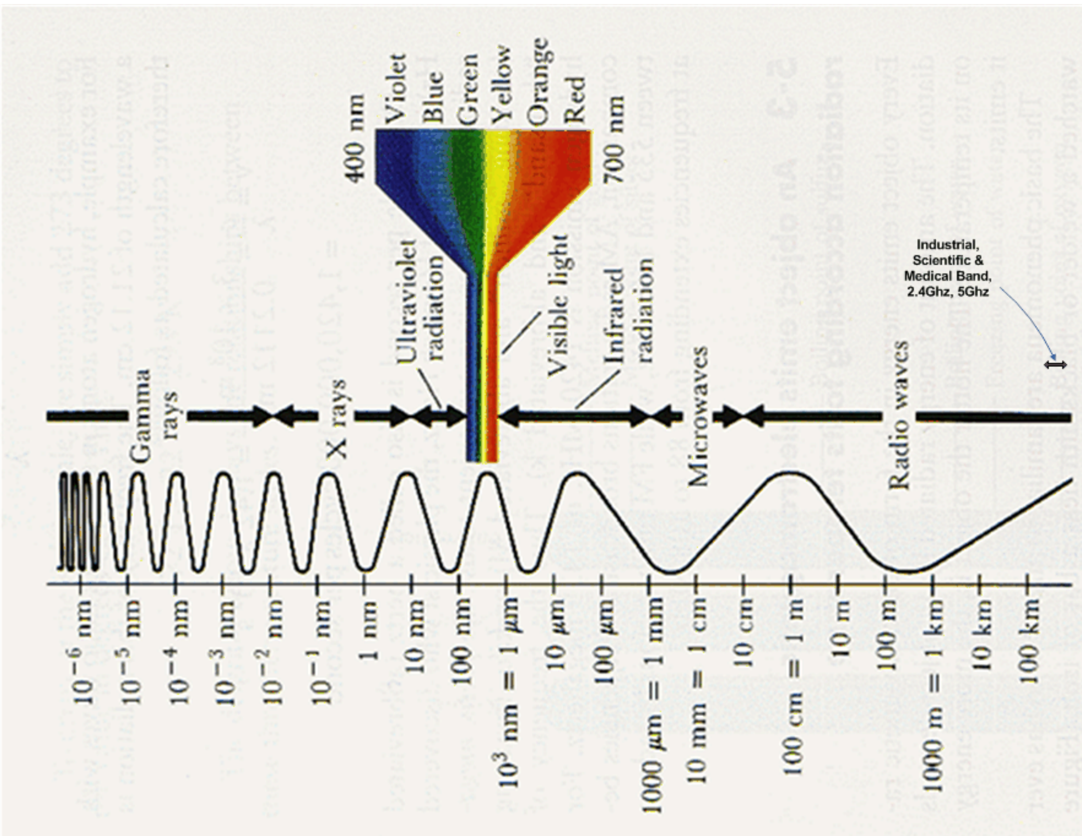


**Fig 1.0 The electromagnetic spectrum** (Credit to, Johns Hopkins University through http://stuff.mit.edu)

## *3.2 The ISM Band*

The ITU in its international radio regulations (ITU-R) designated a number of radio frequency bands for industrial, scientific and medical applications. However radio communications services operating within these bands must accept harmful interference, which may be caused by these applications and the use of these frequency bands for ISM applications, shall be subject to special authorization by the administration concerned, in agreement with other administrations whose radio communication services might be affected

The ISM bands defined by the ITU-R are (bands in ***bald italics*** are subject to local acceptance):

- 6.765-6.795 MHz (centre frequency 6.780 MHz)
- 13.553-13.567 MHz (centre frequency 13.560 MHz)
- 26.957-27.283 MHz (centre frequency 27.120 MHz)
- 40.66-40.70 MHz (centre frequency 40.68 MHz)
- ***433.05-434.79 MHz (centre frequency 433.92 MHz) in Region 1***
- ***902-928 MHz (centre frequency 915 MHz) in Region 2***
- 2.400-2.500 GHz (centre frequency 2.450 GHz)
- 5.725-5.875 GHz (centre frequency 5.800 GHz)
- 24-24.25 GHz (centre frequency 24.125 GHz)
- 61-61.5 GHz (centre frequency 61.25 GHz)
- 122-123 GHz (centre frequency 122.5 GHz)
- 244-246 GHz (centre frequency 245 GHz)

ITU-R divides the world into three **ITU regions** for the purposes of managing the global radio spectrum. Each region has its own set of frequency allocations, the main reason for defining the regions (ITU, 2007).

- **Region 1** comprises Europe, Africa, the Middle East west of the Persian Gulf and including Iraq, the former Soviet Union and Mongolia.

- **Region 2** covers the Americas and some of the eastern Pacific Islands.

- **Region 3** contains most of non-former-Soviet-Union Asia, east of and including Iran, and most of Oceania.

# 4.0 Licensed and unlicensed bands

Radio frequency bands, except ISM bands, for which use a user is required to pay a licence to the local regulator, are called licensed frequencies. ISM bands are normally referred to as unlicensed or licence-free bands, except in the USA where they are called non-licensed bands (Wolleben, 2007).

Wolleben (2007) further states that while the ISM bands were initially unlicensed primarily for use for simple consumer electronics (radio controlled cars, microwave ovens, and the like) increasingly they are being used by systems providing basic internet and telecommunication services.

For many people, the most commonly encountered ISM device is the home *microwave oven* operating at 2.45 GHz. However, in recent years these bands have also been shared with license-free error-tolerant communications applications such as wireless LANs and cordless phones in the 915 MHz, 2450 MHz, and 5800 MHz bands.

Because licensed devices already are required to be tolerant of ISM emissions in these bands, unlicensed low power uses are generally able to operate in these bands without causing problems for licensed uses. Note that the 915 MHz band should not be used in countries outside Region 2, except those that specifically allow it such as Australia and Israel, especially those that use the GSM-900 band for cell phones (ITU, 2007).

Other applications for the unlicensed band are:

- Bluetooth 2450 MHz band
- HIPERLAN 5800 MHz band
- IEEE 802.11 2450 MHz and 5800 MHz bands

# 5.0 Benefits derived from use of ISM Band

The unlicensed spectrum and the low cost wireless technologies that operate on these bands could be of particular value to low-income communities or countries with poor telecommunications and Internet infrastructures.

Neto (2004) in licence-free wireless policy recommendations says that the ISM bands can potentially be used for provision of rural connectivity and Universal Service. Given the identified potential for this technology and its low cost, allowing the use of Universal Service funds for wireless projects in these bands may represent a cost effective utilization of the subsidies.

According to a survey carried out by Neto (2004) on African States, Universal Service programs are so far largely untapped opportunity vis-à-vis unlicensed wireless technologies. From the countries that replied to the survey at least 47% have Universal Service Policies in place. However, only three countries (6%) - mentioned that Universal Service Funds have been used to deploy equipment in the ISM bands– Kenya, Madagascar, and Rwanda.

Neto (2004) further alludes that there are reports that these bands can serve as a viable alternative to leased lines: in Cape Verde the government itself uses the 2.4GHz band to connect the different ministries and government sites, because the leased lines are too expensive. Also in the Seychelles the 2.4GHz band is said to compete effectively with leased lines. Senegal has mentioned that the lack of reliable infrastructure has led operators to develop wireless solutions to offer quality service to their customers.

Experiences in Asia and Latin America have proven that virtually any village community, entrepreneur, small enterprise, public institution or member of the public (via a rural cybercafé) can immediately get connected, no matter where they are, or how far they are from fixed infrastructure.

New and creative enterprises can make rural areas more profitable, affordable and sustainable and served in a way to meet national development objectives. However, this requires creativity and innovation in terms of universal access as well as enabling spectrum management regulations.

Equipment based on unlicensed wireless local area network (WLAN) technologies, such as the ISM wireless technology standards, are now widely available commercially, inexpensive, and require little technical expertise to install. Such equipment can be used to create wireless data networks without investing time and money in acquiring a spectrum license up front (Martin, 2002)

# 6.0 The Role of Potraz in Spectrum Management in Zimbabwe

The spectrum in Zimbabwe is managed by the Postal and Telecommunications Regulatory Authority (Potraz). Potraz is Established by an Act of Parliament, Postal and Telecommunications Act [Chapter 12:05] of 2000. Potraz has the mandate to provide equitable access to the communications space of Zimbabwe. Chindori, (2004), in a presentation, Role of the Regulator, states the following as the functions and powers of the Regulatory Authorities:

- to ensure the provision of sufficient domestic and international broadcasting, postal and telecommunications services through out Zimbabwe.

- To exercise licensing and regulatory functions in respect of broadcasting, postal and telecom system and services in Zimbabwe.
- Ensure that reasonable demands for broadcasting, postal and telecom services are satisfied.
- To promote the interests of consumers in respect of variety, availability, accessibility, affordability and quality of services provided.
- To promote and facilitate a conducive competitive environment in the broadcasting, postal and telecommunications sectors.
- To approve and monitor tariffs charged for the provision of services however the regulator does NOT determine tariffs charged by operators.
- To allocate, assign and manage radio frequency spectrum and numbering.
- To ensure universal service provision of services.
- To advise the relevant Ministers on all matters relating to systems and services.

### *6.1 Statutory Instrument 262 of 2000*

Statutory Instrument 262 of 2001 makes the use of the ISM band in Zimbabwe illegal. Neto (2004) from the survey carried out on African Countries states that Potraz banned the use of ISM bands in 2004. Prior to the ban the 2.4GHz band had been uncontrolled and used extensively for data links to ISPs and within commercial organizations. From the end of January 2004 ISPs could no longer operate within this band.

The possible reasons for the ban are not clear. However it is assumed by operators that interference congested places like Harare, the capital city of Zimbabwe, could have been the major cause of the ban.

Hood (2006) observes that there was a disturbing set of documented and undocumented observations, particularly in the increasingly popular 2.4GHz ISM band, where various devices inexplicably fail to operate at certain times of the day or when specific devices are in use in their proximity. There are also observations that wireless devices in general either operate intermittently, or fail to operate at all around certain facilities such as large-scale computer development labs, research facilities, or hospitals.

The problem thus is real, and there is a critical need for effective management of ISM band interference in Zimbabwe.

## 7.0 Interference, Causes or Sources in the ISM Band

Interference is any electromagnetic disturbance that interrupts, obstructs, or otherwise degrades or limits the effective performance of electronics/electrical equipment. It can be induced intentionally, or unintentionally, as a result of spurious emissions and responses, intermodulation products, and the like, (www.atis.org, 2007)

The impact of interference ranges from having no effects, through modest inconvenience to individual users to, in the very extreme cases, serious commercial or safety consequences. Interference manifests itself to a user as a reduction in coverage distance and performance, (Hartfield, 2005).

National regulatory authorities throughout the world, including Potraz, have, therefore, regarded it as one of their central duties to ensure both an acceptable interference environment as well as maximising the use of the spectrum.

Interference would occur between transmitters and receivers operating within the ISM band in **Industry** WLANS, Industrial Control Systems, communications systems, **Medicine**, hospital devices and **Scientific** research arenas. In Zimbabwe this interference would occur mainly between ISM wireless LANs and industrial control systems and/or hospital equipment (Hartfield, 2005).

Kimmel (2007) states that the most common radio frequency interference (RFI) exposure to medical electronics is from portable transmitters such as cellular telephones or handheld radios.
These transmitters are generally low power. Most cell phones have a 600-mW transmitter. Most handheld radios have a 1-W transmitter, but some are as high as 5 W or more. Even though the power levels are quite low, these transmitters present one of the worst threats to medical electronics because they can be very close to patients.

This RFI is also the hardest to control because these portable devices are everywhere—home, office, factory, automobile, hospitals, and sidewalks.

Another primary source of RFI is mobile and vehicle-installed radios. The automotive industry has found that RF fields in vehicle cabs can reach 100 V/m or more (Kimmel, 2007).

Kimmel (2007) further states that commercial broadcast and fixed base transmitters are much higher power, but unlike those discussed previously, these transmitters are isolated from human contact.

Low-power telemetry units are increasingly found in hospitals. These units pose a potential threat, but the expected power levels are lower than the levels reported for the transmitters above. Telemetry units generate less than 1 V/m, unless the receiving device is almost touching the transmitting antenna (Kimmel, 2007).

However In the ISM band, Kimmel states that the most notable source is the electrosurgical unit, where the field close to the unit might exceed 30 V/m. Industrial RF heaters may run at 10 kW of power, producing fields that are potentially hazardous to both the operator and nearby electronic equipment. Proximity to this equipment is controlled, but the high field strengths affect electronic equipment at much greater distances than fields from other types of transmitters.

## *7.1 Regulatory Trends in ISM Wireless and Hospital Devices*

### 7.1.1 Wireless and Hospital Devices

Research carried out by Cisco Systems (2002) has revealed that interference between medical devices and WLAN technology can be mitigated with a properly conducted site survey and a well-designed network

Modern medicine is moving towards the replacement of cables with wireless connections in hospitals. Wallin (2004) proposes in his research that in today's intensive care and surgery, a great number of cables are attached to patients. These cables can make the care and nursing of the patient difficult. Replacing them with wireless communications technology would facilitate patient care.

Spyropoulos (2007) states that to prevent RFI, equipment manufacturers have begun to consider issues of electromagnetic immunity during design and production. They have also published several directives, of which the most common and most widely accepted is international standard IEC 60601-1-2, which has been adopted as harmonized European standard EN 60601-1-2.9,10

The standard refers to two causes of RFI related problems: the existence of source equipment whose emissions must be limited, and the existence of susceptible equipment that must be adequately shielded in order to be protected from the disturbances in its environment. IEC 60601-1-2 addresses issues relating to tests, measurement techniques, and safety levels of emissions and susceptibility for medical equipment. It also proposes installation and mitigation guidelines to achieve controllable emissions and immunity of equipment (Spyropoulos, 2007).

So two efforts have to made by POTRAZ namely regulating for properly designed wireless networks and regulating for the coexistence of wireless technology and medical devices or any other devices that are likely to be affected by RFI.

### 7.1.2 ISM Band

The report by Neto (2004) makes the following recommendations for Economic Commission for the West African States (ECOWAS) the in cases where license-exemption is not prohibited:

Regulators to ensure that license-exempt commercial applications are not in competition with previously assigned ISM bands commercial services licenses which carry greater financial obligations;

- License-exempt commercial services providers to be registered to allow for minimal consumer protection measures ;
- Where immediate license-exemption is not possible a fast-track and simplified licensing process requiring registration fees only should be applied;
- Urgent steps must be taken to establish and publish widely technical conditions (power limits, interference, etc.) for the use of the ISM bands. It should also be recognized that the ISM bands are used for other telecommunication networks and these must be protected from harmful interference. The technical limits as contained in EN 300 328 (2.4 GHz band)1 and EN 301 893 (5.8 GHz)2 are recommended for adoption by West African Telecommunications Regulators Association (WATRA) administrations;
- In order to minimize interference with existing legitimate systems, license-exempt applications to require the deployment of interference minimizing technologies;

These recommendations promote the proper management of the ISM band telecommunication networks by ECOWAS member states and WATRA is making an effort to harmonise the technical requirements for the ISM band amongst member administrations. ECOWAS and WATRA are realising the economic benefits that can be derived from the systematic use of the ISM bands.

### 7.1.3 Universal Service Subsidies

Unlicensed bands can potentially be used for provision of rural connectivity and Universal Service. Given the identified potential for this technology and its low cost, allowing the use of Universal Service funds for wireless projects in these bands may represent a cost effective utilization of the subsidies (Neto, 2004), In a country like Zimbabwe where resource are over stretched universal access can be more meaningful if low cost technological solutions are implemented.

## *7.2 Research Findings*

Wallin (2004) concluded in tests which included 44 different electronic medical products that none of the tested devices affected the communication of Bluetooth. The tests also revealed that Bluetooth did not cause any interference with, or change in operation of, the tested medical devices. Bluetooth operates in the band between 2.4 and 2.48 GHz (ISM) with a power of 1 mW,

Cisco (2002) observed that interference problems are related to the location, frequency, output power, and radio frequency immunity level of the devices.

> *Classic examples of location-related interference that have involved pacemakers and hearing aids are unlikely (although possible) with wireless networking. For example, the feedback condition that may sometimes result from cordless and cellular phones used in close proximity to hearing aids is unlikely to occur with WLAN devices because they are not likely to come into direct contact with a user's body during normal operating conditions. Furthermore, most of the pacemakers that registered notable interference levels were older models that did not have the level of radio frequency immunity found in newer systems.*

Segal (2005) explains that steps to managing the electromagnetic environment in hospitals may include increasing the distance between sources of electromagnetic interference (EMI) and susceptible devices, lowering the power of EMI sources when possible, removing or relocating devices that are highly susceptible to EMI, and labelling susceptible equipment. Staff and patients also should be made more aware of EMI problems. Administrators should consider electromagnetic comparability when purchasing new medical equipment, even though the cost may be greater. Hospital planners should also consider electromagnetic compatibility (EMC), since most walls and floors are not designed to shield equipment from electromagnetic energy.

Although some hospitals have already banned cellular phones and wireless devices, Segal (2005) suggests this may be unnecessary: "To my mind all walkie-talkies, cellular phones and wireless devices should be excluded from critical-care areas, unless it has been demonstrated that a particular wireless device is safe in that environment. Then you should designate areas where [EMI] sources such as cellular phones can be used."

Bekkaoui (2005) distinguishes between two categories of coexistence mechanisms of interfering technologies operating in ism band. The first category addresses the non-collaborative mechanisms: these mechanisms do not exchange information between two wireless networks but operate independently. Individual devices detect the presence of other kinds of devices by measuring the bit or frame error rate, the signal strength, or the signal-to-noise ratio.

Bluetooth devices classify channels and alter the regular hopping sequence to avoid the most interfered channels. The second category discussed by Bekkaoui (2005) addresses the collaborative mechanisms: these mechanisms exchange information between different networks and intend to support coordination between unlicensed radio transceivers by sharing information between them and locally controlling transmissions to avoid interference.

All these research efforts imply that if factors namely coexistence strategies, coordination, location, frequency and power output, of devices operating in the ISM band implemented carefully interference within the 2.4Ghz band can be reduced to a minimum.

# 8.0 The Case for the District of Binga in Zimbabwe

The district of Binga, with a total land area of approximately 13 000 square kilometres, is the second largest in Matabeleland North province. The district lies in the North-western part of Zimbabwe in the Zambezi River Basin. The bordering districts are Kariba, Gokwe North, Gokwe South, Lupane and Hwange. Binga district also shares a national border with Zambia, demarcated along Lake Kariba and more than half of the lake's shoreline is within the district. Binga lies in agro-ecological regions 3, 4 and 5 which are characterised by high temperatures and low rainfall.

### 8.1.1 Binga Statistical Information

Binga district has an approximate population of 121,452 and the population density is estimated at 9 persons per square kilometre (CSO, 2002). Table 1.2 below summarises the population of Binga District and divides the population into wards

***Table 7.1.1 Population Distribution by Ward***

| | | **Female** | **Male** | **Total** |
|---|---|---|---|---|
| Chiefs | | | 17 | 17 |
| Village/Kraal Heads | | | 1000 | 1000 |
| Councillors | | | 21 | 21 |
| **Total Population** | | **54420** | **67032** | **121452** |
| **Ward number** | **Ward** | | | |
| 1 | Nsenga | 2218 | 2507 | 4725 |
| 2 | Pashu | 4666 | 5668 | 10334 |
| 3 | Simatelele | 2340 | 2455 | 4795 |
| 4 | Sinansengwe | 1314 | 1554 | 2868 |
| 5 | Kabuba | 1484 | 1887 | 3374 |
| 6 | Sinampande | 4116 | 4852 | 8968 |
| 7 | Lubu | 1832 | 2431 | 4262 |
| 8 | Chunga | 1644 | 1973 | 3616 |
| 9 | Sianzyundu | 2676 | 3004 | 5380 |
| 10 | Dobola | 1377 | 1992 | 3369 |
| 11 | Siyachilaba | 1229 | 1570 | 2799 |
| 12 | Saba-Lubanda | 1194 | 1449 | 2643 |
| 13 | Chinonge | 2891 | 3296 | 6187 |
| 14 | Muchesu | 4334 | 4999 | 9333 |
| 15 | Manjolo | 1406 | 1818 | 3224 |
| 16 | Lubimbi | 4208 | 4825 | 9033 |
| 17 | Kariangwe | 3943 | 4315 | 8260 |
| 18 | Sikalenge | 2573 | 2803 | 5374 |
| 19 | Tinde | 2169 | 2506 | 4675 |
| 20 | Nabusenga | 1519 | 1853 | 3372 |
| 21 | Sinamagonde | 7225 | 7637 | 14863 |
| | **TOTAL** | **54420** | **67032** | **121452** |

The district is mainly populated by the Tonga or Batonga people, who are the third largest ethnic group in Zimbabwe. There is very little economic activity taking place in Binga district, due largely to poor infrastructure, yet there is potential for development in sectors such as tourism, fisheries, and other related activities. CAMPFIRE activities, comprising hunting safaris, are a major generator of income for the district council. Formal employment in Binga is mostly found in local government institutions and the few Non Governmental Organisations that are present in the district. The majority of the Tonga people eke out a living from fishing, subsistence farming and carving artefacts.

There are 3 hospitals and 8 Rural Health Centres and a total of 47 Nurses, of which 26 are male and 21 are female. General staff in the district consists of 82 males and 36 females. Mainly subsistence agriculture is supported by 3 dams with 2 small irrigation schemes and a total of 13 Agricultural Extension (AREX) Officers and 1 Office. There are two banks, the Peoples Only Savings Bank (POSB) and Agribank. Furthermore there are 7 Police Posts with unreliable radio communication.

## *8.2 State of Telecommunications Infrastructure*

There is a Telephone Exchange at the Binga Centre which forms part of the national backbone linked by a digital radio through a repeater at Kamativi, from Dete. Various parts of Binga were connected to the Main Exchange through a defunct Telone telephone network using Time Division Multiple Access (TDMA) equipment IRT 2000 which operated in the 2,3-2,5 GHz band. Telone has decommissioned the old telephone infrastructure in Binga.

The Sunday News of the 2nd of December 2007 (page 11) quotes Chief Sinansengwe of Binga saying,

> *"We sweat to find away to get to the district. There is no bus and the last bus that was there pulled off the road years back. There is also need to boost our communication system so as to improve information flow."*

## *8.3 Proposed WLAN for Binga District*

The Binga community intends to setup a **POINT TO PONT** WLAN, to connect the various areas of the district to internet through the existing Telone exchange at the Binga Centre. The WLAN should have a low total cost of ownership and yet must deliver a high quality service. Fig 7.3 illustrates the layout of the proposed WLAN. The WLAN should link all the ten identified information technology centres (ITC), from a feasibility study carried out in the district. These ITCs are Binga Centre, Manjolo ITC, Syanzyundu ITC, Tinde ITC, Pashu ITC, Kariangwe ITC, Lusulu ITC, Lubimbi ITC, Siabuwa ITC and Tyunga ITC. There is going to be a possibility of linking the rest of the district, using affordable technologies to internet through these mentioned ITCs. The WLAN will serve schools, the business community and the general community.

Wireless technologies and satellite technologies have shown considerable potential for economic development as they promise the delivery of information to people who needs it most "everywhere all the time", (Neto, 2004). The lack of affordable access to telephone and Internet connectivity for the sparsely scattered majority in Africa, who are not close to even small urban centers, has been a problem because, it is now well-established, the productivity of poor households must increase if they are to rise out of poverty. Increasing productivity is difficult without timely access to information, the ability to network and learn from others, or the ability to interact with markets, governments, and other resources. Economic growth cannot be achieved without improving the efficiency of institutions, markets and businesses through ongoing learning, (Neto, 2004).

The WLAN if successfully established will contribute immensely towards the development of Binga and Zimbabwe in a bigger way.

**This WLAN complements the efforts of the Government as the computers donated to schools by the Honourable President of Zimbabwe will be connected to the internet through these community efforts**.

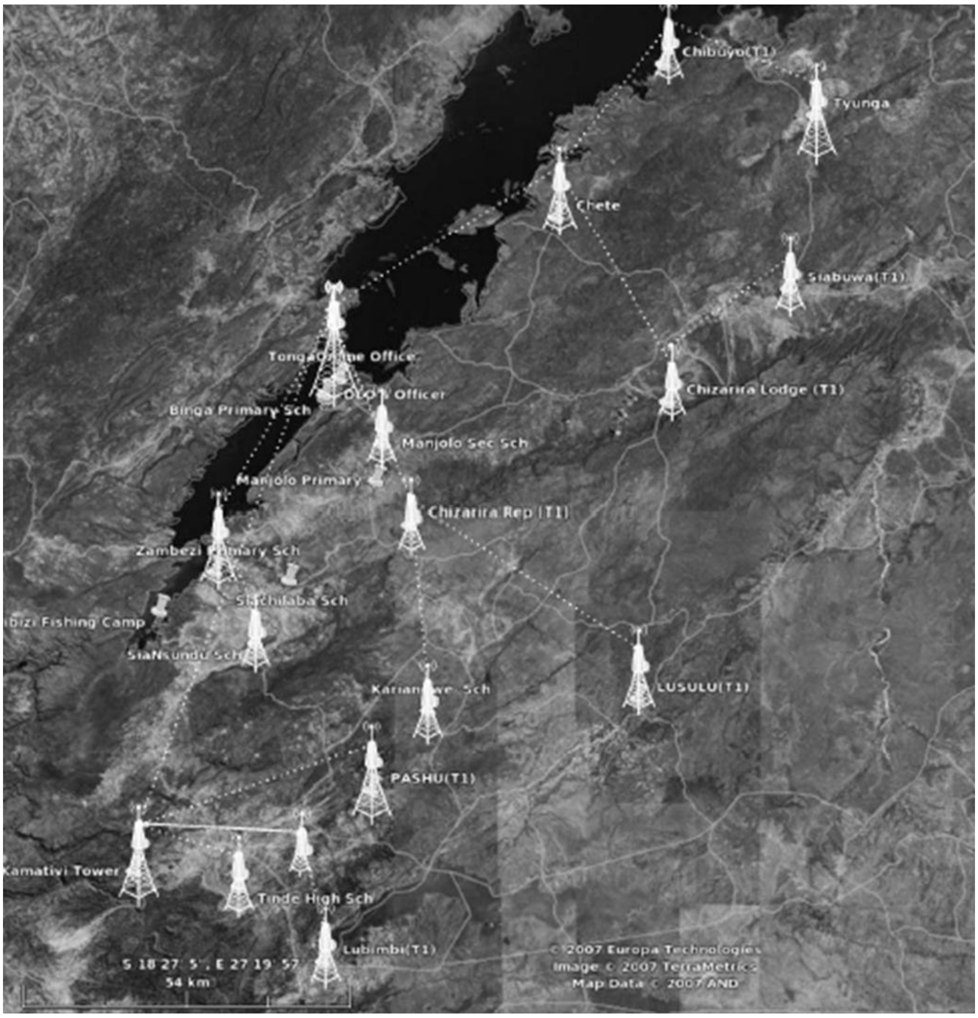


Fig 8.3. Layout of the WLAN proposed for Binga

## *8.4 Requirements for the WLAN*

### 8.4.1 Spectrum Requirements

The Binga community requests through the Binga Rural District Council that Potraz allows that the WLAN operate within the 2.4 Ghz, and 5GHz bands. According to ITU:

**2.400-2.500 GHz (centre frequency 2.450 GHz)**

**5.725-5.875 GHz (centre frequency 5.800 GHz)**

Neta , (2004) reports that this band has witnessed a clear increase in services, access, and innovation in Europe, the USA, and some parts of Africa, encouraged by regulations allowing license-exempt transmission on specific radio bands.

***Frequencies will not be used for commercial purposes, BUT community development only.***

### 8.4.2 Isotropic Radiated Power (EIRP)

**EIRP assignments** by Potraz should be flexible to suite the link distances involved. Line of Sight (LoS) can be as high as 85km, yet in between, in some cases, its not possible to erect a repeater station because:

1. The link goes partly above Lake Kariba and partly above thick forests infested with the wildlife.
2. The link route does not have a source of power.
3. The link route is not accessible i.e. no roads
4. Placing repeaters in unprotected, non-residential, areas is not safe.

**Table 7.4. Illustration of Greatest LoS**

| Link | LoS (km) |
|---|---|
| **Binga Centre Tower to Kamativi Tower** | 85 |
| **Binga Centre Tower to Chete** | 40 |
| **Chizarira Tower to Lusulu Tower** | 45 |

## *8.5 Benefits to District of Binga and Zimbabwe*

### 8.5.1 Low Cost

The socio economic status of the Binga Community demands that infrastructure should be affordable as this project will be funded mainly by the community itself. Most of the technologies to be implemented will be fabricated locally e.g. antennas. Some will even be constructed by the locals. The cost of radios that operate within these frequencies is also very low compared with licensed frequency radios.

Plenty of radios that were decommissioned when the use of the ISM band was banned, is lying idle in industry. The community can utilise some of that equipment for development purposes as some companies have indicated their willingness to donate the equipment if clearance for its use is provided by Potraz.

Neta (2004) has reiterated that ISM band technologies offer the advantage of lowering the cost of upgrading and expanding backbone data networks in underserved areas with point to point wireless transmissions available up to 50 km or more and inexpensive last mile distribution or neighbourhood networks. As the technology evolves wireless has become a very effective, low cost “last mile” solution for those who need universal access most

### 8.5.2 Quick Deployment

The deployment of wireless is quick such that in a short space of time a wide area and broad community base will be covered benefiting.

> *Some features of these wireless technologies including rapid deployment capability, low prices, high system capacity (LAN speeds of up to tens of Mbps over distances ranging from a few meters to several kilometers) are important elements for improving telecommunications infrastructure and access in the ECOWAS region*

### 8.5.3 Low cost of ownership

Maintenance costs will definitely be low as most of the work will be done by locals. Training for the maintenance of this low cost technology will be provided by people who have worked with this technology before. Insurance will therefore not be a very critical factor.

## *8.6 WLAN Beneficiaries of Binga*

The WLAN will benefit schools mainly, however sustainability programs in place demand that immediate communities be involved as users and managers of the facilities.

| **ITC** | **School** | **Existing Telephone Service** |
|---|---|---|
| **Binga Centre** | **Binga High School** | **Yes** |
| | Chininga | No |
| | Msenampongo | No |
| | Nsenga | No |
| | Binga | **Yes** |
| **Manjolo ITC** | **Manjolo High School** | **Yes** |
| | Manjolo | **Yes** |
| | Bulawayo krall | No |
| | Sebungwe | No |
| | Simatelele | No |
| **Syanzyundu ITC** | **Sianzyundu High School** | No |
| | Sianzyundu | No |
| | Saba | No |
| | Zambezi | No |
| | Siachilaba | No |
| | Mangobole | No |
| | Lubanda | No |
| | Gaza | No |
| | Mupambe | No |
| | Junamina | No |
| **Tinde ITC** | **Tinde High School** | No |
| | Malaliya | No |
| | Simbala | No |
| | Chinego | No |
| | Tinde | No |
| **Pashu ITC** | **Pashu High School** | Yes |
| | Mulindi 15 | No |
| | Manyanda 20 | No |
| | Pashu | No |
| | Manyanda 20 | No |
| **Kariangwe ITC** | **Kariyangwe High School** | No |

| | | |
|---|---|---|
| | Lubu | No |
| | Manseme (A) | No |
| | Muchesu | No |
| | Siyanungu | No |
| | Siansali | No |
| | Kariyangwe | No |
| | Tobwe | No |
| **Lusulu ITC** | **Lusulu High School** | No |
| | Kabuba | No |
| | Musazi (A) | No |
| | Nakaluba | No |
| | Sinamagonde | No |
| | Chibila | No |
| | Chipale | No |
| | Zumanana | No |
| | Bmsee | No |
| | Chishizha | No |
| | Gwangwaliba | No |
| | Chuuzya | No |
| **Lubimbi ITC** | **Lubimbi High School** | No |
| | Kamombo | No |
| | Lubimbi I | No |
| | Lubimbi II | No |
| | Siadindi (A) | No |
| | Chinonge | No |
| **Siabuwa ITC** | **Siabuwa High School** | No |
| | Kalungwizi | No |
| | Chitete | No |
| | Mucheni | No |
| | Siansengwe | No |
| | Malube | No |
| | Nagangala | No |
| | Sinampande | No |
| **Tyunga ITC** | **Tyunga High School** | No |
| | Siamupa | No |
| | Sinamwenda | No |
| | Sinamsanga | No |
| | Sizemba | No |
| | Luunga | No |
| Total | 70 | **YES (5)** No ( 65) |

## *8.7 Interference Management strategies for Binga*

### 8.7.1 Coordination of Operators and Frequency Register

The Binga Rural District Council (BRDC) will coordinate all operators of the allocated frequencies so that agreements can be drawn up on changing channels within the bands or changing antenna polarity. BRDC considers that a key first step in this process would be the creation of a frequency register of spectrum assignments by Potraz. This frequency register should contain a core set of technical and location-based information which would form the basis for operators to carry out the necessary interference co-ordinations associated with any proposed change of use and/or trade within a given band. The BRDC would also, in conjunction with Potraz, agree on a common understanding of the technical criteria for calculating interference levels.

### 8.7.2 Use of Available Tools

Some technologies that can be used in frequency management are:

| Technology | Description |
|---|---|
| Orthogonal Frequency Division Multiplexing (OFDM)/Multiple Access (OFDMA) | Breaks the signal into multiple subcarriers; up to 2048 smaller signals. If some signals are negated due to interference, other signals get through such that interference may not be discernible to end user |
| Dynamic Frequency Selection | If interference is occurring on one frequency the transmission dynamically shifts to a different frequency to avoid the interference. |
| Dynamic Bandwidth Allocation | If interference is detected, more bandwidth is allocated to the transmission to strengthen the link budget and overcome the interference |
| Adaptive Antenna Systems (beam forming/steering) | Rather than broadcast over a wide geographic range, a narrow beam is formed between base station and subscriber unit, thus avoiding interference via a strong beam |
| Multiple In/Multiple Out (MIMO) Antennas | Uses multiple antennas at both base station and subscriber unit such that as interference is detected at one frequency, bulk of transmission can shift to another frequency; also boosts throughput via multiple antennas overcoming limitations of a single antenna to overcome interference |
| Software Defined Radios (SDR) | Also known as "smart antenna"; computer associated with the antenna dynamically reads the electromagnetic atmosphere and transmit on best available frequency |

**Table 3 Technologies in the WiMAX specs that mitigate interference potentially enabling successful use of unlicensed spectrum**

### 8.7.3 Other Recommended Best Practices to Minimize the Potential of Interference with Medical Equipment

The BRDC will follow the best practices outlined below are followed to minimize interference.

1. Have a certified installer perform a professional site survey of the facility. This should include a comprehensive study of all devices operating in the radio frequency spectrum in the facility.
2. Have the system installed by qualified professionals.

3. Review the overall layout of the facility and determine areas containing devices prone to interference from wireless as well as various internet work status monitor (ISM) equipment. From this review, you can design antenna "keep out zones," in which access point antennae are mounted several meters away from sensitive equipment to avoid possible problems.
4. Use only properly certified components for the system. This includes only using antennae certified for use with the radios.
5. Develop a frequency-management plan based on the spectrum survey to avoid interference from or with ISM and other onsite wireless equipment.
6. Consider reducing power or reorienting antennas if problems exist or appear.

# 9.0 Conclusion

In Zimbabwe the use of the ISM band for telecommunications and internet networks is illegal. However in other African countries the ISM is being used successfully for the same purpose. Several authorities have established that the ISM band can be used with many advantages in providing ICT for development. This paper recommends for relaxation of the legislation, particularly for rural communities, like the Binga District of Zimbabwe, who are lagging behind in terms Information & Communication Technologies and worse, lack resources to put up basic communication facilities.

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