PROVISION OF BROADBAND INTERNET IN OMAN BY JOINING LTE-A WITH TV WHITE SPACE (TVWS)

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ACRONYMS

CA	Carrier Aggregation
DCI	Downlink Control Information
EPDCCH	Enhanced physical downlink control channel
HS-DSCH	High-Speed Downlink Shared Channel
HS-PDSCH	High-Speed Physical Downlink Shared Channel
HS-SCCH	High-Speed Shared Control Channel
LTE	Long Term Evolution
LTE-A	Long Term Evolution-Advanced
PDCP	Packet Data Convergence Protocol
PDCP	Packet Data Convergence Protocol
PS	Packet Switched
PS	Packet Switched
PBCH	Physical Broadcast Channel
PDCCH	Physical Downlink Control Channel
PDSCH	Physical Downlink Shared Channel
PHY	Physical Layer
PUSCH	Physical Uplink Shared Channel
PLMN	Public Land Mobile Network
UMTS	Universal Mobile Telecommunications System

DEDICATION

It is my genuine gratefulness, warmest regard and honour that I dedicate this work to the greatest leader of our time, the man of peace and tolerance, the builder of the Sultanate of Oman's modern Renaissance, His Majesty Sultan Qaboos bin Said Al Said, the Chief Commander of Armed Forces. May Allah Al-Mighty grant him good health, happiness, and long life.

إهــداء

إنه لمن دواعي الغبطة والسرور وصادق الشكر والامتنان، أتشرف بأن أهدي هذا البحث إلى أعظم قائد في عصرنا، رجل السلام والتسامح وباني النهضة الحديثة لسلطنة عمان، حضرة صاحب الجلالة السلطان قابوس بن سعيد آل سعيد المعظم، القائد الأعلى للقوات المسلحة، حفظه الله ورعاه وأمده بموفور الصحة والسعادة والعمر المديد.

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ABSTRACT

In the last 45 years, the Sultanate of Oman has developed overdramatically and steadily in all aspects of life. This progress has included health, education and transportation sectors along with social and economic areas. The progress has also counted in the telecommunication services with many new land and wireless networks such as fibre optic networks, 3G, 4G/LTE and WiMAX. These telecommunication services have covered major cities and towns in the country, but due to the vast and inhospitable terrains of Oman with its geographical, demographical and social factors, it has been very problematic to cover major rural and urban areas of the country with satisfactory fibre and mobile services for home and mobile users by using one of the current traditional fixed and mobile technologies. Therefore, in this research, we have investigated the feasibility of using Television White Space (TVWS) technology in providing the required internet service by combining it with the ever-evolving Long Term Evolution- Advanced (LTE-A) technology as a solution to the problem mentioned above. For this purpose, and to specify the occupancy of the TVWS spectrum so to suggest a solution based on the LTE-A operating on the TVWS, we have conducted a radio spectrum occupancy measurement survey campaign for 40 MHz to 2800 MHz range. The survey was conducted in five major areas of the country. The campaign has identified that the TV spectrum (470 MHz to 890 MHZ) is idle most of the time. Further, we have implemented our proposed solution through the simulation of the Long-Term Evolution-Advanced (LTE-A) Ver. 12 technology operating in the TV spectrum (470-710 MHz). This type of solution is the first to use Ver. 12 on TVWS even on a simulation level. The simulation approach has been chosen over a real implementation because the technology is still in its early development stage, therefore, the hardware required for the implementation is still out of reach. Our simulation involved planning and implementation of two networks with eight scenarios. One network is our proposed network and the other is the classical LTE network operating

on the 1800 MHz spectrum. The simulation results and analysis have demonstrated that our solution could provide reliable mobile and fixed service to a large number of users in a very large area with high data throughput and good Quality of Service (QoS) by using very little resources such as sites, Base Stations (BSs) and other resources. The simulation has demonstrated that one TVWS Base Station (TVWSBS) could cover up to 110 Km radius area and provide up to 4 Gigabits Per Second (4Gbps) DownLink (DL) and up to 2 Gbps UpLink (UL) data throughput. Therefore, our solution overweighs the traditional LTE/4G network in all aspects.

This type of technology could meet the needs of broadband internet service for rural and congested areas of Oman using most of the existing old TV towers infrastructure and with minimum investment. Therefore, in our research, we are proposing an alternative method of providing broadband internet service that differs from the available traditional methods found in the literature considering the unique particularities of the demographic, geographic, social and environmental factors of Oman.

Additionally, we have outlined TVWS regulations that could be utilised by concerned spectrum authorities in Oman and similar countries. Finally, we have developed an algorithm that could manage TVWS Database (TVWSDB) and could be incorporated in the Service Providers' (SP) network management systems.

1. INTRODUCTION

1.1 BACKGROUND

Over a century ago, when Marconi invented the radio, he undoubtedly could not have envisaged the effects and impact his invention would have on world culture. The innovation progressed from an idea in mind of use by limited people in unique environments to something to which everyone has access in a wider perspective. Today, having a mobile device such as a phone is just about an individual's own civil rights [1].

In order to make a simple radio device operative, radio spectrum is required. Radio spectrum is a component of the electromagnetic spectrum, which is used for radio transmissions. It is composed of a selection of Radio Frequencies (RFs) ranging from extremely low (3 Hz) up to very high (300 GHz) values. There are multiple other applications of RF in most modern-day wireless equipment: as an example, RF is used in automatic door-openers, TVs, mobile telephones, Wireless Area Networks (WANs), Global Positioning Systems (GPSs) and other wireless devices [1], [2].

Despite the Sultanate of Oman having developed rapidly in all aspect of life in the last 45 years, including in the telecommunication sector, nonetheless, much of the countryside, as well as some suburban areas, lack behind in terms of the fixed and mobile broadband services due to the vast country area, with its scattered population and difficult geographical topographies.

This research study has investigated the root of the shortage/absence of fixed and mobile broadband in some parts of Oman that may have contributed to preventing some users from obtaining satisfactory service in their villages during weekends and holidays. The investigation has been clinched from the literature review, an official survey of customer satisfaction carried out by the authority, along with Service Provider websites, and not mentioning the researcher's own personal experience. Furthermore, the problem has been further investigated and confirmed by conducting a spectrum occupancy

measurement campaign, completed for five major urban and suburban areas in Oman. Subsequently, the research has highlighted the current possible solution of the problem through the completion of an in-depth critical study, alongside the ongoing analysis of similar researches and studies, as detailed in Chapter 2 (Literature Review). The literature review has revealed that there are a few possible technology solutions that could be adopted in order to partially solve the mentioned problem. The most promising solution is that of the LTE-A operating on the 900, 1800 and 2600 MHz spectrum. Nonetheless, this technology will incur tremendous financial compulsions for the infrastructure, hardware, personnel and maintenance. Alternatively, the research has identified another possible solution to the problem; the LTE-A operating on the lower TVWS spectrum is a promising solution. Therefore, and due to the early stage of the device development, this research has implemented the solution in the form of simulation using one of the latest version of the ICS Designer from ATDI company. The simulation has confirmed that LTE-A operating on the lower frequencies of TVWS potentially could be adopted for Oman and similar countries in an effort to resolve the problem of the shortage/lack of internet broadband service. Throughout our simulation, we sought to explore the possibility of emulating the LTE-Advanced on the TVWS available spectrum, which was found to be vacant in our spectrum occupancy survey. The following paragraphs in this chapter will introduce the thesis to the reader, followed by other chapters.

1.2 THE STUDY CONTEXT

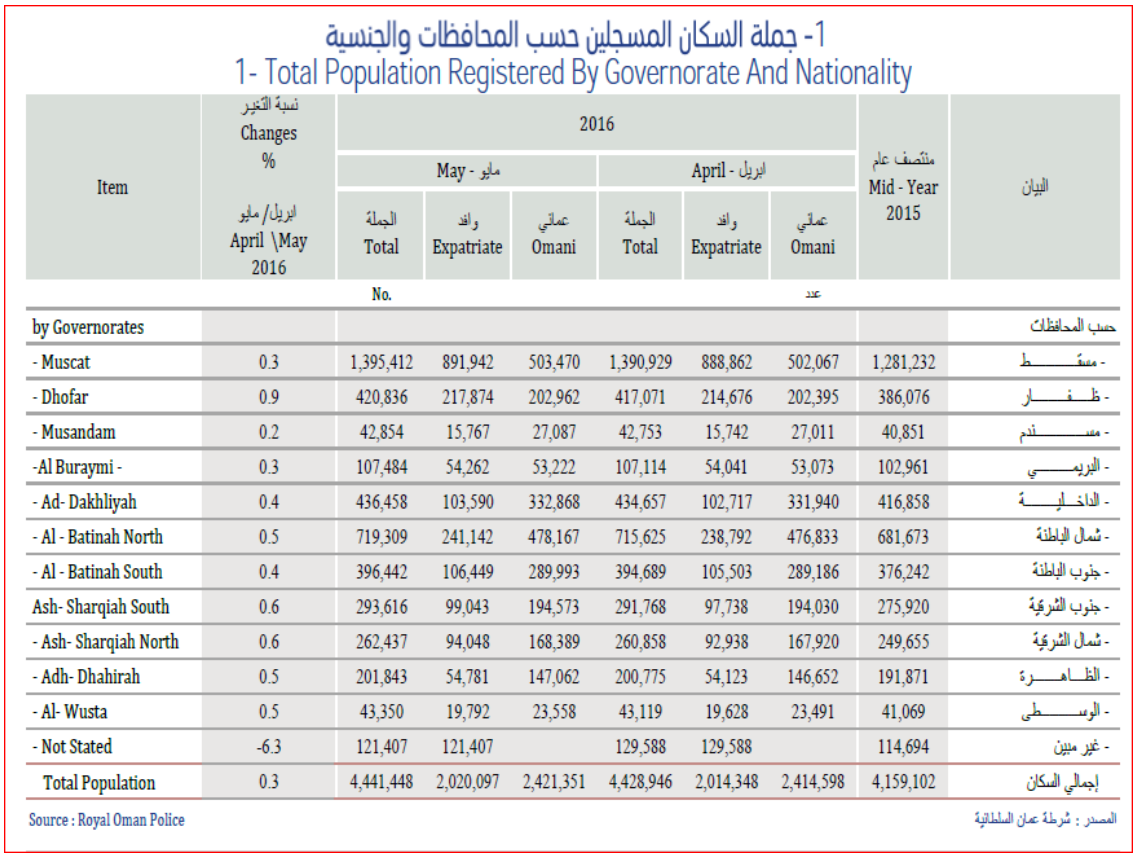
Oman is located in the south-east of the Arabian Peninsula in the Middle East and spans a total area of approximately 310,000 km^2 (Figure.1-1). Its geographical topography comprises high mountain ranges, dry deserts, and lush plains. In addition, the Hajar mountain range forms a high arch spreading from the north-west of the country towards the south-east, with the mountain's highest peak—notably that of Jabal Shams (Mountains of the Sun)—rising to more than 3,000 metres or 10,000 feet above mean sea level. The

Oman coastline stretches for more than 1,700 km. In actual fact, the Omani coastline expands from the Arabian Sea and the entrance to the Indian Ocean at the southwestern fringe to the Sea of Oman and Musandam sector in the north. It oversees the Straits of Hormuz and the door to the Arabian Gulf—a place known to have played a vital role in Oman's overall strategic planning and development [3], [4].

Figure 1-1: Sultanate of Oman's Map

As per the 2016 Oman's National Centre for Census and Information (NCSI) monthly statistical bulletin of May 2016, the population of the country was seen to amount to 4,441,448 as of the end of May 2016, demonstrating a growth rate of 0.3% when compared with mid-2015. The population of Omani residents reached 2,421,351, whereas expatriate

numbers totalled 2,020,096 [5].



1- جملة السكان المسجلين حسب المحافظات والجنسية
1- Total Population Registered By Governorate And Nationality

Item	نسبة التغير Changes % ابريل/مايو April \May 2016	2016						منتصف عام Mid - Year 2015	البيان
		May - مايو			April - ابريل				
		الجملة Total	وافد Expatriate	عماني Omani	الجملة Total	وافد Expatriate	عماني Omani		
		No.					عدد		
by Governorates									حسب المحافظات
- Muscat	0.3	1,395,412	891,942	503,470	1,390,929	888,862	502,067	1,281,232	- مسقط
- Dhofar	0.9	420,836	217,874	202,962	417,071	214,676	202,395	386,076	- ظفار
- Musandam	0.2	42,854	15,767	27,087	42,753	15,742	27,011	40,851	- مسندم
-Al Buraymi -	0.3	107,484	54,262	53,222	107,114	54,041	53,073	102,961	- البريمي
- Ad- Dakhliyah	0.4	436,458	103,590	332,868	434,657	102,717	331,940	416,858	- الداخلية
- Al - Batinah North	0.5	719,309	241,142	478,167	715,625	238,792	476,833	681,673	- شمال الباطنة
- Al - Batinah South	0.4	396,442	106,449	289,993	394,689	105,503	289,186	376,242	- جنوب الباطنة
Ash- Sharqiah South	0.6	293,616	99,043	194,573	291,768	97,738	194,030	275,920	- جنوب الشرقية
- Ash- Sharqiah North	0.6	262,437	94,048	168,389	260,858	92,938	167,920	249,655	- شمال الشرقية
- Adh- Dhahirah	0.5	201,843	54,781	147,062	200,775	54,123	146,652	191,871	- الظاهرة
- Al- Wusta	0.5	43,350	19,792	23,558	43,119	19,628	23,491	41,069	- الوسطى
- Not Stated	-6.3	121,407	121,407		129,588	129,588		114,694	- غير مبين
Total Population	0.3	4,441,448	2,020,097	2,421,351	4,428,946	2,014,348	2,414,598	4,159,102	إجمالي السكان

Source : Royal Oman Police — المصدر : شرطة عمان السلطانية

Table 1-1: Population of Oman [5]

The current data issued by the National Centre for Statistics and Information (NCSI) shows that a bulk of the Sultanate population resides in the Governorate of Muscat—the capital. Muscat's population has been seen to witness growth amounting to 0.3% when compared with the previous month (June 2016), with new population figures amounting to 1,395,412 persons. Muscat also is recognised as the only Governorate where the number of expatriate residents exceeds the variety of Omani populations. The number of expatriates living in the Governorate reached 891,942 persons compared with 503,470 Omani citizens. The Governorate of North Al Batinah taped the second most significant variety of population in the Sultanate, with 719,309 persons, logging a development rate of 0.5%. The number of Omani residents was found to equate to 478,167 persons, compared to 241,142 expatriates. The Governorate of A'Dakhliyah was found to be the third most populated governorate in the Sultanate with 436,458 people, 332,868 of whom are Omanis. The Dhofar Governorate has around 420,836 residents, with 217,874 Omanis

and 202,962 expatriates [5].

The occupants of the South Al Batinah and South A'Sharqiyah similarly tape-recorded a development rate of 0.5%. The inhabitants of the Governorate of South Al Batinah reached 396,442 individuals, including 194,573 Omanis; individuals of the Governorate of South A'Sharqiyah were found to total 293,616 persons, consisting of 194,573 Omanis. In addition, A'Sharqiyah-North and A'Dhahirah recorded 262,437 and 201,483 persons, respectively. Finally, Alburaimi, Alwusta and Musandam Governorates taped 107,484, 43,350 and 42,852 individuals, respectively [5]. Table. 1-1 displays Oman's population as in May 2016.

1.3 THE TELECOMMUNICATION REGULATORY AUTHORITY (TRA)

The Telecommunications Regulatory Authority (TRA) of the Sultanate of Oman was established in 2002 in mind of liberalising and promoting Telecom Services under the Telecommunications Act, as issued under Royal Decree No. 30/2002. The TRA is dedicated to developing the Telecoms sector in the Sultanate through both managing and sustaining telecommunications and related solutions, and encouraging the number of suppliers, as well as named beneficiaries, whilst also ensuring that customers obtain intercontinental standards of telecom solutions, with a sensible range of selection at affordable costs. As a result, it is of the Authority's opinion—as well as in consideration to regulations—that the advancement of facilities and the destination of unknown financial investment into the sector will lead to the promotion of the Sultanate's economic climate, whilst simultaneously enhancing the work skills for residents [6].

At the present time, the National Broadband Strategy is being established so that not only will it be beneficial at a personal level, but also will offer more flexible communication at the organisational level by making it accessible to the economic high-brand web. Accessibility to the broadband net, provided through various innovations and availability systems, will promote intense competition throughout the telecommunications

market. The technique is recognised as being well positioned to improve the competitiveness of the field, in addition to overall commerce in the region [7].

1.4 CURRENT TELECOMMUNICATION REGULATIONS IN OMAN

In 2003, the Council of Ministers sanctioned the General Policy for the liberalisation of the telecom sector, and the updated General Policy Framework was revealed in 2012. The sector now has acknowledged and effectively dealt with mobile operators. Nevertheless, most markets are not yet completely practical.

Oman became involved on a course of market liberalisation and partial privatisation in 2003, under consideration of the Telecommunications Regulatory Act, which established—and continues to manage—the Authority. The Act has subsequently been improved in specific respects. It stipulates that no one is allowed to establish, provide or operate any telecom system or service without obtaining a license from the Authority or officially exempted by Authority [6].

1.4.1 Classes of Licensing

The Act remains prescriptive concerning the method of licensing that may be applied, especially Article 21, which defines three classes of license. In brief, the three classes of license and their related scopes of service provision are as follows [6]:

1.4.1.1 Class 1:

- Creation or operation of open telecommunications network; or
- International telecoms structure; or
- Offering open telecoms services; or
- International right to use to services;
- Issued by a Royal Decree, based upon a proposition by the Minister following the endorsement of the Authority.

1.4.1.2 Class 2:

- The set-up of public telecommunication services that rely on utilising the capacity

of telecommunication network of Class 1 license;

- The provision of several other public telecommunication services that require the internal resources (numbering) to be exploited without abusing any natural resource of the Sultanate.

1.4.1.3 Class 3:

The development or venture of private telecommunication solutions, or otherwise the provision of such types of service by operating an infrastructure, or establishing of a private telecommunications network not linked to the open network or by utilising the capacity of a public telecommunication network.

1.5 THE NATIONAL FREQUENCY ALLOCATIONS AND ASSIGNMENT PLAN

The Oman's National Frequency Allocation Plan comprises a table of frequency allocations that constitute the frequency allocations and the frequency utilisation in the Sultanate of Oman by legal and physical entities, engaged in ordering the development of and the purchase of Radio-Electronic Installations (REI), or in planning frequency usage by the present REI. The table, however, does not present any right for a frequency band use (or a precise frequency) for expansion, production, import and operation of the REI, without the issuance of suitably finalised approval by the Telecommunications Regulatory Authority (TRA); this is authorised for this duty by the Government of the Sultanate of Oman. This table and its related regulations are continuously under the optimisation of TRA for embracing the ever-increasing demands of the radio telecoms sector as far as is compatible with the National Telecoms Act, international trends and existing applications [6], [8].

1.5.1 Description of the Frequency Allocation Table of the TRA

The Frequency Allocation Table (the name of the table) comprises two different categories, namely services and allocations. The first is the primary and secondary services. A band may be allocated to more than one service on a worldwide or regional

basis. These services are as follows:

- Services printed in capitals (for example, FIXED) are referred to as primary services. This is a primary service in areas smaller than a region or a specific county. This is a primary service in that area or country.
- Service printed in normal characters (for example, Mobile) are referred to as secondary services. Devices or stations shall not cause any harmful interferences to stations of primary services to which the frequency has already assigned. Secondary stations could not claim protections from harmful interferences.

The heading of the table comprises four columns: the three left-most columns represent one of the regions, whilst the fourth column presents nationwide frequency allotments. Where an allocation occupies the entire three left columns of the table or just one or two of these three columns, this is a worldwide allocation or regional allocations, respectively. The frequency band described in each allotment is suggested in the left-hand leading corner of the table concerned. The order of radio communication service listing in each band does not suggest relative top priority within each category. In the case that there is a parenthetical adding to an allocation in the table, the service allocation is limited to the type of operation shown. Table -12 shows the allocation of 470 to 862 MHz spectrum [[8].

Column 4 not only indicates the frequency bands but also recognises the category of user permitted to utilise it in the territory of Oman. Amongst the following classifications appointed for each frequency band are:

- ARMED FORCES: Frequency bands provided for solely using stations for the governmental security purpose;
- CIVIL: Frequency bands provided solely for using stations for those functions other than security;
- SHARED: Frequency band offered the shared use of both military and civil user

categories.

460 – 942 MHz

Allocation to services			
Region 1	Region 2	Region 3	Suitanate of Oman
460-470 FIXED MOBILE 5.286AA Meteorological-Satellite (space-to-Earth) 5.287 5.288 5.289 5.290			**460-470 (CIVIL)** FIXED MOBILE 5.286AA Meteorological-Satellite (space-to-Earth) 5.287 5.289
470-790 BROADCASTING 5.149 5.291A 5.294 5.296 5.300 5.304 5.306 5.311A 5.312 5.312A	**470-512** BROADCASTING Fixed Mobile 5.292 5.293	**470-585** FIXED MOBILE BROADCASTING 5.291 5.298	**470-790 (CIVIL)** BROADCASTING Fixed 5.300 Land mobile 5.296 Mobile except aeronautical mobile 5.300 5.149 5.311A
	512-608 BROADCASTING 5.297	**585-610** FIXED MOBILE BROADCASTING RADIONAVIGATION 5.149 5.305 5.306 5.307	
	608-614 RADIO ASTRONOMY Mobile-satellite except aeronautical mobile-satellite (Earth-to-space)		
790-862 FIXED BROADCASTING MOBILE except aeronautical mobile 5.316B 5.317A	**614-698** BROADCASTING Fixed Mobile 5.293 5.309 5.311A	**610-890** FIXED MOBILE 5.313A 5.317A BROADCASTING	**790-862 (CIVIL)** FIXED BROADCASTING MOBILE except aeronautical mobile 5.316B 5.317A
	698-806 BROADCASTING MOBILE 5.313B 5.317A Fixed 5.293 5.309 5.311A		
5.312 5.314 5.315 5.316 5.316A 5.319	**806-890** FIXED MOBILE 5.317A BROADCASTING		5.316A

Table 1-2: Nationwide frequency allotments for Oman and the regions [8]

1.6 TVWS REGULATIONS IN OMAN

Throughout the course of the researcher's discussion with TRA, it became apparent that there are no TVWS regulations in Oman as of yet; at this time, they are in the process of vacating some of the radio spectra in the lower 1GHz and negotiating with the parties concerned to pay some financial incentives prior to 2018, which is the future year for switching to digital switch over. Additionally, and per same discussions with TRA, there is a plan to invite some service providers and device manufacturers for consultation and visit some of the regulators in the world, such as those of Singapore.

1.7 OMAN'S TELECOMMUNICATIONS SERVICE PROVIDERS

There are four major telecommunications companies in Oman, in addition to five reseller companies. The major telecoms companies are Oman Telecommunication (OmanTel), Oman Mobile, OOredoo and Oman Broadband Company (OBC). OmanTel is

the major national telecommunications company and is responsible for the primary infrastructure of land-based communication and home broadband. On the other hand, OmanTel and Ooredoo cover mobile and cellular communication, in addition to wireless internet services, such as 3G, LTE/4G and WiMAX. Additionally, the Oman Broadband Company is a state-owned business, established in 2014 in mind of accelerating broadband deployment in the Sultanate, and handles and devices key strategies in the field of high-speed broadband in Oman. The company offers optical fibre networks for use by qualified operators in the provision of broadband services, such as OmanTel [9].

1.8 TELECOMMUNICATION SERVICES STATISTICS

Oman has witnessed tremendous growth in the telecoms sector since the 1970s due to ever-increasing economic and social prosperity. The government has disbursed a wealth of money towards the building of a modern telecommunication infrastructure, including fibre optic and wireless infrastructure. Service Providers (SPs) have contributed to building such infrastructure, especially wireless communication towers and stations around the Sultanate.

By the end of May 2016, mobile subscribers grew by 0.5% when compared to the end of 2015, reaching 6,677,326 customers with a boost of 30,652 subscribers. Half of these mobile subscribers enjoy mobile broadband service where it exists. Table. 1-3 describes the subscribers' indication and distributions [10].

23 - عدد منتفعي خدمات الاتصالات حسب النوع
23 - No. Of Telecom Subscriber Services By Type

Item	نسبة التغير % أبريل \ ديسمبر Changes % Apr \ Dec (15 \ 16)	2016 مايو May	2016 أبريل Apr	2016 مارس Mar	الجملة في نهاية ديسمبر Total End of Dec 2015	البيان
		No.		عدد		
A- Fixed Line :-						أ- الخط الثابت :-
1- Fixed Post Paid	4.5	339,789	336,175	333,554	325,083	1- الهاتف الثابت (الأجل الدفع)
2- Fixed Pre paid (1)	7.7	60,352	60,475	59,569	56,021	2- الهاتف الثابت (مدفوعة القيمة مسبقا)(1)
3- Public Telephone - pay phones	–	6,801	6,801	6,801	6,801	3- الهواتف العمومية
4- ISDN channels (Equivalent DELS)	-18.5	36,876	45,238	45,244	45,256	4- قنوات الشبكة الرقمية للخدمات المتكاملة
5-WLL Connections	-15.2	1,501	1,754	1,750	1,771	5- الخطوط الثابتة اللاسلكية
Total Fixed Telephones Lines (1+5)	2.4	445,319	450,443	446,918	434,932	- إجمالي خطوط الهاتف الثابت (1-5)
B- Mobile Phone :-						ب- الهاتف المتنقل :-
1- phone post paid mobile	2.5	599,611	597,732	594,558	585,166	1- الهاتف المتنقل (الأجل الدفع)
2- Pre paid mobile	0.3	6,077,715	6,063,434	6,045,312	6,061,508	2- الهاتف المتنقل مدفوع القيمة مسبقا
-Operators	-0.5	5,010,607	5,017,307	5,003,363	5,036,378	- مشغلين
-Resellers	4.1	1,067,108	1,046,127	1,041,949	1,025,130	- إعادة البيع
Total Mobile Subscribers (1+2)	0.5	6,677,326	6,661,166	6,639,870	6,646,674	- إجمالي منتفعي الهواتف المتنقلة (1+2)
C-Internet Services :-						ج- خدمات الإنترنت :-
1 -Total Internet Subscribers (Dial-up)	-4.7	2,641	2,656	2,672	2,771	1 -إجمالي منتفعي الإنترنت بواسطة الاتصال الهاتفي:-
1-1 Post Paid	-4.7	2,641	2,656	2,672	2,771	1-1 الأجل الدفع
1-2 Pre paid	–	0	0	0	–	1-2 المدفوعة القيمة مسبقا
2 -Total Fixed Broadband Subscribers(2)	10.7	258,254	254,178	250,214	233,233	2-إجمالي عدد منتفعي خدمة النطاق العريض الثابتة (2)
-Total Internet Subscribers (1+2)	10.5	260,895	256,834	252,886	236,004	- إجمالي منتفعي الإنترنت (1+2)
- Active Mobile Broadband Subscribers	4.1	3,387,767	3,385,544	3,377,913	3,253,949	- عدد المنتفعين النشطين للانترنت ذو النطاق العريض بالهاتف المتنقل
-No. of National Leased Circuits	1.1	3,858	3,858	3,832	3,815	- عدد الدوائر المحلية المؤجرة

1- Card fixed Telephone
2-Include DSL , Wireless and Wi Max
Source:- Telecommunications Regulatory Authority

1- بطاقات الهاتف الثابت
2- تشمل خدمة DSL والخطوط المؤجرة و واي ماكس
المصدر:- هيئة تنظيم الاتصالات

Table 1-3: Subscribers' indicator, End of 2015 -May 2016 [10]

Additionally, fixed broadband service covered more than 258 thousand homes and businesses. It is noticeable that fixed lines again are increasing due to the fact they are shared with the fixed broadband installation.

1.9 DEFINING THE RESEARCH PROBLEM

Radio Spectrum is an intangible, precious, natural resource that cannot be exhausted; however, the spectrum, in fact, is not infinite. Accordingly, so as to ensure its efficient usage, Spectrum Regulations have been established and practised worldwide. The procedures implemented in mind of Spectrum Management almost a century back have been found to be satisfactory; however, in the last few years, a higher usage of wireless transmission—in addition to a greater demand for spectrum—has necessitated Spectrum Regulatory Authorities in the making of revisions to their procedures. Furthermore, studies carried out in the contexts of North America, Europe, Japan, Oman (in this research) and other countries have found that 30–80% of the current licensed spectrum remains idle most

of the time, whilst the unlicensed spectrum remains saturated most of the time [11].

1.9.1 Saturation of Unlicensed Radio Spectrum around the World

Since the start of the 20th Century, when opportunities concerning wireless communications through electromagnetic radiation initially were witnessed, a fixed allocation policy was successful in radio spectrum utilisation. Nonetheless, during the course of the last two decades, for example, in line with the use and requirements of radio spectrum substantially increasing, the disadvantages of the fixed-allocation plan have fallen into the spotlight. Amongst other factors that have contributed to the unlicensed spectrum saturation, the most important factor is the high demand for bandwidth, as necessitated by new wireless devices, either when they communicate with Service Providers (SPs) or when communicating with one another [11]. Moreover, the extensive data exchange recognised between cell towers and landlines also is regarded as an important factor for congestion. To add to the problem, new smartphones, as well as other wireless devices, and their usage of Cloud Computing and Online Storage, has made the issue more severe: for example, any new smartphone/tablet can synchronise a picture to many other mobile or fixed devices, with a 1MB image resulting in tens of Megabytes of network traffic [12].

In order to address the issue, as mentioned above, many new policies have been introduced to the world: for instance, as an option concerned with efficiently maximising spectrum, different versatile radio spectrum allocation policies have been recommended. In an attempt to add to the opportunity to embrace flexible spectrum access as a different radio frequency regulation element, there are many different types of research and study that have suggested the adoption of Dynamic Spectrum Access (DSA) [13], [14].

DSA is based upon Cognitive Radio (CR) emerging technology, which allows secondary users (unlicensed) to gain temporary access to licensed spectrum allocated to paid users (authorised), provided that the individually licensed spectrum is free to use.

This type of access is termed ‘obtaining the spectrum opportunistically’. It is envisaged that such a plan eventually will decrease the hassle underpinning the existing spectrum allocation policy, without risking the overall efficiency of existing radio arrangements [13].

1.9.2 Limitations of Broadband Services in Oman

Although there is home broadband, 3G and 4G/LTE service in some major urban areas in Oman, the coverage is limited to residential and commercial centres and open areas in the major cities and towns. The service also is restricted to various suburban and rural areas. Many factors have contributed to this limited mobile broadband in Oman, as we will see in the following paragraphs. In fact, according to the Information Technology Authority (ITA)’s survey conducted on February 14, 2014, which involved 11,000 households, approximately 80% of household have internet access. The same study also revealed that 70% of all web users believe that they usually suffer from extremely low internet speeds, with the cost considered to be too high [15].

Rural areas in Oman, much like any other rural areas around the world, need network and internet access of some type. Not only does network access offer rural folks standard web-browsing, online shopping, and other information benefits that many people appreciate, but also networks could be utilised within the farmlands of rural areas in Oman. Farmers can use networked systems to keep track of crops and animals, and even operate specific equipment through the use of long distance/remote control; this allows farmers’ time and trouble in maintaining land observations in person, or the control of all devices by hand, to be converged. Individuals living in rural areas likewise could require connections to a network through which they can receive essential weather, climatic and other safety details. Many of the persons residing in metropolitan locations or in major cities take such types of service for granted; for rural folk, however, a reliable high-speed internet service is a luxury they can only imagine. In the countryside, regular internet

access often is extremely slow and costly at best, and non-existent at worst. Problems in installing and maintaining long lengths of wire across sparse populations of rural areas mean wired connections are both unappealing and expensive. Wireless is a potentially valuable method for providing rural areas in Oman with high-speed internet [16].

As per the author's knowledge, the majority of the manpower employed as working in the major cities belongs to the countryside; therefore, they travel back to their hometowns and villages for weekends and holidays. Accordingly, in the main cities, there is a high demand for mobile internet service during weekdays, which causes spectrum saturation. On the other hand, there is a substantial relief during weekends and major holidays as a result of temporary migration. As for internet services during weekdays, the majority of working individuals are linked to the mobile internet, such as through smartphones and laptops via 3G, 4G/LTE or WiMAX, in addition to Wi-Fi, which is found in residences and public places, such as cafés, airports, and shopping centres.

1.9.3 Internet Service Limitations in Oman

During 2012, the TRA carried out a local country-wide field study aimed at identifying the number of unserved and under-served villages and towns lacking telecommunication services across the nine areas in Oman; the survey covered around 2,577 cities of 5,143 villages. The feedback from the study was input into a primary database, assembled with the 2010 Census Data, in addition to operators' coverage reports; these then were analysed and evaluated. The table below supplies a brief overview of the study: of the 5,143 villages, 3,385 villages (65.81%) were found to be covered by some telecom services, whilst 434 villages (8.43%) were covered by 3G services, whereas nine villages (0.17%) were covered by 4G (Table. 1-4) [17].

Description	No. of villages/towns	% of total
Overall No. of villages listed in Census 2010	5,143	100%
Total No. of villages surveyed	2,577	50.10%
Overall No. of villages already covered by telecom services	3,385	65.81%
• Already covered with Fixed Service	1,187	23.08%
• Already covered with 2G Mobile Service	3,306	64.28%
• Already covered with 3G Mobile Service	434	8.43%
• Already proposed/planned under Nawras WiMax rollout	1,431	27.74%
• Already covered by Omantel LTE (4G)	9	0.17%
Overall No. of Un-served Villages including villages with zero population	1,759	34.20%
• Total No. of un served Villages only with zero population or Housing Units	929	18.06%
• Net Total of Un-served villages	830	16.13%

Table 1-4: Survey of un-served-under-served settlements [17]

1.9.4 Price Benchmarking Research of Retail Telecom Services

The Telecommunications Regulatory Authority (TRA) introduced a Price Benchmarking research centred on retail telecom services, utilising a sample from the Sultan Qaboos University. Strategy Analytics Ltd—notably an independent consulting company based in the United Kingdom— offered professional input to the research study. The most recent survey compared the rates of the telecoms services in the Sultanate of Oman with those of GCC countries, as well as some handpicked nations similar to Oman, such as Jordan, Tunisia and Malaysia, and the UK (Table.1-5) [18].

Service	Omani Average prices compared with GCC countries	Omani Average prices compared with all selected countries
Fixed voice, Residential	🟡	🟡
Fixed voice, Business	🟡	🟡
Fixed broadband, Residential	🔴	🔴
Fixed broadband, Business	🟡	🔴
Mobile voice, Post-paid	🔴	🔴
Mobile voice, Pre-paid	🔴	🔴
Mobile voice, Business	🔴	🟡
Mobile broadband, Low usage	🟢	🟡
Mobile broadband, High usage	🔴	🔴
International calls from Fixed lines	🟢	-
International calls from Mobile	🟢	-

Prices above average 🔴
Prices close to average 🟡
Prices below average 🟢

Table 1-5: Price Benchmark Study Findings [18]

The TRA's research study was designed in mind of standardising the costs of retail telecom services for Fixed Voice, Mobile Voice, and Data, Mobile Broadband, Fixed Broadband and International calls across selected countries, with a comparison conducted in mind of rates to all readily available offers, highlighting the most affordable end-user charges for a package of services [18].

Rates are recognised as a function of numerous variables primarily consisting of competitor level, population density, operational and capital expense, service quality requirements, government taxes and costs. In order to ensure the contrast is sensible and implementable, a conventional usage profile was created with the aid of real data for each of such services in Oman, complete with the costs of various services gathered on the same data from the chosen nations. Prices then were computed for the same use profile in different countries, based upon Purchasing Power Parity (PPP).

With services converging, the service providers offered various service packages and price plans to fulfil the diverse needs associated with different users. The study supplies just an overall basic evaluation of rate level; whilst comparing the prices of chosen retail services with those of benchmark countries, the report highlights Oman's overall ranking in comparison to the countries chosen. This research similarly analyses Oman's position compared to a prior works completed in 2012. Concerning the table below, the prices for fixed broadband residential, mobile voice and mobile broadband for high usage are high when compared with the GCC and other selected countries [18].

As was mentioned, Salalah City and the entire Dhofar region were recognised as major summer holiday destinations for Omanis and other Arabian Gulf vacationers. The Manson rain season begins on June 21st and lasts until September 21st each year. During the period of scorching weather in the rest of the country, as well as in neighbouring countries, it is fresh and pleasant, with drizzling rain in Salalah and across its high mountainous areas. A great and continuous moist breeze also is witnessed throughout this

season [4].

Throughout the daytime, vacationers, along with locals, are scattered around the area, visiting major natural attractions, such as water springs, waterfalls, deep valleys, caves and other attractions. Most families prefer to picnic around those attractions, with almost every adult utilising high specification smartphones and smart pads. The recent mobile internet coverage is limited to major areas, with those regions mentioned demonstrating very limited or no internet services. The Salalah's 180K population quadruples during the period; this results in a high demand for mobile services, including mobile broadband, which is required to send personal videos and pictures. The visitors, along with the locals, demand high-speed wireless broadband services to exchange such images and data with families in the Sultanate and across GCC countries. The demand is increasing every season, not only as a result of the increase in visitor numbers but also due to the high demand for new broadband-hungry smartphones and wireless devices, along with new drones' high-definition video cameras. In order to verify this further, the National Centre for Statistics and Information (NCSI) reports that the total number of international and regional Khareef Salalah visitors recorded during the period of June 21–August 30, 2014 stood at 415,209, compared with 399,747 visitors during the very same duration of 2013, thus representing an increase of 3.9%. The majority of Khareef Salalah visitors were Omani, representing 76.2% of total visitor numbers, whilst other GCC citizens represent 16.1% of the total visitor count [19].

Breaking down the visitor figures in terms of geographical origin, the NCSI statistics reveal that the overall number of GCC visitors (also comprising Omanis) increased by 3.9% over the stated period this year, equating to 383,434 visitors, compared with 369,139 visitors over the same period in 2013. Meanwhile, the overall variety of visitors from other Arab non-GCC countries taped a substantial increase of 71.5%, standing at 7,129 visitors compared with 4,157 visitors tape-recorded over the same period in 2014.

On the other hand, the broad variation of visitors from Asian nations decreased by 8.9%, from 24,178 visitors in 2013 to 22,021 visitors this year [19].

The overall number of Khareef Salalah 2014 visitors from European countries witnessed an increase by 2.1%, recording 1,634 visitors in 2014 compared with 1,600 visitors in the year before. Similarly, the overall number of visitors from American Continents rose 33%, recording 556 visitors this year compared to 418 visitors in 2013; the variety of visitors from African nations reduced by 16.6%, standing at 121 visitors in 2014 compared to 145 visitors recorded over the same duration in 2013. The variety of visitors from Oceania increased by 20.2%, totalling 131 visitors compared with 109 guests over the same period last year [19].

1.10 COMPLICATIONS OF EXTENDING BROADBAND INFRASTRUCTURE IN RURAL AREAS

All broadband networks require significant upfront financial investments before the first client is served. Moreover, in the case of a potential wired network, they also would consist of the installation of fibre optic cables on a street or, in the event of a possible wireless network, the installation of antennas on a base station tower, with the backhaul connection supplied to the tower. Both types of investment are frequently referred to as ‘dealt with investments’ as they usually do not substantially vary in terms of a consumer’s use of the network [20].

Broadband networks, in a comparable vein, incur operating expenses; these costs consist of various products, such as network maintenance, electricity, and help desk services. A few of these operating expenses are relatively fixed in nature and do not substantially differ in line with customer use. Such expenditures consist of the maintenance of the central part of a network: for instance, a trunk fibre optic wire for a wired system or a radio tower as a telecasting system. Other operating expenses differ in terms of consumer usage, such as help desks or connection costs [20].

The capacity of a given fibre optic system or radio tower is not infinite; therefore, at some level of use, other consumers produce the requirement for more substructure; this is evident in the design of mobile networks. As a cell inside a cellular network reaches ability, it is changed with several smaller sized cells that enhance overall capability through allowing the added reuse of radio spectrum, albeit at the additional cost of added cell sites. Alternatively, more radio spectrum could improve the network; once more, this is just an added cost for spectrum and for devices to exploit the additional spectrum [20], [21].

In the provision of broadband services, an important driver in expenses—both in terms of maintenance and operation—is the physical density of the population served: the more clients along with a street or within the range of a radio tower, the more costs are expanded over customers. The maintenance expenses associated with a more substantially utilised radio tower are spread out over a larger number of consumers [20], [22].

However, there is promising plans set-up by TRA and service providers to provide 4G services to selected areas of the country. This plan will be costly and time-consuming, and it will not cover major areas; therefore, there is a need to identify and consider a new technology that is capable of providing more efficient services to the countryside at a minimum cost [23]. In consideration of this need, LTE-A and TVWS is recognised as a potential technology with the capability to provide such services to those areas in Oman and other countries experiencing similar issues.

As can be seen from the above, the conclusion may be drawn that there are limited broadband internet services in Oman due to difficult geography and scattered population with more than six million mobile telephones.

1.11 AVAILABILITY OF THE INTERNET IN OMAN

As has been ascertained in the previous sections, we can see that there are very limited, fixed and mobile internet services available in most rural areas of Oman as a result of the vast and hostile environment and geography of the country. As displayed in Figure 1 and

Figure 2, the 4G/LTE services are limited to the centre of major cities in Oman, whilst fibre broadband also has started to cover some of the major cities in the country [24].

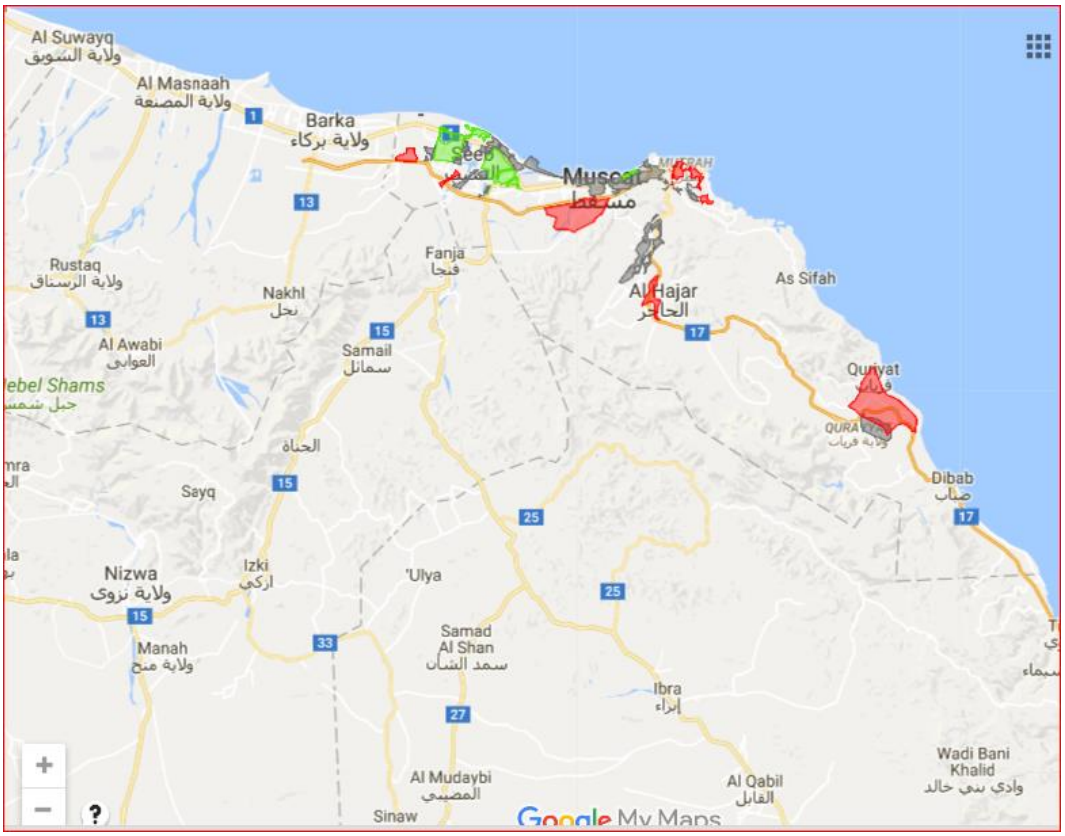


Figure 1-2: Oman Fibre Optic Network as of July 2016 [24]

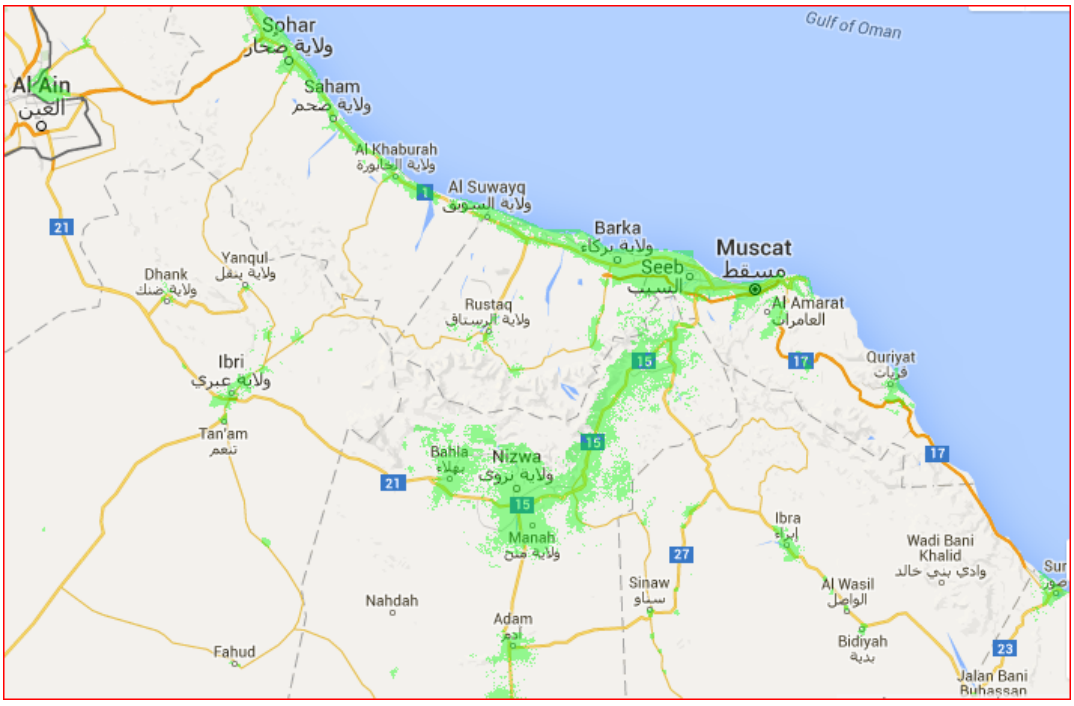


Figure 1-3: OmanMobile 4G Coverage as of July 2016

Figure 1-4: OOREDOO 4G Coverage as of July 2016

1.12 SUMMARY OF THE RESEARCH PROBLEM

To summarise the problem this research is seeking to solve, there is an absence/shortage of internet service broadband across the rural areas of Oman as a result of the incompatible terrain, such as high mountains, deserts, and scattered population, notably spanning a large country. Furthermore, there are high costs associated with introducing current technology in the provision of such a service, with limited technological solutions able to be implemented in an effort to solve the problem; existing technologies, if implemented, would induce very high costs and would be very difficult to achieve the required goals in the near future due to the long time required to implement such solution.

In consideration of the problem apparent across Oman, Table 1-6 summarises and compares the existing and futuristic broadband technology that may be able to solve the issue under examination, along with advantages and disadvantages.

Solution	Advantages	Disadvantages
Fibre	Very fast, reliable and Operational	Significant investment, Limited coverage
ADSL	Operational	Slow, big investment and Limited access in rural areas
Satellites	Fast, big coverage and operational	Significant investment, costly
3G/4G/LTE/WiMAX	Fast	Significant investment, Limited coverage and range
TVWS	Long range, NLOS, Big coverage areas	Limited speed, At testbed level
LTE-A on TVWS	Long Range, Big coverage areas, NLOS, Fast, Little investment	On final development
Wi-Fi	Very Fast and very inexpensive	Requires one of the above technology to access the Internet. Very limited coverage areas.

Table 1-6: A Comparison of Broadband Services (Advantages and Disadvantages)

1.13 RESEARCH QUESTION, AIMS AND OBJECTIVES

Due to the vast area of unfriendly topography and scattered villages and population in Oman, and also as a result of temporary population migration from large cities and towns to small villages and countryside during weekends and public holy days, authorities and Service Provider (SPs) are facing significant challenges and obstacles in the provision of reliable fixed and mobile broadband services to many medium-sized and small villages located around the country, especially across the more mountainous and desert areas. Furthermore, rural areas also are seen to be lagging in broadband service because of the same reasons.

1.13.1 Research Question

Referencing Chapter, I, and the attention directed towards the research problem under examination, there exists limited broadband service in major urban, suburban, and rural areas of Oman, with its young educated population. The demand for better service is growing with the growth of the young population, along with the rapid advancement in the fixed and mobile data hungry devices, which, in turn, results in the need to establish a solution to this issue. Therefore, if nothing is to be done soon, the problem will intensify dramatically. Accordingly, the following research question has been devised:

How can broadband internet be provisioned/enhanced in the Sultanate of Oman's major urban, suburban and countryside areas, incurring only minimum financial costs whilst achieving high coverage and speed?

1.13.2 Aim

The uppermost purpose of this research work is to *propose a proven solution* centred on improving broadband internet services in Oman, including the extension of service to major countryside areas in the regions lacking the service. The solution also would be aimed at improving the availability, quality and speed of the current broadband service in major urban and suburban areas.

1.13.3 Objectives

This research work will explore the following areas concerning telecommunications in Oman:

- To analyse the currently licensed radio spectrum utilisation/occupancy in some major cities and rural areas.
- To evaluate the current broadband internet limitations and obstacles inherent in the main towns and rural areas.
- To review the current solutions available in the literature and related work, and technologies that can help to improve the current domain of the broadband internet.
- To find the most efficient technology that is capable of meeting Oman's requirement which could be useful in improving the sector under examination.
- To implement the proposed solution using one of the network simulators and analyse, report and validate the results
- To develop TVWS recommendations and regulations framework for telecommunication authority and service providers.

1.14 RELATED WORK

In the literature review of Chapter 2, we review and investigate various solutions, focusing on the TVWS geolocation databases solution and the LTE-A operating on the TVWS and 2.6 GHz spectrums. Some of those studies are summarised below.

1.14.1 Recent TVWS Projects

The Office of Communications (Ofcom)—the telecommunication regulatory of the UK—has given manufacturing companies a green light to gain the benefits of a ground-breaking new wireless technology of TVWS spectrum (470-790 MHz). The decision was revealed after a sequence of effective preliminary industry experiments and trials, and after consultation with stakeholders. The access to the TVWS spectrum would be on the geolocation database techniques [25], [26].

In September 2013, South Africa (Cape Town) conducted several experiments of the TVWS technology following the issuance of a draft report and recommendation of regulations, driven from the trials. The TVWS network included several BSs situated at Stellenbosch University's Faculty of Medicine and Health Sciences in Tygerberg, Cape Town, which provided broadband internet service to ten schools within a 10-kilometre distance. The schools had been pre-selected based on closeness to the BSs, neighbouring IT and network support, and also various other connectivity requirements. Each school obtains dedicated 2.5 Mbps service with similar to ADSL in order to avoid downtime during institution hours [27].

Google, Microsoft and regulatory authorities in Kenya are piloting TVWS technology, tailored to allowing connectivity in country areas and eliminating obstacles for small companies interested in internet company stipulation [28]. Microsoft India is also experimenting with TVWS technology in rural areas of India in mind of providing free internet to India using TVWS technology. However, Microsoft India has

recommended that the spectrum needed for 'White-Fi' be provided free for it to be able to roll out the technology on a mass scale. Microsoft has declared it has no intent of ending up being a solution supplier and that the company will encourage regional business owners to supply last-mile connectivity in areas that are difficult for telecom provider to get to. Nonetheless, the plan may not prove acceptable to the federal government. Union minister for communications and IT informed that spectrum will only be assigned with the auction and also no exemptions will be made. He also indicated that the federal government will not give any kind of spectrum without public auction and the only exception will be for the defence and also the protection establishments he, nonetheless, said the federal government is considering Microsoft's proposal [29].

On 27 April 2016, Carlson Wireless Technologies, Inc. California—an international leader in TV White Space (TVWS) technology—introduced its third generation TVWS chip component, the Picasso Gen3, to the global market. The component was developed as part of an ongoing close partnership between Carlson Wireless and MediaTek—recognised as a market leader in wireless communications chip layout. Carlson’s Gen3 revolutionises the economics of TVWS by substantially lowering device, as well as linked infrastructure prices, whilst improving broadband throughput and also IEEE 802.11af interoperability, making robust and budget-friendly broadband connectivity viable for many of individuals [30], [26].

Utilising low-band spectrum in vacant UHF TV frequencies and also the new IEEE 802.11af Wi-Fi standard, Carlson's Picasso Gen3 chip will permit many customers to receive a reliable broadband link with data download accelerate to 96 Mbps from a single base station. The range of the UHF signal is 3–5 times above a traditional microwave Wi-Fi signal. The big CapEx, and also OpEx savings, is realised by a 10X decrease in a number of base stations required. Different from other wireless technologies, Carlson’s Gen3 low-band non-line-of-sight (NLOS) signal passes through wall surfaces, trees,

vegetation, and over hillsides and long distance [30].

1.14.1.1 LTE-Advanced at 2.6 GHz and 800 MHz

One of the simulated network published papers contrasts the downlink throughput performance of LTE-Advanced in two various frequency bands. It additionally deals with the impact of smartphone orientation, with results quoted for three various elevation angles. It considers the higher LTE-Advanced band at 2.6 GHz, as well as the TV white space band at 800 MHz. The radio network is modelled utilising an advanced 3D ray-tracking device combined with gauged 3D radiation patterns for the BS and mobile phone antennas [31]. The throughput performance for a great deal of BS and also mobile device locations is explored in two various UK cities, both of which use the computationally reliable received bit data rate formula developed by the paper's authors to calculate packet error rate as a feature of network structure as well as Signal to Noise Radio (SNR). The method minimises simulation runtime by a factor of greater than 300. Comparable ordinary throughput vs SNR results is observed in both regularity bands; however, greater K-factor and overall obtained power levels are observed when the customer devices are tilted to 45° in altitude. Throughput results demonstrate, to that the effectiveness of service provider aggregation in between LTE and also TVWS bands, relies on the cell dimension and also the kind of city environment [31].

1.14.1.2 LTE System Release 8 on 2,500-2,690 MHz and 470-710 MHz

Another paper has been published on prototype TVWS BS and also ND that is readily available in the TVWS. In order to garner an understanding of the communication in the TV band, UHF converters are linked to off-the-shelf LTE eNodeB (eNB) and data card, and further transform a communication frequency from the existing band to the UHF band. In that paper, the LTE system is based on Release 8 using 2.6 GHz is used as the existing band 38 (2,570-2,620 MHz) for the TDD mode and Band 7 (Uplink: 2,500-2,570 MHz, Downlink: 2,620-2,690 MHz) for the FDD method. A protected frequency range in the TVWS spectrum is 470-710 MHz [32].

The off-the-shelf eNB contains two primary boards: one is a baseband board based upon the LTE Release 8, whilst the other two are RF boards for FDD Band 7 and also TDD Band 38. A UHF converter, with its control board, is attached to both TDD, and also FDD RF boards separately, and converts an RF from 2.6 GHz to UHF. It is recognised that a user interface of the control board is the Universal Serial Bus (USB) user interface [32].

		System Load		
		Low	***Medium***	***High***
TVWS Bandwidth	***1.4 MHz***	10 km	15 km	20 km
	5 MHz	20 km	22 km	25 km
	20 MHz	25 km	30 km	35 km

Table 1-7: Distance Covered According to BW [32]

		System Load		
		Low	***Medium***	***High***
TVWS Bandwidth	***1.4 MHz***	940 kbit/s	320 kbit/s	130 kbit/s
	5 MHz	780 kbit/s	310 kbit/s	120 kbit/s
	20 MHz	770 kbit/s	300 kbit/s	110 kbit/s

Table 1-8: Data Throughput According to BW [32]

1.14.1.3 LTE-Advanced using a Combination of the 800 MHZ and 2.6 MHz

Another study case of simulating the LTE-Advanced network using a combination of the 800 MHZ (upper TV spectrum limit) and higher 2.6 MHz license-free spectrum (carrier aggregation) has been accomplished. The simulation was for two locations, namely 4 km x 4.4 km area in the city centre of Bristol, and an 11 km x 13 km area in the centre of London. The total number of BSs in each location was 23 BSs and three sectors in each BS. The total stationary subscribers (Ns) in each sector amounted to 300, located 50m–1000m from BS. With 10 MHz bandwidth and 43 dBm BS transmit power, and by using 64 QAM modulation and 4/5 code rate, the maximum data rate was found to be 40.32 Mbps (Table.1-9) [31].

TABLE I
CHANNEL MODEL PARAMETERS

Parameter		Value
LTE Advanced Bandwidth		10 MHZ
Carrier Frequency		800 MHz, 2.6 GHz
Number of BS		23
Number of Sectors		3
Number of UE per Sector		300
BS heights (m)	Bristol	24, 31, 33, 10, 27, 27, 34, 45,77, 50, 9, 7, 28, 13,7, 10, 21, 30, 23, 9, 48, 28, 12
	London	25, 61, 18, 18, 43, 26, 15, 24, 37, 59, 114, 74, 30, 92, 8, 57, 122, 60, 82, 58, 43, 28,49
UE height (m)		1.5
UE locations		50 m-1000m from BS
BS transmit power (dBm)		43
BS antenna type		6 dual polarised uniform linear array
UE antenna type		(Omni-directional) NOKIA mobile phone
Antenna 3dB azimuth/elevation beamwidth	BS	65°/15°
	UE	360°/36°
BS antenna downtilt		10°
UE rotation		Azimuth = 0°, Elevation = 0°, 45°, 90°
User mobility (m/s)		0

Table 1-9: LTE-Advanced using a combination of the 800 MHz and 2.6 MHz [31]

1.15 OUR PROPOSED SOLUTION

In the Literature Review chapter, we have completed an in-depth review and investigation of a number of solutions that are likely to solve the identified problem, including the expansion of broadband internet to rural areas. Unfortunately, however, all these solutions will require tremendous financial investment required for implementations, maintenance, labour and recurrent cost. Most of the solutions have been tested, experimented or simulated in greenfield or with limited users and base stations, not mentioning small scale deployments. If we must select one of them to solve the problem, it would require expansion of the current infrastructure, including a very large number of BSs, along with towers, and a connection to internet back hole and gateway. Accordingly, the proposed solutions mentioned above, as well as others, have proven not to satisfy our sought solution owing to the fact they all fall short of our required needs of coverage area and data throughput. Therefore, we propose the LTE-A (Ver. 12 and above) on TVWS spectrum (470-710 MHz) be enhanced and implemented, which we believe would offer a

practical and cheaper alternative solution to most of Oman's—and similar countries'—broadband internet service issues. Due to hardware nonexistence, so far, the proposed implementation would be in the form of simulation using one of the most advanced and accurate simulators in the field. The main differences between proposed technologies in the literature and our proposal are listed in Table. 1-10 below:

Network	Frequency	Band Width	Obstacle Penetration	Coverage Radios	DL	UL
LTE-A-TVWS (Our Solution)	590 MHz	120000 MHz	Excellent	Up to 110 Km	Up to 4 Gbps	Up to 2 Gbps
LTE-A	1800/2600 MHz	20 MHz	Medium	< 6 Km Radios	Up to 200 Mbps	Up to 100 Mbps

Table 1-10: Comparison between Our Proposed Solution and the Current Technologies

The main idea underpinning the deployment of the LTE-A on the TVWS network is to complement the existing fixed, 3G and LTE/4G networks as fixed/wireless broadband internet service, where such exist in one form or another, and to further introduce such services to areas regarded as limited or without service, especially in those areas discussed earlier. The network topology would consist of main LTE-A Base Stations (BSs) and Nodes (NDs) operating on the TVWS. The BSs will be located where they can be reached by NDs. Where the BSs have located away from the main power grid, they will be powered by solar/wind or both. As the internet connection backhaul for the BSs, they will be connected to the national fibre network, or otherwise, via a microwave link. An alternate backhaul connection will be another TVWS Base Station (TVWSBS) linked to another TVWSBS that is connected to a reliable backhaul [33, 34].

The research has assumed that the TVWSDB management and maintenance will be co-manged by the Authority and Service Providers; that means that the UEs will not maintain the channel allocation, nor should it have to. There will be one or more channels dedicated for transmission request. When any N sends a request for transmission, the TVWSDB of the BS will grant an un-utilised channel and mark the channel as occupied and accordingly updates its DB. When the transmission ceased, the BS will mark the

channel as vacant and updates the DB [33, 34]. The specifics of the solution are given in Chapter 5.

1.16 THESIS OUTLINE

This thesis is broken down into seven different chapters, as discussed below:

Chapter 2 provides a breakdown of the literature available in the field of fixed and mobile broadband wireless technology that could be adopted in Oman and similar countries, which could provide service to rural areas, considering similar problems and the solutions devised in this regard. This will help to enlighten the researcher and reader.

Chapter 3 will consider and discuss design and research methodology to be applied, along with a rationale as to the decisions made in this regard.

Chapter 4 will present our spectrum occupancy campaign across five major areas in Oman, with the data gathered undergoing analysis.

Chapter 5 provides the implementation of our proposed solution though simulation where two networks have been considered; our proposed LTE-A-TVWS (7 scenarios) and LTE-1800 (one scenario). The simulation will be carried out in the form of scenarios depicting internet service requirements and resources during two recurrent annual seasons. The chapter also compares the two networks by analysing their performance.

Chapter 6 centres on the drawing of conclusions, highlighting the various solutions available in answer to the research question, as well as any limitations of the present work and recommendations for future work.

2. LITERATURE REVIEW

2.1 INTRODUCTION

In this section, the literature related to the topic under examination has been reviewed in detail. The associated research work carried out on the CR, TVWS and LTE-A areas, in addition to the CR, TVWS and LTE-A standards and regulations around the world, are discussed in-depth. The same also have outlined the challenges facing the communication society. In the next few sections, the terminology and technical terms relating to TVWS, CR and LTE-A also are explained.

2.2 SPECTRUM HOLE AND TV WHITE SPACE (TVWS)

The zone of space–time-frequency, within which the secondary use is perspective, is known as a spectrum hole. This hole also can be described as an under-utilised band of frequencies that takes secondary transmissions without interference, with the operation of primary transmissions. Although a frequency is unutilised at a particular time, the use this frequency by Secondary Users (SUs) can cause interference to nearby frequency licensed users, or Primary Users (PUs); therefore, the objective is centred on offering adequate service to SU whilst, at the same time, safeguarding PUs from interferences; this provides the reason as to why a spectrum hole is specified as a frequency band within which an SU transmitter can transfer without causing any disruption to any PU receivers [35], [36].

These holes appear as the frequencies are allocated over long stretches of time and for long distances by Regulatory Bodies, but actual communications usage takes place over a very short period—sometimes just a few seconds and metres. However, it was difficult to amend policies as the life of technology is assessed by affordable needs and techniques that have a developing duration for profitability. Dynamic access techniques are used to benefit from the spectrum holes without causing interference to neighbouring users [37-40].

2.3 OVERVIEW OF TV WHITE SPACE (TVWS)

The term White Space (WS), in general, is used to describe the gaps between two consecutive frequencies intentionally left unused so as to prevent interferences between frequencies. There is a gap (White Space, WS) of 6 MHz or 8 MHz between TV channels; they occupy the range of 54 MHz–216 MHz for the VHF band, as well as 470 MHz–890 MHz for the UHF band. For example, the VHF Channel 2 begins at 54 MHz, whereas Channel 3 begins at 60 MHz. The same applies to the UHF channels, where Channel 14 starts at 470 MHz and Channel 15 begins at 476 MHz. When most TV channels changed over to digital broadcasting in the USA, UK, Canada, Japan, Singapore and other countries, frequency regulators began working to determine the best way of utilising the vacated spectrum without depriving current licensed users. The TV vacated frequencies, and the gaps existing between channels, are referred to as TV White Space (TVWS) [41], [42], [43].

TV transmission has excellent propagation, ability to penetrate buildings and vegetation, appropriate non-line of sight connectivity, and broadband payload capacity. Moreover, TVWS can be used in many applications, such as Wide Area Wireless Internet, video teleconferencing, and sharing, rural internet access, enterprise, and home wireless networks. [41] FCC has permitted the dynamic access of unlicensed users in TVWSs, with the Institute of Electrical and Electronics Engineers (IEEE) having established the 802.22 and 802.11af standards' requirements [44], [45].

2.4 AN OVERVIEW OF COGNITIVE RADIO (CR) TECHNOLOGY

In order to refine utilisation—and to further boost the radio spectrum—Cognitive Radio (CR) is regarded as a novel method. CR technological innovation is the solution to realising Dynamic Spectrum Accessible (DSA) networks, where secondary (unlicensed) users can make use of the unused licensed spectrum when the opportunity arises. This scheme may be utilised in a way that constraints the amount of disturbance to the vicinity

of the prime user (licensed) [46]. CR is recognised as an intelligent wireless communication system that is conscious of atmosphere and which adopts the methodology of learning by building to study its environment and accordingly adjust to statistical abnormalities in the input inducements, encompassing highly reliable communication and efficient utilisation of the radio spectrum as its two primary objectives [47].

CR is built on a Software Defined Radio (SDR), which is a transceiver that can place much or the majority of the complex signal handling and processing involved in communications within a digital form. In its purest form, SDR receivers essentially may comprise an analogue-to-digital convert chip, coupled with an antenna [48]. All signal-detection and filtering may be automatically performed in the digital domain using a regular PC. The main characteristic of CR is its transceiver ability, requiring awareness of its geographic location, and identifying and authorising its users, encrypting/decrypting transmission, sensing nearby operating wireless devices, adjusting output power and adjusting modulation [47], [49].

2.5 TVWS AND CR RECENT REGULATIONS ACROSS THE GLOBE

In its Second Report (FCC-08-260, November 2008), the USA Federal Communications Commission (FCC) approved the use of specific TVWS channels through the use of unlicensed devices [50]. This report has been set-up in mind of making spectrum more accessible by industrialists and service providers, aiding in the development of their products' specifications and services so as to pave the way for Wireless Broadband with high data rate, security and QoS. Subsequently, in November 2011, the FCC approved Spectrum Bridge, Inc. to create and maintain the first geo-location database of all available TVWS channels that are not utilised by licensed users in Wilmington, NC, and the vicinity [51]. When an unlicensed device in the area is used to transmit in the TVWS channels, it first requires that its geo-location information is sent to the central Spectrum Bridge's database; in return, this is sent back to the available

channels, with power in real-time facilitated. Furthermore, FCC approved the first TVWS outdoor fixed device made by Agility White Space Radio (AWR) from Koos Technical Services, Inc. (KTS). The device works with the Spectrum Bridge's database, and can only operate in Wilmington, NC, as well as in nearby areas [50, 52].

On February 17, 2012, the US Congress passed legislation authorising the FCC to negotiate with analogue TV and cable broadcasters, who have not yet moved to the digital broadcasting service. The legislation intended to offer them financial incentives to transfer to other vacated TV bands. It further assures the participating broadcasters in maintaining the same signal strength, availability, and coverage area if they move to suggested broadcasting channel. As per compensation, the legislation earmarked $1.7 billion to be offered to those broadcasters who agree to relocate their broadcasting TV channel; for those broadcasters not wishing to participate in the incentive, it also stated that all reasonable efforts would be made to maintain broadcasting signal and coverage areas [53].

The main objectives of the auction were to pave the way to creating a nationwide interoperable Wireless Broadband Network through establishing a contiguous 20 MHz spectrum and accordingly combining other public safety agencies used spectrum. The expected revenue of this incentive auction was an estimated at $15 billion, which was a part of the payroll cut plan raised to the US Congress [53].

In the above discussion, two main topics were discussed: the first centres on how the licensed spectrum can be utilised, whilst the second is concerned with TVWS spectrum use. Intelligent technology, such as Cognitive Radio (CR) devices, need to be manufactured and approved by regulators prior to allowing access to the spectrums mentioned.

In June 2011—and through utilising the FCC's Second Report (FCC-08-260)—the Institute of Electrical and Electronics Engineers (IEEE) approved and published IEEE 802.22 for Wireless Regional Area Networks (WRAN) using Cognitive Radio (CR) [54].

The main purpose of the IEEE 802.22 was to share the TVWS spectrum for broadband internet access in the rural areas, as well as those locations considered difficult to reach. It was the first defined standard for air interface using CR to access the TVWS opportunistically and licensed spectrum on a non-interfering basis. The standard specifies the CR's Medium Access Control (MAC) devices, Physical Layer (PHY), along with guidelines and measures for operating in the TV bands 54 MHz to 862 MHz [44].

In several European countries, studies have shown that approximately 56% of the TV spectrum is unused when it is averaged over the whole geographic area; however, when the overpopulation is averaged, the TVWS available is averaged at approximately 49%, which is lower than in the USA. Fair spectrum—which is Helsinki-based start-up company—has been licensed to create the first European geo-location TVWS database [55], [56]. The database will support the test radio license for CR devices granted by Finnish Communications Regulatory Authority (Ficora) to Turku University of Applied Sciences. As the UK's TVWS regulations concerns and deals with the growing spectrum overload on mobile networks, the UK has launched a service that would be capable of doubling the range of Wi-Fi available today. Ofcom has put forward this plan in mind of enhancing Wi-Fi services using TVWS. According to Ofcom, the recycling of the current TV spectrum is a greatly efficient way of maximising the use of limited spectrum resources. The UK's 'enhanced Wi-Fi', as it was named, would operate in the White Space of 470 to 790 MHz spectrum so as to enable services across cities and towns with the ability to extend services to rural areas [42], [57]. The technology also would benefit Machine-to-Machine (M2M) connections as TV frequencies cover significant areas and penetrate thick walls and physical obstacles effectively. Trials of enhanced Wi-Fi are being conducted by BT on the island of Bute, Scotland, with some degree of success experienced so far [34]. Ofcom regulations stipulate that, when the main device, router or hotspot needs to be operated in the TV White Space (TVWS) to provide services to customers, it first has

to consult online with one or more databases. The core purpose of this session is to determine the channel/s and power that can be used, whilst the station is to update the database of its location, channel, and power it has reserved for itself. Ofcom also has ensured the licensed users that this method would not interfere with their current transmission agreement, especially digital terrestrial television and wireless microphones. Ofcom is considering commercialising this service during 2013, as well as the use of current FM White Spaces in the future [42].

2.6 CURRENT RESEARCHES ON TVWS GEO-LOCATION DATABASES

This section covers the theoretical research studies that have been conducted in this field, and which might be considered enthralling when viewing through the lens of a geo-location system. Owing to the fact that, in the USA, some business companies presently are developing a database system, with the FCC controlling such activities and directing with various official workshops, the analysis of the database administrator's suggestions may be practical for the suitable implementation of the geo-location database system [58].

On January 26, 2011, FCC published an order associated with the assignation of TVWS database administrators, involving nine companies being assigned as TVWS geo-location administrators. These businesses are Comsearch, Frequency Finder Inc., Google Inc., KB Enterprises LLC and LS Telecom, Key Spectrum Bridge Inc, Bridge Global LLC, Telcordia Technologies, Neustar Inc, and WSdb LLC. All of them were supposed to be responsible for establishing the database systems needed to recognise the unoccupied channels at a specific location and time; the nine companies chosen have conducted several workshops since March 2011 so as to develop the database system plans. These are two of the considered proposals [58].

2.7 GOOGLE

Google provided proposition to the FCC, providing the information sought by FCC and Google's expertise. Google is a member of the White Spaces Coalition and is

recognised as a creator of the White Spaces Database Group. From the start, it has been an advocate for the unlicensed, efficient use of white areas. Its work with the coalition fellows and commission personnel, and in the development of testing systems, provides Google with the proficiency and experience required to be a database administrator. Engineers at Google design the necessary database in internet-related software. Google suggests a flexible and market-driven strategy, without restriction, in the variety of database suppliers and database architecture specification, considering an open-architecture design. More specifically, they propose a clearinghouse design model [59].

2.8 SPECTRUM BRIDGE

Spectrum Bridge is a company with sufficient support and technical knowledge to establish a wireless database system; they developed the first cellular billing clearinghouse, produced the first online exchange for secondary market spectrum and had pioneering management functions in multiple telecom technologies, from soft switches to ad-hoc networks [60].

A trial variation was established in January 2009, with a complete online WS version available in June 2009. The company was so successful that it created the first white space network in Virginia in September 2009. Its successes have positioned them to start installing more WS networks [60].

2.9 TVWS AND CR STANDARDS

Several TVWS standards have been produced and approved by the Federal Communication Committee of the USA, Office communication Ofcom (UK), and other spectrum regulators in the world, for manufacturers to develop and build compatible devices. Moreover, they have endorsed regulations and issued guidelines to standardisation organisations in order to establish working groups. Accordingly, the IEEE has established working groups, such as IEEE 802.22 for Wireless Regional Area Network (WRAN) and IEEE 802.11af [61], [62]. The IEEE 802.22 was approved in 2011; the IEEE 802.11af work group was formed in 2009 so as to modify 802.11 Physical (PHY) and Media Access

Control (MAC) layers by the FCC's TVWS regulations and channel access coexistence. As a result, the IEEE 802.11af work group released its second draft (Draft 2.0) as its first stable draft [62], [58], [63].

2.10 COGNITIVE RADIO ALGORITHMS

Spectrum-sensing is the most important component when establishing CR. Spectrum-sensing is a system providing awareness of spectrum usage and the existence of Primary Users in a geographical area. Such awareness may be established through geo-location and database-using beacons, or otherwise by local spectrum-sensing cognitive radios [64], [65]. Beacons provide transmitted information of the occupancy of a spectrum, as well as other advanced features, such as channel quality; however, a broader application area, complete with lower infrastructure requirement, is provided by spectrum-sensing using cognitive radios, which will be discussed hereafter [36]. Traditionally, spectrum-sensing was understood as a means of measuring the spectral content or otherwise of determining the radio frequency energy over the spectrum [66]. In general terms, it involves identifying spectrum usage characteristics across multiple dimensions, such time, space, frequency and code. It also involves determining the modulation, waveform, bandwidth and carrier frequency, etc., all of which require more powerful signal analysis techniques and additional computational complexity [36],[67].

2.11 TESTBEDS

Testbeds are platforms set up for experimentation with large development projects. They are used to validate scientific theories, algorithms, protocols and new technologies and discover more unseen practical problems for future exploration [68], [69]. There are typically two types of testbeds namely controlled testbeds and open testbeds. Controlled testbeds are used to test partially or fully integrated networks through prototyping. The main requirements are:

- Flexibility: The flexibility requirement is to be able to run different experiments that

involve various platforms

- High degree of control: concerns creating very diverse settings for testing
- Isolation: required to validate the results
- Repeatability: required to validate the results
- Safety: errors generated by all components of the network have to be carefully monitored to ensure that there is no harmful radiation affects anyone in close proximity during testing (safety the high degree of control. In addition to that, isolation and repeatability are [70].

Controlled testbeds consist of up to a hundred nodes and that depends on the scale of the testbed that is required to achieve accurate results. Controlled CRNs testbeds can be based on a number of different technologies, including signal propagation simulation, large anechoic chambers or testbeds in remote isolated areas where sufficient spectrum is available. There are two examples of existing radio testbeds that have cognitive networking capabilities; Carnegie Mellon University's emulator and ORBIT radio grid testbed at Rutgers University in New Jersey are the two most used controlled CR testbeds [71], [72].

Open Testbeds can support large-scale experiments under real physical and environmental conditions and take real effects into account such as signal propagation, real world objects and obstacles, mobile objects, people and interference from other Radio Frequency (RF) devices. The open testbeds consist of mixed devices and applications, mobile and stationary hosts and various device densities (Heterogeneity). It also uses a rich spectrum of licensed and unlicensed spectrums. The testbed is programmable and target different classes of applications and involves real users to achieve a high degree of realism. The Open testbeds, in general, are larger in scale than the controlled testbeds in order to allow genuine and challenging experiments. The most popular testbeds are GENI (Global Environment for Network Innovations) [73], [74], CREW (Cognitive Radio

Experimentation World) [75], (Open Access Research Testbed for Next-Generation Wireless Networks) [76], CORNET (COgnivite Radio NETwork) [77], and Emulab. GENI is a virtual laboratory for at-scale networking research supported by the National Science Foundation; CREW is a European Union Framework Program 7 (FP7) project created to establish an open federated test platform; ORBIT is a radio grid testbed used for evaluation of next-generation WLAN protocols at Rutgers University [70]; CORNET at Virginia Tech is a mixed WLAN testbed based on CR technology; CORAL is a Wi-Fi- CR networking lab that has been established at the Communication Research Centre in Canada and; Emulab is a network emulation testbed developed by the University of Utah. In the next few paragraphs, the Researcher will introduce one of these popular CR testbeds (CORNET) and how it is used [77].

2.12 LTE-ADVANCED VER. 12 (OVERVIEW)

LTE-A Rel-12 includes two Channel State Information (CSI) improvements: 4Tx (Transmit) Precoding Matrix Index (PMI) feedback codebook increase and aperiodic feedback Physical Uplink Shared Channel (PUSCH) mode [78]. The CSI enhancements make it possible for the Evolved NodeB (eNB) or eNodeB to complete the transfer of data packets prior to legacy CSI feedback; hence, enhancing spectral efficiency. The Rel-12 4Tx codebook enhancement primarily targets cross-polarized antennas and, thus, the reuse of the 8Tx dual codebook structure. In addition to the improved codebook, a new aperiodic CSI feedback PUSCH mode is presented in Rel-12, with increased CSI accuracy given that it provides both sub-band Channel Quality Indication (CQI) and sub-band PMI feedbacks [79].

2.12.1 Small Cells

Different small cell improvements were assessed in Rel-12. A Physical Layer research study was established in mind of enhancing spectrum system efficiency through increasing transmission efficiency and minimising overheads. Systems for efficient

operation of the small-cell layer, as presented in Rel-12, consist of interference mitigation through efficiently powering On/Off small cells, discovery cell signals, and processing, and Radio Based Synchronisation based upon Network Listening. For efficiency spectral enhancements in Rel-12, the greatest supported modulation was increased from 64 QAM to 256 QAM for both PDSCH and PMCH [80], [79].

Individually, a Higher Layer research concentrated on movement toughness, decreasing the signalling load via the core network due to handover, and improved per user throughput and system capability using the dual connection. The second connection became the primary objective of the following work product in Rel-12; this referred to circumstances where a UE is capable of using radio resources supplied by at least two separate network points, namely a Master eNodeB and one Secondary eNodeB joined with non-ideal backhaul. Movement robustness can be improved through maintaining control airplane termination in a macro node whilst permitting offloading of user plane traffic flow to Pico nodes inside the macro coverage. This option, likewise, may be able to decrease signalling overhead towards the core network through keeping the mobility anchor in the macro cell [80].

Associated with small enhancements, likewise, Rel-12 has several femtocell improvements, comprising movement to shared Home eNodeB (HeNB), and LTE X2 (Interface in between eNBs). The flow to a target HeNB shared by several operators relies on the concept that the source HeNB picks the Public Land Mobile Network (PLMN) to be utilised on the target side. The difficulty is that the target PLMN selected should work with the UE in regards the subscription when such an HeNB is hybrid/closed. Rel-12 improves UE mobility procedures through the inclusion of the ability to report and read to the source eNB (preceding to the handover decision) a list of appropriate PLMNs of the target cell. When selecting and getting this brand new list to trigger the handover, the source eNB also is improved with the ability to verify that it, in fact, is an equivalent

PLMN or the serving PLMN [80].

Enhanced information traffic results in network densification, which can include deploying multiple small cells, particularly various HeNBs, within each macro sector. Rel-12 facilitates scalability by allowing an eNB link to its next-door neighbour HeNBs within one or more LTE X2 Gateways (X2GW) [80].

2.12.2 Carrier Aggregation

Carrier Aggregation (CA) refers to combining two or more frequency channel bandwidths so as to form a wider channel bandwidth. The frequencies could be contiguous or non-contiguous. Such a type of spectrum aggregation was first introduced as part of LTE-A Version 12 in LTE-A v.12 [81].

From the paper, [81], we can conclude that 64QAM provides the greatest performance for LTE-Advanced, and when the code rate of 5/6 is set, the system delivers a high peak data rate. In brief, the code rate is directly related to the throughput of the system modulated by 64QAM and the maximum code rate for the system with 8x8 MIMO is 5/6. When the simulation used 8x8 MIMO, 120 MHz bandwidth, 64 QAM and 5/6 code rate, the maximum throughput of LTE-A found to be 4.032 Gbps [82],[81].

Furthermore, it is recognised that the majority of early LTE-Advanced adopters will likely focus on provider aggregation as higher data rates are a simple sell. To keep their networks running smoothly, operators will have to explore much deeper into the LTE-Advanced toolkit [83].

Besides provider aggregation, four other key features differentiate LTE-Advanced from its predecessors. The very first of these is referred to as multiple input, numerous output (MIMO), which permits base stations and movable units to send and receive information, making use of several antennas. LTE currently supports some MIMO; this is only the case for download stream, however. Moreover, it limits the variety of antennas to four transmitters in the base station and four receivers in the handset. LTE-Advanced

permits approximately eight antenna pairs for the download link, and as many as four pairs for the upload link [81], [84].

MIMO serves two functions: in loud radio environments, such as at the edge of a cell or within a moving automobile, the numerous transmitters and receivers work together to focus the radio signals in one certain instruction, with such 'beamforming' recognised as improving the stamina of the acquired signal without increasing transmission power. If signals are robust and noise is low, however, such as when fixed users are close to a base station, MIMO can be used to increase data rates or the number of users for a given quantity of spectrum. The method, known as spatial multiplexing, permits several data streams to travel over the very same frequencies at the same interval. A BS with eight transmitters, for instance, can send out eight streams at the same time to a Node(N) with eight receivers. Since each stream reaches each receiver at a somewhat various angle, strength and time, processing algorithms in the smartphone can mean these inputs are integrated, with the distinctions to figure out the real streams then used [85], [81].

As a rule of thumb, spatial multiplexing is to be able to proportionately increase data rates to the variety of antenna pairs readily available. Therefore, within the best circumstances, eight pairs could potentially enhance information rates as much as eightfold [86]), [87].

2.13 CONCLUSION

In this chapter, we have investigated recent studies and regulations of the TVWS, CR and LTE-A operating on TVWS spectrum. After having analysed TVWS database administration method, it is clear that all propositions are essentially analogous. The database design is almost the same; it requires some data/information sources, synchronisation in between various DBs, the gaining of public access to and registration from secondary devices, and some security controls so as to guarantee the appropriate operation of the system. As far as the business strategy and plan are concerned, the entities

are required to provide all essential elements so as to facilitate the construction of the database system. Nevertheless, there are some variances in cost charges. Some companies have made attempts to garner access free of charge, whilst others, on the other hand, propose a business strategy with heavy expenses.

All TVWS propositions are merely preliminary propositions; some are not clear yet, nor detailed. They suggest the first scopes and design that the database system ought to have. Nonetheless, the literature review revealed that the recent studies and simulation on LTE-A operating on the TVWS spectrum is promising. The technology requires significant enhancements so as to meet our requirements; therefore, we are proposing an enhanced implementation of the technology based on LTE-A operating on the TVWS spectrum through simulation in the absence of compatible hardware so far that could support our proposal. Additionally, a TVWS algorithm has been developed in this thesis to manage TVWS database and channels' allocation.

3. METHODOLOGY AND APPROACH USED

3.1 INTRODUCTION

There are a few types of methodologies that are used in computer science amongst them are Formal, Experimental, Build, Process and Model [88].

Formal: This methodology is generally used to prove facts about algorithms and systems. This allows the researcher to formally specify software element to automate an implementation of verification of a component. Additionally, this method allows the researcher to test the complication of the algorithm.

Experimental: It is used to assess new solutions for the problems. It consists of two phases; exploratory where the researcher takes a measurement to help in the identification of the questions and the evaluation phase where the attempt to answer these questions [89].

Build: This research methodology involves creating an object, either a physical artefact or a computer software system, to prove that it is conceivable. The building of the artefact must be new or it must contain new features that have not been established before in other objects.

Process: This methodology is used to recognise the processes used to achieve tasks in Computing Science. It is mostly used in the fields of Software Engineering and Man-Machine Interface which deal with the method humans build and use computer systems it may also be used to understand cognition in the field of Artificial Intelligence.

Model: the model methodology is used to define an abstract model for a real system. This model is much less complicated than the system it is trying to model and consequently, will allow the researcher to better understand the system and to use the model to accomplish trials that could not be performed in the system itself for the reason of cost or availability. The model methodology is every so often used in combination with the other four methodologies. Experiments constructed on a model are named simulations

[90].

3.1.1 Chosen Methodology

Our research involves a combination of two types of the above-mentioned methodologies. We will be using Experimental and Build methodologies to implement our solution. We will use both phases of the Experimental methodology; identification and the evaluation phases where we will attempt to answer the question formulated in Chapter 1 and we evaluate of the answer in the form of the simulation analysis.

3.1.2 Description of the method and design

In mind of achieving the objectives stated earlier on in this thesis, a research methodology deemed appropriate to the present study is employed. The currently licensed radio spectrum utilisation in Oman, from the researcher's perspective, would benefit from the completion of a field study using a radio spectrum analyser device for at least five days at different five locations; this would include four urban areas (Ruwi, Alghobrah, Alkhodh and Salalah), and one medium town (Ibri). The five locations will be chosen in consideration of the following criteria: one location will be the business type area, the second will be a residential area, the third will be a combination of both commercial and residential, the fourth will be a tourist attraction area; and the last will be in the form of medium sized town with temporary migration during weekdays, weekends and holidays. Many of educated young men in this town work in bigger cities during working days and they return home during weekends and holidays. So the internet traffic and demand increases during weekends and holidays. This is detailed in Chapter four.

The data collected will be analysed in order to determine the real radio spectrum occupancy in the 40 MHz to 2800 MHz. An in-depth understanding of the current technology available for wireless broadband implementation in Oman will be garnered, with the latest wireless mobile technology feasible to be implemented in Oman examined. Thus, TV White Space (TVWS) and LTE-A technology will be considered. Furthermore,

the LTE-A network operating on TVWS spectrum will be simulated, analysed and tweaked, with recommendations made in consideration to the most appropriate settings for the network so as to satisfy the requirements with minimum hardware and spectrum usage. Additionally, a TVWS algorithm will be developed in this thesis to manage TVWS database and channels' allocation. The simulation details and the algorithm are given in chapter five.

A vision aimed at enhancing the wireless broadband in Oman will be developed; this will need to fulfil the demands of mobile broadband in rural areas of Oman. Furthermore, recommendations and guidelines for TVWS regulations in Oman, that can be utilised by the TRA and service providers, will be drafted and proposed in mind of implementing such technology in the Sultanate. Those recommendations are given in chapter 6.

During the time span of the research, there have been several discussions with the TRA, and Radio Television Authority (RTA), OmanTel, Oman Broadband Company personnel along with emails correspondence with other agencies in the countries. Those discussions were aimed to gather data concerning telecommunication regulations, spectrum allocations and licensing, analogue TV bands and geographic distribution of the channels besides validating data collected by the radio spectrum analyser instrument. This type of activity is referred to as a secondary data collection procedure. Additionally, the researcher has conducted several workshops for concerned workmates which involved a brief about the project for feedback.

3.2 RESEARCH INSTRUMENTS

In consideration of guidelines found in [91], and also in mind of completing the spectrum occupancy campaign of the 40–2800 MHz to confirm the spectrum occupancy, the researcher has utilised an advanced radio spectrum analyser equipment from Anritsu and simulation software package from ATDI company. These two systems are described below.

3.2.1 Spectrum analyser Measurement System

The equipment used in the survey comprises Anritsu MS2721B, which is a high-performance radio spectrum analyser; the MS2721B handheld operated on rechargeable battery operated spectrum analyser is capable of measuring from 9 kHz to 7.1 GHz and encompasses a built-in amplifier (Figure. 3-1) [92].

Figure 3-1: Anritsu MS2721B (25 MHz–7.1 GHz)

Additionally, an ultra-wideband Omni-directional antenna (DA 3200 by E&OE AOR, LTD Japan), with a frequency range of 25 MHz–3000 MHz and a laptop computer also used for the measurement (Figure.3-2).

Figure 3-2: DA 3200, Ultra-Wideband Omnidirectional

3.2.2 The Simulator and Planning Tools Used

We have looked into more than four simulator packages and testbeds. The majority of the simulators provide the simulation of a blank area in a map; they do not take into consideration the natural topology of the area. They assume that the area is flat and the simulation results would be lacking real life reading. We have reviewed [93], which draws a comparison between different types of wireless simulation package; we have found none of the investigated and compared simulators could fulfil our requirement; therefore, we have completed various other investigation and searches before identifying

a simulator named ICS Designer, which is provided by Advanced Topographic Development & Images (ATDI). The company provides several simulation products that take into consideration near real world environment and situations by utilising multi-layer maps that have topological and environmental data [94].

ICT Designer is one of the simulation software provided by the same company (ATDI), and we have obtained a paid research license in order to simulate our proposed solution. The software has the ability to model multiple-technologies (mobile, broadcast, fixed services, microwave, satellite, radar, aeronautical, point-to-multipoint). There is no restraint or restriction of bandwidth or frequency bands, and multi-technologies can be maintained in the same project (high flexibility of the tool).

It includes the ability to create coexistence research studies between different technologies (LTE vs DVB-T & mobile vs fixed). It can access multi-resolutions maps (Rasters 2D & 3D and Vectors) and can provide multiple databases (SQL, XML and Distributed RDB). The ICS designer can manage GSM, GPRS, EDGE, WCDMA, HSPA, HSPA+, LTE (TDD and FDD), along with WiMAX, Wi-Fi, CDMA2000, EVDO, TDMA, FDMA, DVB-H, Tetra, DVB-T/2, ISDB-T, DMR, BWA, TV, FM, MLAT, DME, radars, microwave links, Mesh, and model the effects of wind farms on other radio communication systems. The simulator highly flexible and can support multi-technology and has no limits or constraints of the bandwidth or frequency bands. Additionally, the software is capable of being connected to radio spectrum analysers along with radio occupancy measurement data files/tables such as ours. The main features of the software are in Table.3-1 [94].

Number	Feature
1	Coverage calculations including multi-resolution, deterministic, and statistical
2	propagation models, outdoor, indoor, mixed outdoor/indoor, diffraction, lateral
3	diffraction, troposcattering, sub path integration, climate components, absorption,
4	reflexions, 3D engines, user programmable models
5	Coverage analysis and reports by servers, overlapping, noise and others
6	Measurement correlation, tuning and import
7	Interference analysis for MFN, SFN, COFDM, Eb/N0, Ec/I0, C/N+I, C/I, Threshold
8	degradation, NFD matrices, IRF and C/I tables, adaptive C/N+I required,
9	Desensitization, Intermodulation, point to point, point to multipoint, coverage,
10	space/earth, windfarm interference analysis
11	Frequency planning
12	Network planning (PHY_ID, RSI, TAC, LAC, PN codes, RSRP, SNIR, RSRQ…)
13	Handover / neighbor planning
14	Traffic analysis for voice, data, throughput, and distribution
15	Automatic site searching and optimisation
16	Human hazard analysis
17	Prospective planning for automated multi-technology site planning, montecarlo, impact studies, constraints, and subscriber oriented planning
18	MW link path budgets for multi-resolution, adaptive modulation, diversity, and objectives
19	Advanced import/export features for ASCII files or complete databases
20	Online worldwide maps in real-time (internet connection required)
21	Multi-threading
22	Multi-core parallel computing

Table 3-1. ICT Designer Main Features [95]

The simulator can import radio spectrum survey data along with demographic data from external sources such as Municipality's database. We are planning to import our data collected in our radio spectrum survey to utilise it in our simulation and planning. Additionally, we have approached our National Survey Authority in Oman to provide a detailed Map of selected areas in order to load it to the simulator prior to setting up our simulation environment.

The next two figures (3-3 & 3-4) how some screenshots of the simulator ICT Designer:

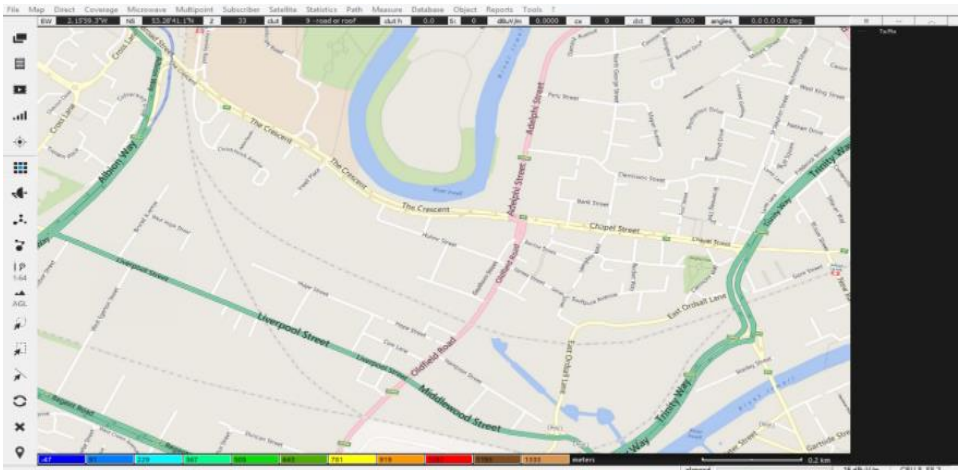


Figure 3-3: A screen shot of the ICT Designer

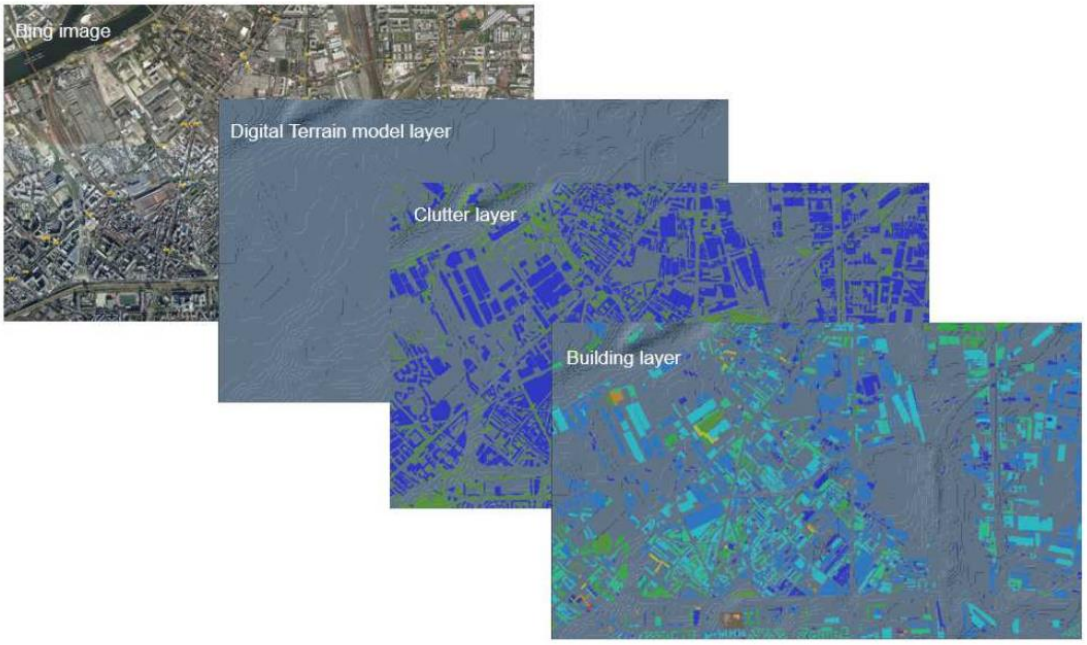


Figure 3-4: ICT Designer Multi-Layer Map Capabilities

3.3 SIMULATION DESCRIPTION

Our simulation network layout area (Scenario-1-5 and Scenario-8) covers approximately 843 km^2 of Salalah Greater City with different clutters, such as mountains, forests, urban, suburban, airport, seaport, buildings and roads. Whereas, Scenario-6 will be a data path link between Muscat and Ibri on the northern part of the country. And Scenario-7 will cover around 600 km^2 around Ibri town with 500 NDs served by Muscat's site through Jabal Shams's site link created in Scenario-6. The subscribers will be set-up in these clutters so as to study the effects of each clutter on the connection and quality of service for each group of subscribers. Finally, Scenario-8 will simulate the LTE-A operating on the 1800 MHz.

Our proposed network named LTE-A-TVWS and will be operating on the 470-710MHz TVWS spectrum with a 120 MHz Band Width (BW) for transmitting and 120 MHz BW for receive for all scenarios (1-7) while the other network (Scenario-8) will operate on the 1800 MHz with 5 MHz BW.

The main BSs would be located in the best possible locations, as suggested by the simulator (search site), where the signal can be received and sent to NDs (TX/Rx signal). The BSs will be either powered by solar, wind or the main power grid. The fixed NDs also would be powered by the same method while the mobile ones could be in the form of a mobile User Equipment (UE). As the internet connection backhaul for the BSs concerns, they will be connected to a national fibre network or by a microwave link. Another alternate backhaul connection will be one or more BSs that are linked to anther BS, which, in turn, is connected to a reliable backhaul (MW, Fibre). This link has been demonstrated in Scenario-6. Additionally, some sites could be portable and deployed on the main tourist attractions on the peak tourist season and turned off automatically during off-peak hours and seasons.

In the simulation, we will set-up the two networks; one is an LTE-A-TVWS with

seven scenarios and the second is an LTE-A-1800 with one scenario. All Base Stations (BSs) would be installed per the best area search described in chapter 5. In scenarios 1-5 of LTE-A-TVWS and Scenario 8 of LTE-A-1800, the BSs would act as servers to **fixed** external Nodes (NDs) that are located on rooftops and other outdoor locations. In Scenario-6 of the LTE-A-TVWS, we will build a connection path that connects two distanced sites through a third one to provide a service to a remote location. This is a link only. In contrast, Scenario-7 will be utilising Scenario-6 link for a fourth site that serves 500 mobile roaming NDs. In all scenarios, some of the LTE BSs would be connected to the main fibre network, microwave links or other BSs for the gateway to the internet except for Scenario-7 which will be connected to BSs that are in turn connected to the main provider site through a third site.

After creating the BSs, users' creation would follow. The simulation would start by defining the potential network area (Mask). The total scenarios that would-be setup and executed are eight scenarios. Seven scenarios will be implemented and demonstrated on our proposed solution (LTE-A TVWS) and Scenario-8 will be for the LTE-A-1800 MHz. These scenarios are briefly described below while the real scenarios setup, execution and analysis would be accomplished in chapter 5.

Scenario-1 will be the calibration of the simulator to determine the degree of confidence. It will involve installing one BS with four sectors and 100 NDs located in different clutters and with the same DownLink (DL) and Up Link (UL) demands (8 and 4 Mbps). Having created the network with the BS and NDs, an attempt to connect (Parent) all NDs to the BS, and accordingly determine the achieved data throughput and compare it to the demanded data rate, will be carried out; in other words, to determine the QoS achieved after the connection. Notably, the BS and the NDs work on the same frequency (590 MHz).

Scenario-2: 5000 NDs with directional antennas will be generated in randomly

selected locations in the mask and attempt to connect (parent) as many NDs as possible to one four-sectored site (4 BSs) and eventually install four more four sectored-BSs. This scenario represents the internet demand during off-peak tourism season in Salalah greater city.

Scenario-3: Studying the effect of changing NDs, antennas into Omnidirectional

The purpose of this scenario is to examine the effect of modifying some NDs configurations on the performance of the network; in this instance, we will change the NDs' antennas types from directional into omnidirectional.

Scenario-4: Tourism Peak Season- This scenario will depict the internet traffic demand during the peak monsoon season in Salalah when the demand rises to more than four times normal days. We will generate and install 20,000 NDs on the same mask and keep the same BSs on the same sites.

Scenario-5: In this scenario, we will simulate the closest to real life situation where you have different users with different demands in different times. In this scenario, we will create 5000 NDs and group them in six categories each group will have its unique DL, UL and percentage of the time they are in operation. The NDs' DL requirement will range between 4 Mbps to 24 Mbps for DL and 4-16 Mbps for UL. As the activity concerns, it will range from 40-100% for DL and 20-100% for UL. The idea behind this scenario is taken from real life experience of the researcher during his visits to the area when noticed that there are many users have very limited internet service demand with low activities that can be satisfied by minimal DL and UL service. In contrast, there are many users with drone cameras with high definition video quality that require very high-speed internet service especially when they desire to upload their videos directly to YouTube or to their families across the country and the neighbouring countries.

Scenario-6: the connection between two distanced sites through a third one. The idea

is to build a reliable link between two distanced sites through a third one so it can provide an internet service to a remote area that presumably lacks the service. The link will potentially be utilised in Scenario-7.

Scenario-7: (Mobile LTE-A TVWS)

The main objective of this scenario (Scenario-7) is to utilise the link created in Scenario-6 to provide internet service to 500 mobile NDs roaming around an area that lacks broadband internet service.

Scenario-8: This is the LTE-A-1800 scenario.

Full details of the simulation's scenarios are given in chapter 5.

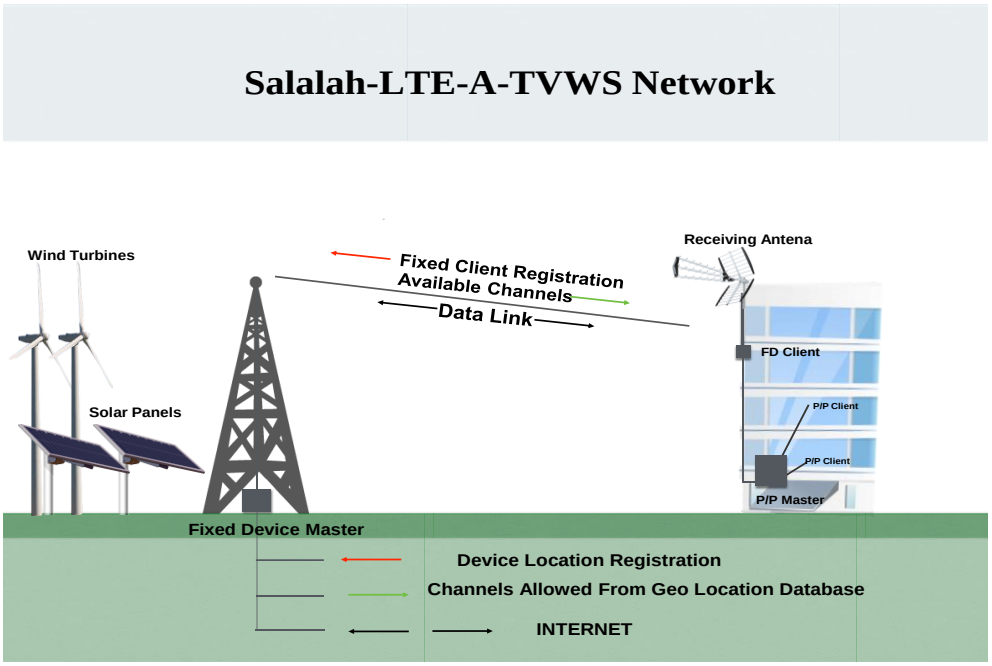


Figure 3-5: Salalah Proposed LTE-A TVWS Network

3.4 IMPLEMENTATION OF THE SOLUTION USING SIMULATION

According to the radio spectrum occupancy campaign carried out in Oman by the researcher, and the subsequent analyses, the radio spectrum of 470 MHz to 890 MHz (a total of 420 MHz), was found to be mostly unutilised; this is the analogue TV spectrum (TVWS). Our simulation will utilise contiguous 240 MHz of the unused 420 MHz, starting

from 470 MHz–710 MHz with a centre frequency of 590 MHz. The other assumption—and for the sake of the simulation—is to treat this spectrum as fully licensed spectrum to the National Carriers (standalone spectrum), and not aggregated with other spectrums. This means no other users outside the SPs network are granted access to this spectrum, much like the 3G, LTE and WiMAX spectrums.

There will be two networks implemented in the simulation: one will be an LTE-A operating on the TVWS spectrum (470-710) with 120 MHz BW, which is our solution to the problem whilst the second one will be an LTE network operating on the 1800 MHz spectrum with 5 MHz Band Width (BW), similar to the current LTE technology. The idea behind deploying two almost similar networks is to study the behaviour of each one and accordingly to compare both to establish the differences in data throughput, user satisfaction (QoS) and financial cost for infrastructure, operation and maintenance.

3.5 SIMULATION SETUP AND CALIBRATION

In order to calibrate and validate the simulator for LTE-TVWS network, we will install one BS with four sectors and create 100 Nodes (NDs), and accordingly attempt to connect them to the same Base Station (BS); the main purpose of this step is to initialise and thus verify that the simulator is acting as properly as possible. This means comparing the simulation results with real life situations. We can summarise this into three questions. Does the orientation information of the BS and the ND on the simulation look be the same as the real one on the ground (elevation, distance)? All of this will be done in Chapter 5. The digital maps that are going to be used in the simulation have been obtained from ATDI.

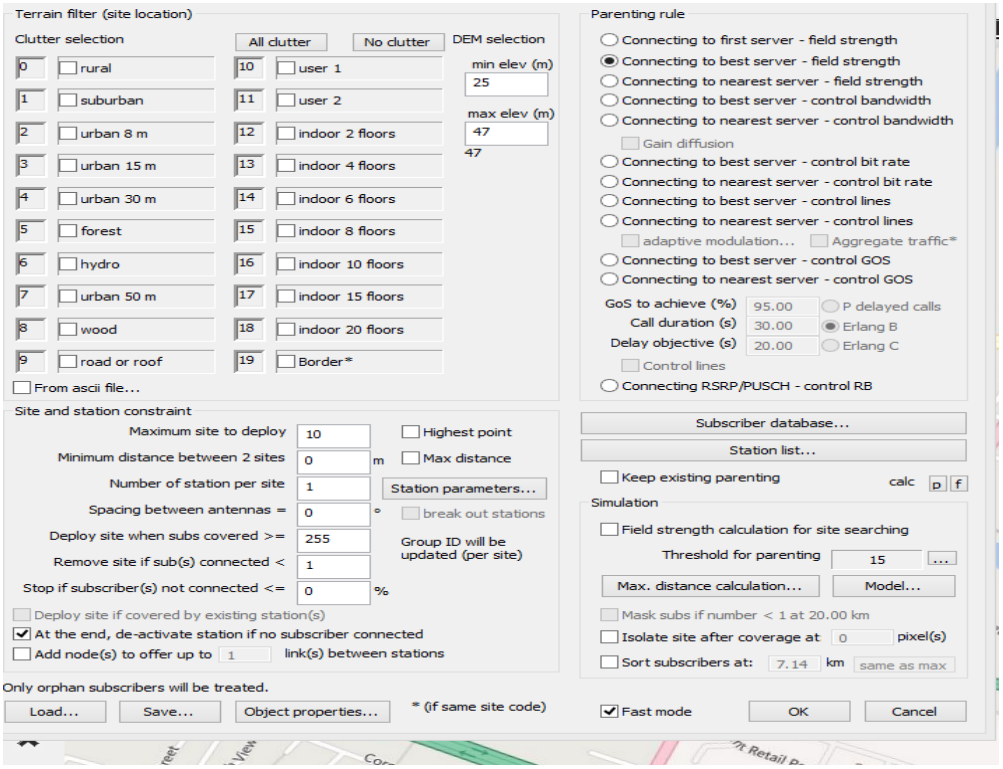


Figure 3-6: Screen Shot of the ICT Designer Planning Tools

3.6 CONCLUSION

In this chapter, we have laid down our proposed methodology to carry out our research which included a description of the selected radio spectrum analyser and simulator, the initial network setup environment and scenarios and that included the calibration scenario description. The chapter also established the ground of the radio spectrum survey areas criteria for selection the five locations of the survey. In the same chapter, we have described the simulated networks. One is our proposed LTE-A-TVWS network and the second is the LTE-1800 network and briefly described their scenarios. In the next two chapters 4 and 5, the radio spectrum occupancy campaign and the implementation of the proposed solution will be deeply explained and verified.

4. RADIO SPECTRUM OCCUPANCY CAMPAIGN IN OMAN

4.1 INTRODUCTION

The signals measured/detected can be classified into three categories, namely black, grey and white spaces. The black spaces are those frequencies most commonly utilised all the time, such as the broadcasting and mobile telecommunications, whilst grey spaces are those frequencies moderately utilised, such as the aeronautical radio navigation, Maritime/Fixed links/PMR/PAMR and fixed mobile. White Spaces (WSs) are recognised as those frequencies that are never or rarely occupied, such as the gaps between TV channels that are intentionally left blank to prevent interferences between analogue TV channels or other unoccupied frequencies. The analysis of the data collected is presented in Table 7 [96]. This chapter will detail the Radio Spectrum Occupancy Measurement Campaign the has been carried out by the researcher for five locations in Oman. The campaign was carried out for two weeks' period for each of the five locations. Furthermore, the chapter will also study the effect of estimating or forecasting the spectrum activity for eight weeks and compare the findings with the real two weeks' spectrum usage.

4.2 THE RADIO SPECTRUM OCCUPANCY MEASUREMENT CAMPAIGN

In order to identify the degree of spectrum occupancy in various major urban and suburban areas of Oman, as part of the problem identification for the PhD research, the researcher has conducted radio spectrum measurement campaigns for five such locations. The five locations were selected for the campaign, namely Ruwi, Alghobrah, Alkhodh, Salalah and Ibri. A description of each location is provided as follows:

Ruwi (A): The Central Business District of Muscat, surrounded by high mountains, and is the home for Muscat Stock Market, the main telecommunication hub, the home of the Central Bank, and the location of headquarters for many national and international Banks and companies. Ruwi is located at bearings N23.35.53, E58.32.15, and has a

population of approximately 90,000. The measurement system was put on top of a seven-storey building, which itself is located on top of a hill overlooking the city. The measurement was carried out over four consecutive days (December 24, 2013–December 27, 2013) [97].

Al Ghobrah (B): A suburb of Muscat—the capital city of the Sultanate of Oman. It is an evolving town with many malls, hospitals, schools, hotels and other local businesses. The town is well planned and is known for its lake park design, especially with walkways and children's playground. Al Ghobrah is located at bearings N23.36.4, E58.24.19, and has a population of approximately 30,000 [97].

Alkhodh (C): A major residential and commercial area of the capital Muscat, with a population of around 50,000. Located 25 km Northwest of Ruwi, at bearings N23.37.10, E58.12.19. It is close to the Muscat International Airport and is the location for the Sultan Qaboos University. It is a very fast-developing area.

Salalah (D): The second largest city in Oman with a population of more than 100,000, located at bearings N17.1.38, E54.9.35. Due to its uniquely cool and rainy tropical climate during summer, the population quadruples during this period due to an influx of tourists from all over the country and from the Gulf States. This sudden increase in tourists further increases the overall demand for mobile communications, especially broadband internet access, which ultimately causes the interference, degradation or deprivation of mobile internet services [98].

Ibri (E): The Wilayat of Ibri is distinguished by its archaeological landmarks, varying between forts, castles and towers. Ibri is a very popular town and is located at 300 km west of the capital Muscat at bearings N17.1.38, E54.9.34. This town is one of the growing new towns of the country with most of the young people working in the capital area Muscat and they migrate back and forth during working days, weekends and holidays. This is a temporary migration.

All of the measurements were plotted in Table 8, with the readings showing band-by-band the utilisation for all locations, whereas Figure 15 presents a graphical representation of such usage.

4.3 OBSERVATIONS AND ANALYSIS

According to Oman's Telecommunications Authority (TRA) National Spectrum Plan in Table-1, the spectrum of 40 MHz to 3 GHz is divided into 15 Bands. These bands are assigned to different services. For example, Band 1 (40-87.5MHz) is assigned to FIXED, MOBILE, BROADCASTING, AERONAUTICAL RADIONAVIGATION and can be utilised for PMR, ISM, Amateur, PMR/PAMR, Military systems, ILS/marker beacons services [6].

Band	Frequency span(MHz)	Allowed Services in Oman	Major Utilisation
1	40-87.5	FIXED, MOBILE, BROADCASTING, AERONAUTICAL RADIONAVIGATION,	PMR, ISM, Amateur, PMR/PAMR, Military systems, ILS/marker beacons
2	87.5-108	BROADCASTING	FM sound Broadcast, SRD
3	108-223	AERONAUTICAL RADIONAVIGATION, AERONAUTICAL MOBILE (R), FIXED, MOBILE except aeronautical mobile (R), METEOROLOGICAL-SATELLITE (space-to-Earth), MOBILE-SATELLITE (space-to-Earth), AMATEUR, AMATEUR-SATELLITE, MOBILE except aeronautical mobile (R), MARITIME MOBILE (distress and calling via DSC), BROADCASTING	ILS/Localizer, VOR, Aeronautical mobile, Aeronautical mobile distress communication, Fixed links, Mobile applications, Meteorological satellites, Low earth orbit satellites, Amateur, Amateur Satellite, PMR/PAMR, Maritime, DSC for distress and calling, Shipborne AIS, SRD. TV (B/PAL).
4	223-400.05	BROADCASTING, AERONAUTICAL RADIONAVIGATION, FIXED, MOBILE, MOBILE-SATELLITE, AERONAUTICAL RADIONAVIGATION, MOBILE-SATELLITE (Earth-to-space)	Analogue TV (B/PAL), T-DAB, Military systems, EPIRB, Mobile applications, ILS/Glide path, Mobile satellite applications, TETRA
Band	Frequency span(MHz)	Allowed Services in Oman	Major Utilisation

5	400.05-470	STANDARD FREQUENCY AND TIME SIGNALSATELLITE, METEOROLOGICAL AIDS, METEOROLOGICAL-SATELLITE, MOBILE-SATELLITE, MOBILE except for aeronautical mobile, FIXED, AMATEUR, MOBILE	Meteorological radiosondes, Meteorological satellites, Low earth orbit satellites, SRD, Satellite EPIRB, PMR/PAMR, TETRA, Fixed links, ISM, Amateur, PMR446, IMT (CDMA450/3G),
6	470-566	BROADCASTING	Broadcasting, SRD (Wireless Audio Applications), Analogue TV (G/PAL), DVB-T,
7	566-606	BROADCASTING	Broadcasting, SRD (Wireless Audio Applications), Analogue TV (G/PAL), DVB-T,
8	606-806	BROADCASTING	Broadcasting, SRD (Wireless Audio Applications), Analogue TV (G/PAL), DVB-T,
9	806-890	BROADCASTING, FIXED, MOBILE except for aeronautical mobile, FIXED, LAND MOBILE	Broadcasting, SRD (Wireless Audio Applications), Analogue TV (G/PAL), DVB-T, Fixed links, PMR/PAMR, GSM-R
10	890-960	LAND MOBILE	GSM-900/UMTS900, GSM-R
11	960-1215	AERONAUTICAL RADIONAVIGATION	Navigation systems, Galileo, GLONASS, GPS
12	1215-1710	RADIOLOCATION, RADIONAVIGATION, RADIONAVIGATION-SATELLITE, FIXED, MOBILE, EARTH EXPLORATION-SATELLITE (passive), BROADCASTING, BROADCASTING-SATELLITE, MOBILE-SATELLITE, METEOROLOGICAL AIDS, METEOROLOGICAL-SATELLITE	Radiolocation systems, Radar and Radionavigation systems, GPS, GLONASS, Satellite navigation systems, Fixed links, PMR/PAMR, Passive sensors (satellite), T-DAB, S-DAB, Mobile satellite applications (S/E), Distress and safety communications (including GMDSS), Meteorology, Meteorological satellites,
13	1710-1880	LAND MOBILE	GSM-1800, IMT, MCA, FWA
14	1880-2170	LAND MOBILE, MOBILE-SATELLITE, FIXED,	Cordless telephone system(DECT), IMT/UMTS/3G, Mobile satellite applications, Fixed links,
15	2170-2800	MOBILE-SATELLITE, FIXED, MOBILE except for aeronautical mobile, MOBILE, Amateur, AERONAUTICAL RADIONAVIGATION, RADIONAVIGATION	Mobile satellite applications, Fixed links, Mobile applications, IMT/BWA, Amateur, ISM, SRD, WAS/RLAN, Radar and Radionavigation systems,

Table 4-1: Oman Radio Spectrum Allocation Table [6]

4.3.1 Global Measurement Setup

The measurements had been taken for more than two weeks for all locations on different dates. The scanning time for all locations was between one and a half minute to two and a half minutes and that depended on the time the device took to save the record to the external flash memory. The scan was for the range of 40-2800 MHz. The total collected records were around 15K for each location then filtered and stored into an excel

worksheet. The 15K measurements worksheet that had been taken for two weeks then filtered into four groups. The first group contained all the entries for the measurements taken during the period of 12AM-5:59 AM; the second was for 6AM-11:59 AM; the third was for the 12PM-5:59 PM; and the last was for 6PM-11:59 PM.

When checking the traffic, it is observed that the threshold point was different between the locations and that depended on the traffic and the interferences When there is a lot of genuine traffic, the signal rises way above the noise level because the active signal is clear of the noise level so we have to take the threshold point just above the noise level. But when there is little traffic, then there is a lot of noise so the threshold point has to be much closer to the noise level. Noise in the radio spectrum is the unwanted signals which is generated by the different type of events including natural phenomena and home appliances.

4.3.2 Duty Cycle

Another acronym used in the analysis is the duty cycle which is the percentage of time that the measured channel/band is occupied/active compared to the whole period of the measurement. For example, if Channel-1 is observed for 24 hours and it found to be active 3 hours then the duty cycle will be 3/24 * 100 = 12.5%. In brief, the duty cycle is the total time a signal is operated within a given period. In fact, in our analysis, we are calculating 4 types of duty cycles.

In our measurements, we have 551 channels measured (5 MHz each) and these channels grouped into bands according to the table. 999 (15 Bands). The bands' width varies from tens of channels to hundreds of them in each band. So a band consists of more than one channel.

4.3.2.1 Duty Cycle-1 (real channel duty cycle):

It is the real overall **individual channel** utilisation, based on the operation of the channel on actual time. We take the total readings of each channel and divide by the whole

readings (15K) and then we sum all and divided by total channels (551). This number is very small because it is measuring the exact amount of time the channels are occupied and in most measurements, the utilisation is zero but a few range from 4-7%.

4.3.2.2 Duty Cycle-2: (Standard Channel Duty Cycle)

It is the **channel's** operation regardless of the time it has operated in. In this case, we count the times the channel has been used (even for a fraction of a millisecond) and increment the counter and finally divide the total channels observed by the total measured (551 channels) and convert to a percentage. This number should be bigger than Duty-Cycle-1 because it calculates the number of channels used regardless of their time of appearance or duration.

4.3.2.3 Duty-Cycle-3:(Real Band Utilisation)

This is the **actual utilisation of each band** in the 15 bands and it is the real occupancy of the band during the measuring time. This calculation takes each individual band occupancy (how many times it appears) and divide it by the number of readings (15K).

4.3.2.4 Duty Cycle-4: Standard Band Utilisation

This is the fourth type of duty cycles which is the **band utilisation** duty cycle and it is the total number that the band has appeared on the readings regardless of the time the band has stayed in operation, then divided by the total number of bands (15) and converted to a percentage.

In our analysis, we will concentrate on the channel duty cycle (Duty Cycle -2) and Band Duty Cycle (Duty Cycle-3 & 4). This is to find out how much these bands are occupied in order to either fully utilise the free bands or to opportunistically utilise the partially utilised bands (Cognitively).

4.3.3 Measurement Details of Ruwi.

The city of Ruwi (N 23:35:53, E 58:32:15) is surrounded by high mountains and has modern land and mobile telecommunication infrastructure. The measurement equipment

was positioned on the top terrace of a seven-storey building, with the antenna placed in the middle of the roof. The building was located on top of a hill overlooking the commercial district of Ruwi, Muscat.

Figure 4-1: Ruwi (N 23:35:53, E 58:32:15)

The measurements were conducted between December 23, 2013, 7:26:57 PM and January 7, 2014, 5:46:57 PM with almost no interruptions. Table 999 below summarises the findings which are explained and analysed in the following subparagraphs and depicted in Figure. 888.

RUWI (A) BAND DUTY CYCLE				
ALL TIME	12AM-6AM	6AM-12PM	12PM-6PM	6PM-12AM
21.80%	17.20%	17.10%	17.60%	17.20%

Table 4-2. RUWI (A) Band DUTY CYCLE

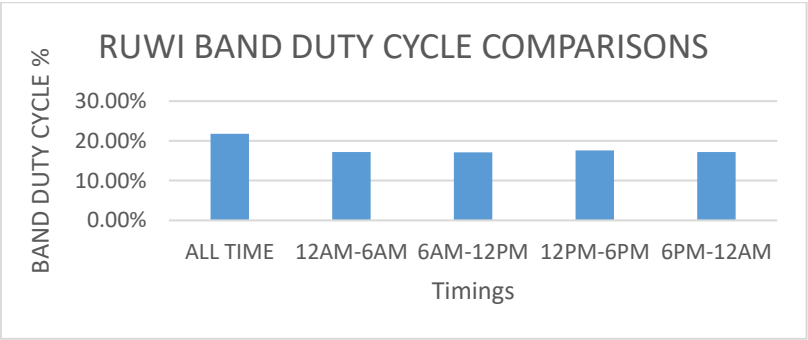


Figure 4-2: RUWI BAND DUTY CYCLE COMPARISONS

4.3.3.1 Analysing Ruwi's Traffic of the Whole Period (two weeks)

With reference to the main data, it is noticed that the maximum peak power detected (traffic) was –6.6 dBm in the FM broadcasting frequencies, whereas the minimum peak power also was in the FM frequencies, at approximately –13.5 dBm, with the average power around -9.78 dBm. The overall duty cycle for the measured band duty cycle (Duty-Cycle-3) was calculated as being around 22% this is in line with similar metropolitan cities around the world, due to the fact that Ruwi is the Commercial Business District (CBD) and the main urban area of the Capital Muscat. [99]

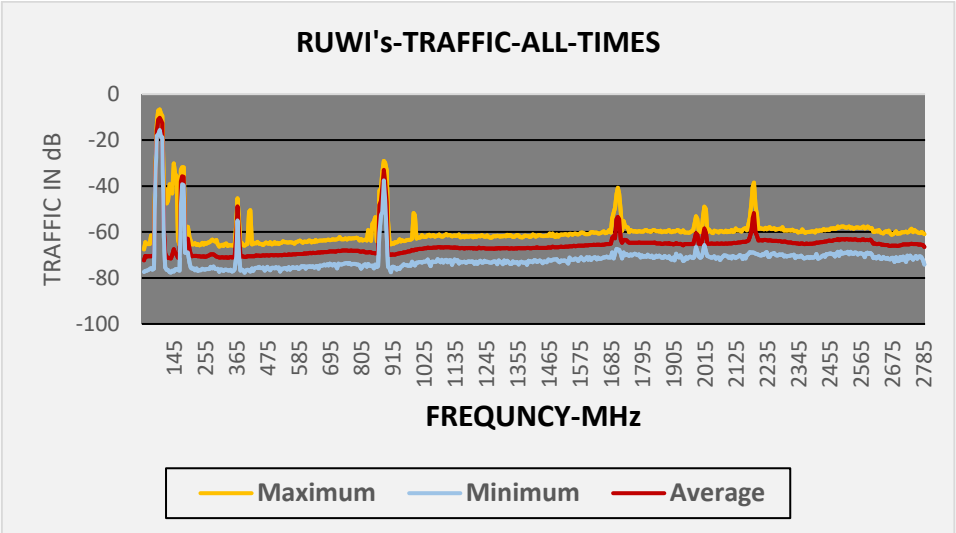


Figure 4-3: Ruwi-TRAFFIC (40MHz–2800 MHz)

The total utilised bands found to be 120 bands out of 551 measured bands. The figure below depicts the utilised bands compared to the total measured bands.

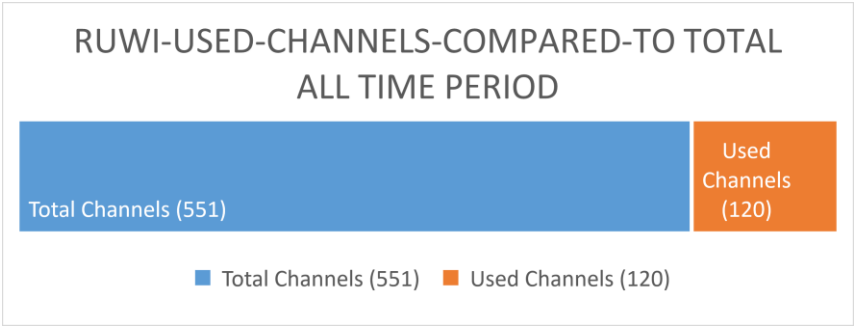


Figure 4-4: Utilised Channels Compared with Total Measured Channels (Ruwi-All)

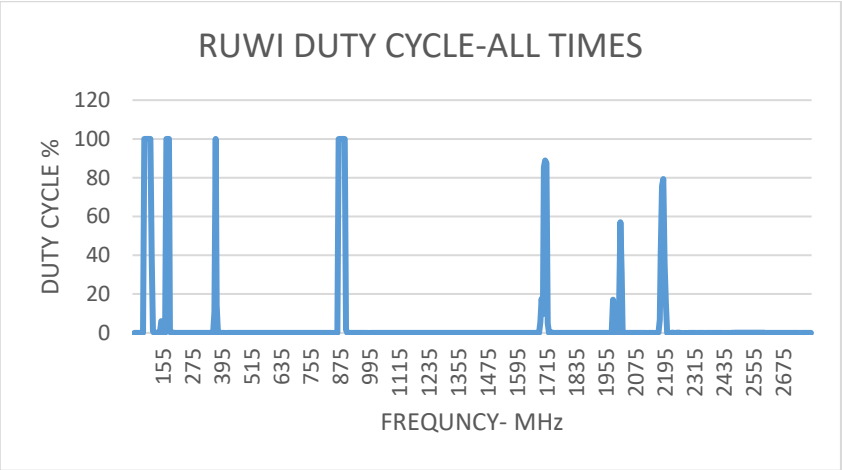


Figure 4-5: Ruwi-Duty-All Time Channel Duty Cycle (Duty Cycle-2)

4.3.3.2 Analysing the Traffic of the Period (12AM-6AM)

When we looked into group 1 (12AM-5:59 AM), we observed that the occupied channels were 95 channels out of 551 measured channels and compared to 120 utilised channels in all the time. Further, the duty cycle for the (12AM-5:59 AM) group found to be %17 compared to %22 of the whole measurement period due to the fact this is the early period of the day.

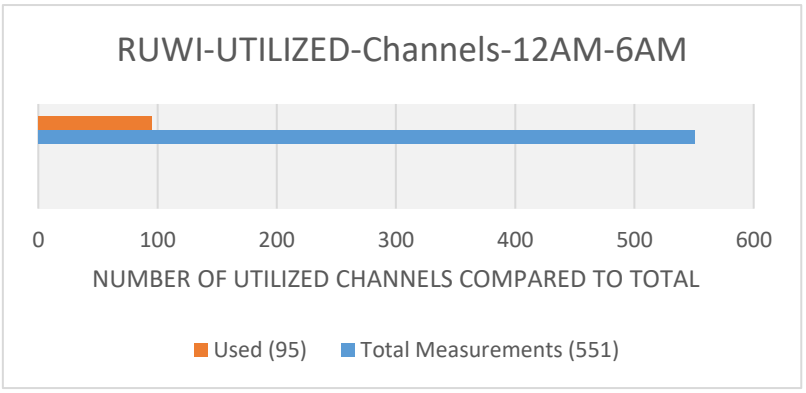


Figure 4-6. Ruwi Utilized Bands Compared with Total - 12AM-6AM

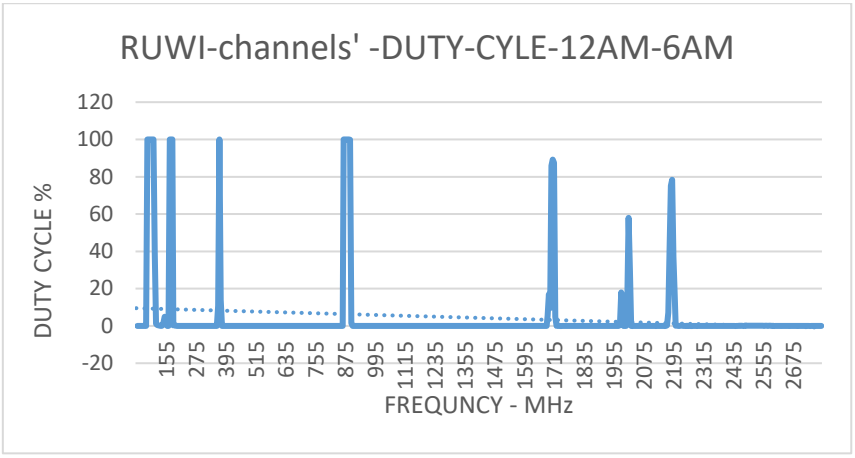


Figure 4-7. Ruwi Channel Duty Cycle for 12Am-6AM

4.3.3.3 Analysing the Traffic of the Period (6AM-12PM)

Moving to the analysis of the 6AM-12PM, we noticed that the total channels detected were 94 with little increase in the traffic. Additionally, the channel duty cycle of this period measured found to be %17 which are similar to the previous period.

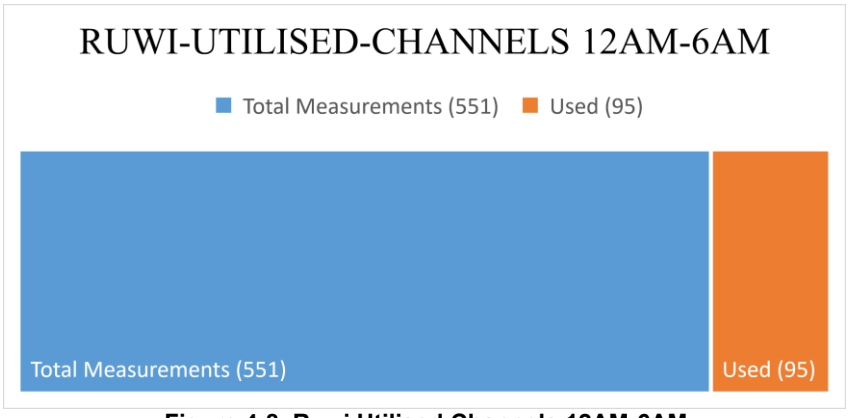


Figure 4-8. Ruwi Utilised Channels 12AM-6AM

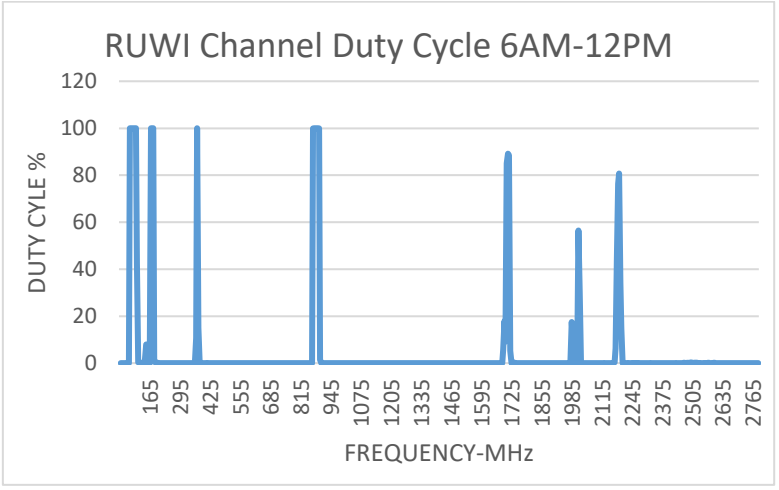


Figure 4-9. RUWI Channel Duty Cycle 12AM-6AM

4.3.3.4 *Analysing the Traffic of the Period (12PM-6PM)*

Moving to the period of 12 PM to 6 PM, we found that 97 channels had been utilised compared to the total of 551. And the duty cycle found to be %17.6 with a little increase from the previous period.

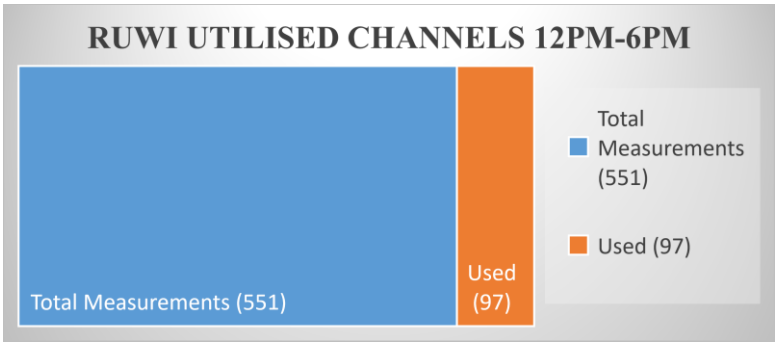


Figure 4-10. Ruwi Utilised Channels 12PM-6PM

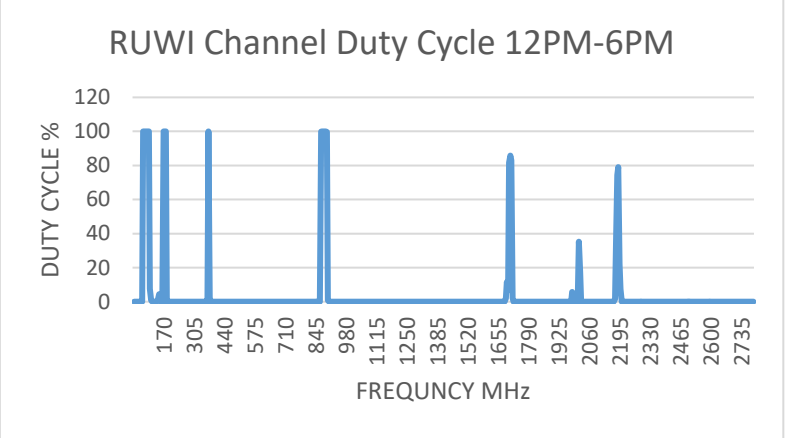


Figure 4-11. RUWI Channel Duty Cycle 12PM-6PM

4.3.3.5 *Analysing the Traffic of the Period (6PM-12AM)*

And finally, the 6PM-12AM measurement and analysis found that the utilised channels were 95 channels compared to the 551 measured and this is in line with the other periods. Additionally, the duty cycle of the same period found to be just over %17.

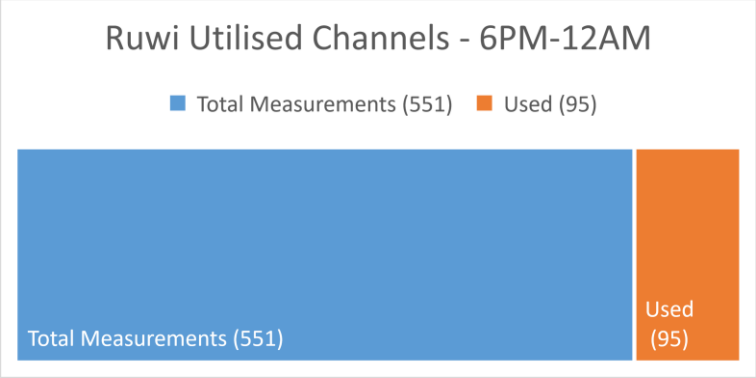


Figure 4-12. Ruwi Utilised Channels 6PM-12AM

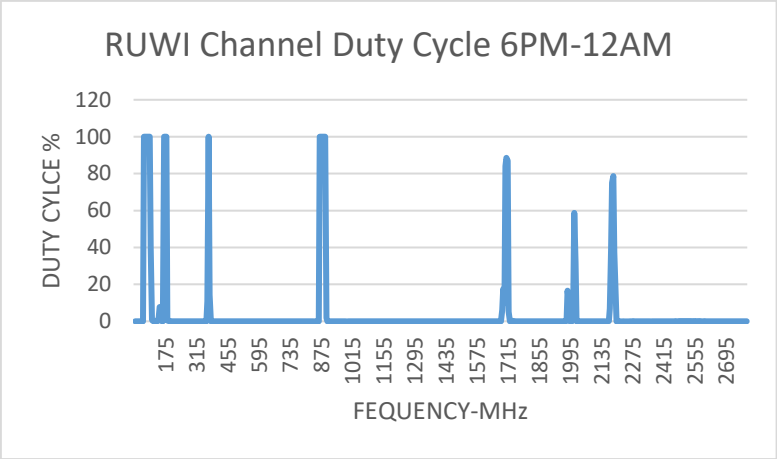


Figure 4-13: RUWI Channel Duty Cycle - 6PM-12AM

4.3.4 Measurement Details for AlGhobrah

AlGhobrah is located at bearings N 23.36.4, E 58.24.19. The measurement equipment was positioned on the rooftop of a three-storey building, with the antenna placed in the middle of the roof.

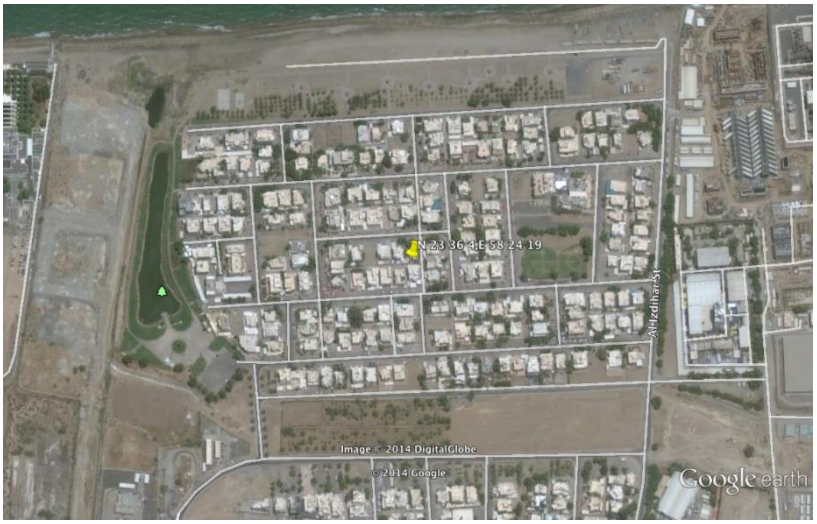


Figure 4-14: Alghobrah (B): N 23 36 4, E 58 24 19

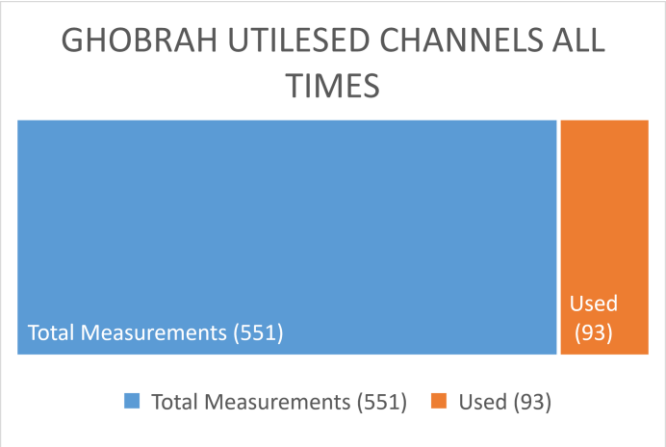


Figure 4-15.Ghobrah Utilised CHANNELS All Times

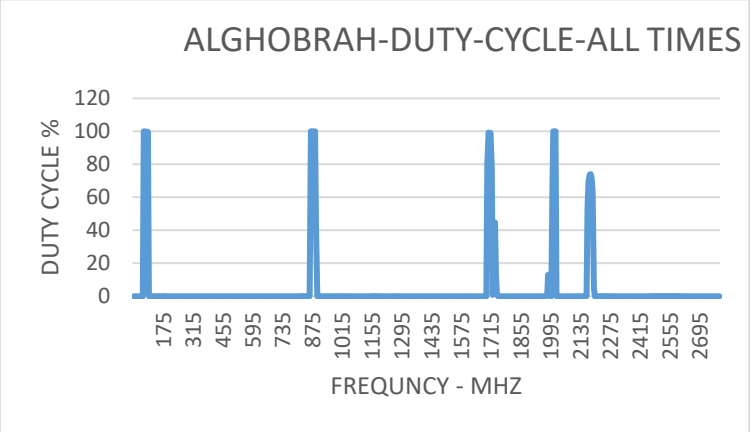


Figure 4-16. Ghobrah Channel Duty Cycle-All Times

ALGHOBRA·(B)·Channel·DUTY·CYCLE¤				
ALL·TIME¤	12AM-6AM¤	6AM-12PM¤	12PM-6PM¤	6PM-12AM¤
16.9%¤	10.9%¤	11.3%¤	12.2%¤	13%¤

Table 4-3. Alghobrah Channel Duty Cycle

The first six hours of the day the band usage was 16.9%. whereas the period of 6AM-12PM was 11%, next six hours' usage was 12.1. The channels duty cycle for the period of 12PM-6PM calculated to the 12.2% which is slightly higher than the 12AM-6AM. As the fourth period of the day (6PM-12AM) concerned, the channels duty cycle was 13.1% which is the highest in the whole day.

When taking the measurements, it was noticed that Band 1 channels were not utilised at all, whereas Band 2 channels were utilised to a total of 75%, with Band 3 channels utilised to 22.8%. On the other hand, Bands 4–9 were totally unutilised. The range of utilisation across bands 11, 12, 14 and 15 was as low as between 2.1% and 7.4%, which

fall within the White Space (WS) category. However, Band 10 was more than 50% utilisation. Finally, 33.3% utilisation was observed in Band 13.

4.3.5 Measurement Details for Alkhodh

Alkhodh is close to the Muscat International Airport and is the location for the Sultan Qaboos University. It is a very fast-developing area. It is both a residential and commercial area at bearings N23.37.10 E58.12.19.

Figure 4-17: Alkhodh (C): N 23 37 10, E 58 12 1

The total utilised channels for the whole period found to be 99 channels out of the 551 measured while the overall duty cycle for the measured spectrum was calculated to be around 18%%. The channel usage for the periods of 12AM-6AM, 6AM-12PM, 12PM-6PM and 6PM-12AM found to be 70, 89,95 and 83 channels, whereas the channel usage for those periods calculated to be 13%%, 16%, 17%% and 15% consecutively.

AlKhodh (C) Channel Duty Cycle				
ALL TIME	12AM-6AM	6AM-12PM	12PM-6PM	6PM-12AM
18%	13%	16%	17%	15%

Table 4-4: AlKhodh Channel Duty Cycle – All Periods

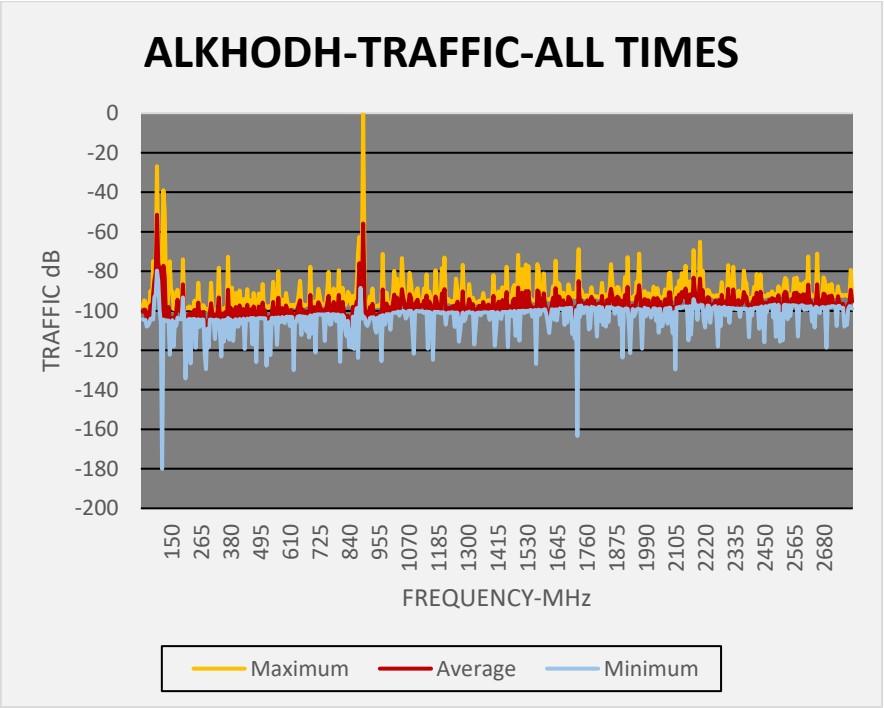


Figure 4-18, Alkhodh Spectrum Traffic All Times

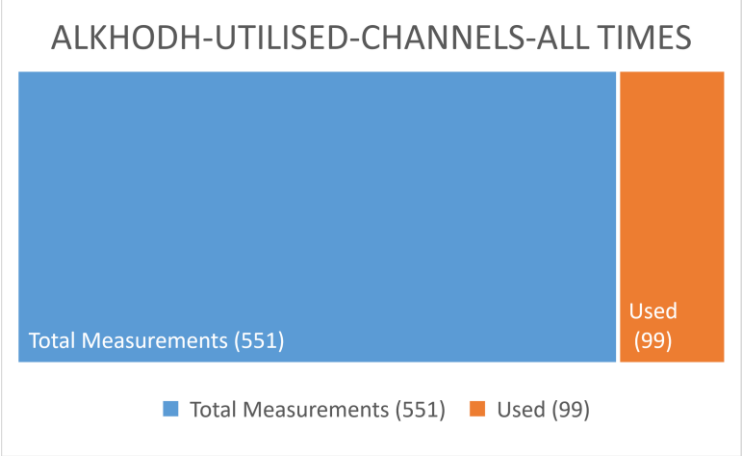


Figure 4-19.Alkhodh Channels Usage Compared to Total

4.3.6 Measurement Details for Salalah

Salalah is the second largest city in Oman with a population of more than 150,000; this population quadruples during the summer months due to its uniquely cool and rainy tropical climate, with monsoon wet winds blowing in from the Indian Ocean, forming light-to-moderate rains that transform mountains to lush green milieu. Salalah is located in the South of the country (N 17.1.38, E 54.9.35), with a distance of 1,000 km from Muscat—the capital.

Figure 4-20: Salalah (D)- N 17 1 38, E 54 9 34

The measurement system was placed on top of a four-storey residential building located on the outskirts of the city.

SALALAH (D) CHANNEL DUTY CYCLE – ALL PERIODS				
ALL TIME	12AM-6AM	6AM-12PM	12PM-6PM	6PM-12AM
24%	16.2%	16.7%	16.7%	15.97

Table 4-5: SALALAH (D) CHANNEL DUTY CYCLE – ALL PERIODS

The total utilised channels for the whole period found to be 132 channels out of the 551 measured while the overall channel duty cycle for the measured spectrum was calculated to be around 24%%. The channel usage for the periods of 12AM-6AM, 6AM-12PM, 12PM-6PM and 6PM-12AM found to be 89, 92,92 and 88 channels, whereas the spectrum usage (duty cycle) for those periods calculated to be 16%%, 16.7%, 16.7%% and 16% consecutively.

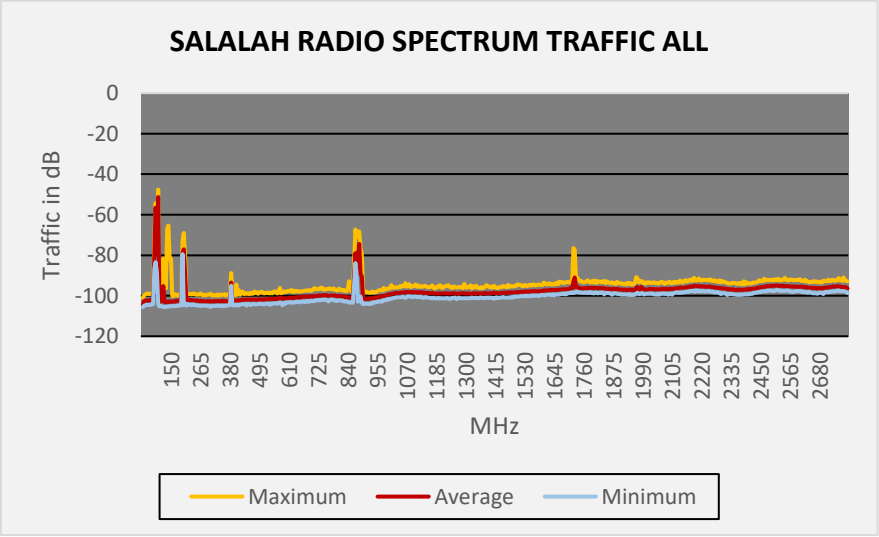


Figure 4-21 SALALAH RADIO TRAFFIC ALL TIMES

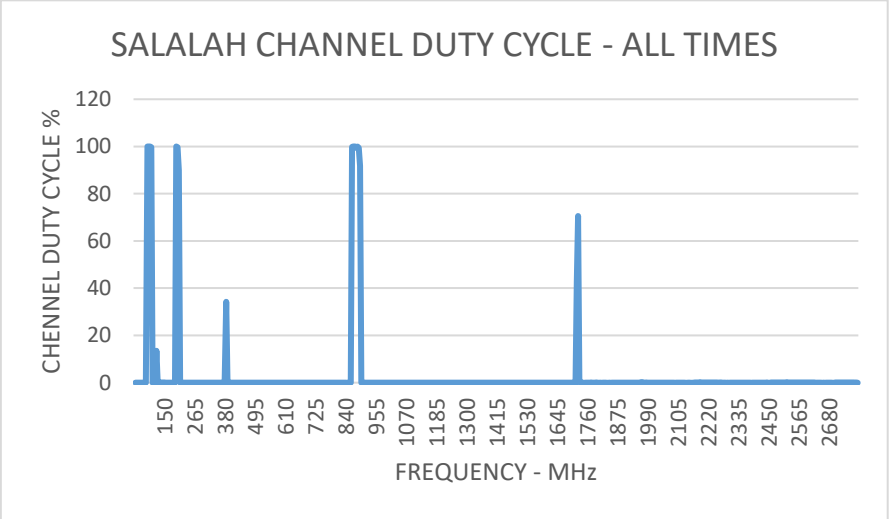


Figure 4-22. SALALAH Channel Duty Cycle all Time

4.3.7 Measurement Details for Ibri

Ibri City is located 300 km West of Muscat, between the mountains and the Empty Quarter Desert, with a population of 45,000. It is recognised as a hub for communication backhaul. The measurement system was placed on top of a three-storey residential building located in the centre of the city (N 17.1.38, E 54.9.34).

Figure 4-23: Ibri (E)- N 23 14 7, E 56 30 50

Being a mid-sized town with less population than the other four locations, the total utilised channels for the whole period for Ibri found to be 57 bands out of the 551 measured while the overall duty cycle for the measured spectrum was calculated to be around 10.3%%. The channel usage for the periods of 12AM-6AM, 6AM-12PM, 12PM-

6PM and 6PM-12AM found to be 35, 40, 34 and 34 channels, whereas the duty cycle for those periods calculated to be 6.4%%, 7.4%, 6.2%% and 7.1% consecutively.

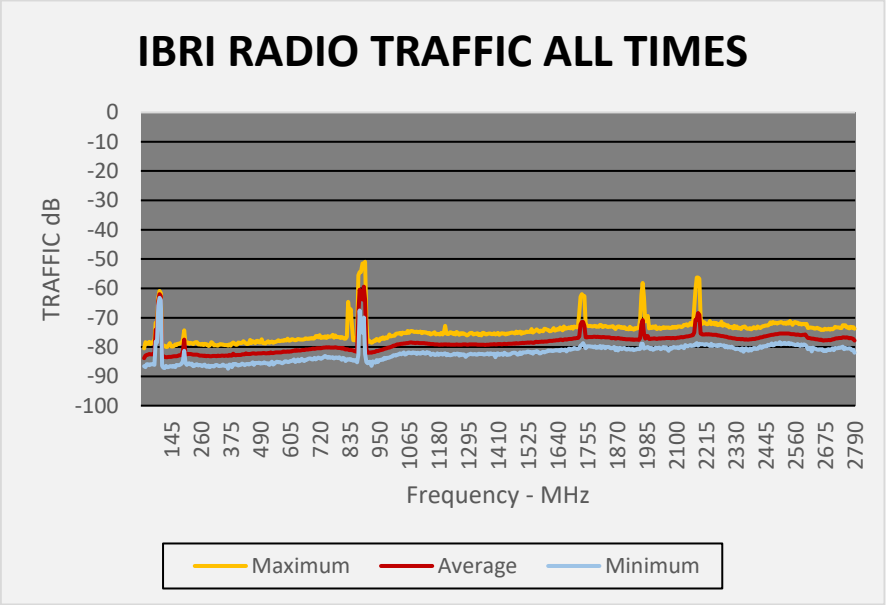


Figure 4-24: Ibri Radio Traffic All Times

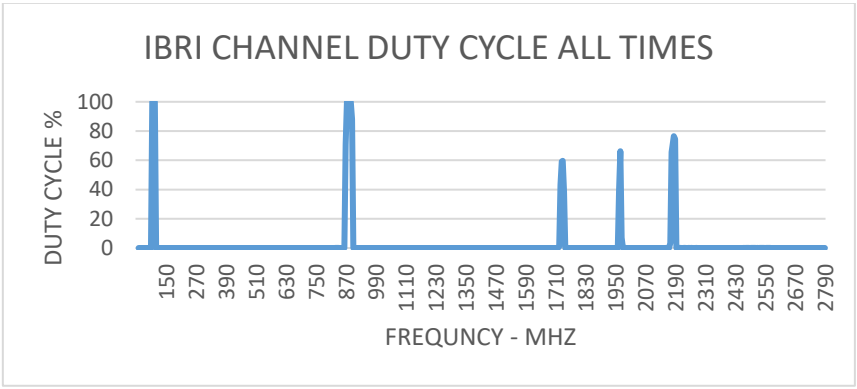


Figure 4-25: Ibri Channel Duty Cycle All Times

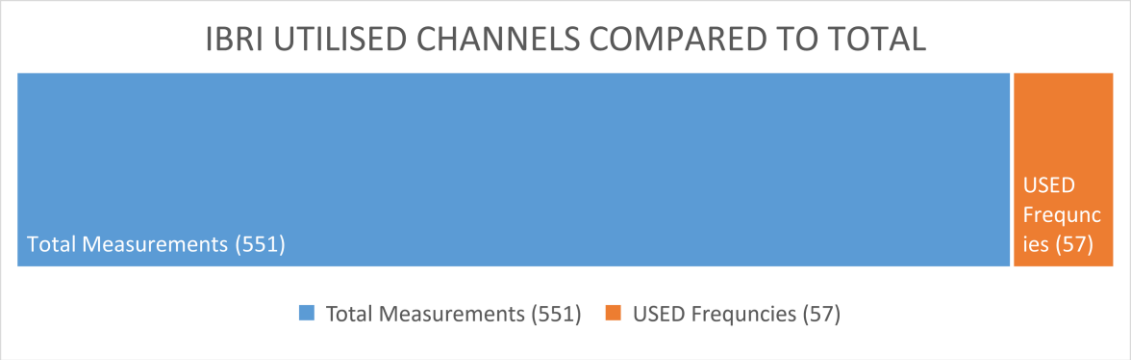


Figure 4-26: Ibri Utilised Channels

4.3.8 Band Utilisation (Duty Cycle-4)

Table.4-6 below summarises the band measurements across all five locations. It comprises five columns and fifteen rows. The column indicates all five locations, whilst

the rows show all fifteen bands' occupancy. Description of all bands' allocations and assigned services are shown in Table below.

The data is divided into two parts: the first is to find the duty cycle of each band across all locations; the second states the duty cycle of all bands for a specific location. The two locations Location A (Ruwi) and Location C (Alkhodh) detected using Band 1 at 20% usage whilst the other three locations using Band 1 at 10% usage. As far as Band 2 is concerned, Ruwi, together with Location B (Al Ghobrah) and Location C (Alkhodh) were found to be using to the maximum. Location D (Salalah) and Location E (Ibri) used this band approximately 75% of the time. The time utilisation of Band 3 was found to vary in relation to the five locations; thus, Ruwi utilises 69.57%, Salalah 43.48%, ALGobrah 30.43%, Alkhodh 26.09%, and Ibri 0%. Band 4 is lightly utilised in Alkhodh 11.11%, Ruwi at 8.33% and Salalah at 2.78%, whilst the two other locations do not use this band at all and remain completely free at ALGobrah and Ibri. Similarly, Band 5 is lightly utilised in Ruwi at 14.29% whilst it remains completely free at ALGobrah, Alkhodh, Salalah and Ibri.

Table 4-6. Band by Band Utilisation for All Locations, All Times in percent of time domain

Band	Frequency span(MHz)	Ruwi	Al Ghobrah	Alkhodh	Salalah	Ibri
1	40-88	20%	10%	20%	10%	10%
2	88-108	100%	100%	100%	75%	75%
3	108-223	69.57%	30.43%	26.09%	43.48%	0%
4	223-400	8.33%	0%	11.11%	2.78%	0%
5	400-470	14.29%	0%	0%	0%	0%
6	470-566	0%	0%	15.79%	0%	0%
7	566-606	0%	0%	0%	0%	0%
8	606-806	0%	0%	10%	0%	0%
9	806-890	47.06%	58.82%	29.41%	41.18%	47.06%
10	890-960	14.29%	7.14%	7.14%	7.14%	14.29%
11	960-1215	3.92%	13.73%	21.57%	0%	0%
12	1215-1710	5.05%	4.04%	17.17%	1.01%	0%
13	1710-1880	17.65%	20.59%	14.71%	44.12%	14.71%
14	1880-2170	18.97%	17.24%	18.97%	15.52%	15.52%
15	2170-3000	47.58%	33.87%	20.97%	67.74%	23.39%

Band 6 and 8 is only utilised by Alkhodh at 15.79% and at 10% respectively due to its location near the airport and military camps, whereas Band 6 and 8 remain completely unused in other four locations Ruwi, ALGobrah, Salalah and Ibri. Similarly, Band 7 remain completely free of utilisation in all five locations. Band 9 is highly utilised by ALGobrah, Ruwi, Ibri and Salalah with percentages ranging 41.18%-58.82% and Alkhodh utilisation of this band is 29.41%. Band 10 is utilised 14.29% by Ruwi and Ibri whilst 7.14% by ALGobrah, Alkhodh and Salalah. Band 11 is completely free at locations Salalah and Ibri but is lightly utilised by Ruwi, ALGobrah and Alkhodh, with a range of utilisation between 3.92%-21.57%. Similarly, Band 12 has never been utilised in location Ibri, but is moderately utilised in Alkhodh 17.17% and lightly utilised at Ruwi 5.05%,

ALGobrah 4.04% and Salalah 1.01%. Band 13 is moderately utilised in two locations, namely Salalah and Al Ghobrah at 44.12% and 20.59% respectively. Elsewhere, it is slightly utilised at Ruwi 17.65% and 14.71% at Alkhodh and Ibri. Band 14 is lightly utilised in all five locations ranging 15.52%-18.97%. Ruwi and Alkhodh utilised 18.97%, Al Ghobrah 17.24%, whilst Salalah and Ibri utilised at 15.52%. Finally, Band 15 is moderately utilised in Salalah 67.74%, Ruwi 47.58%. Whilst slightly utilised in ALGobrah 33.87%, Ibri 23.39% and Alkhodh 20.97%. Figure. 4-27 is a representation of such findings.

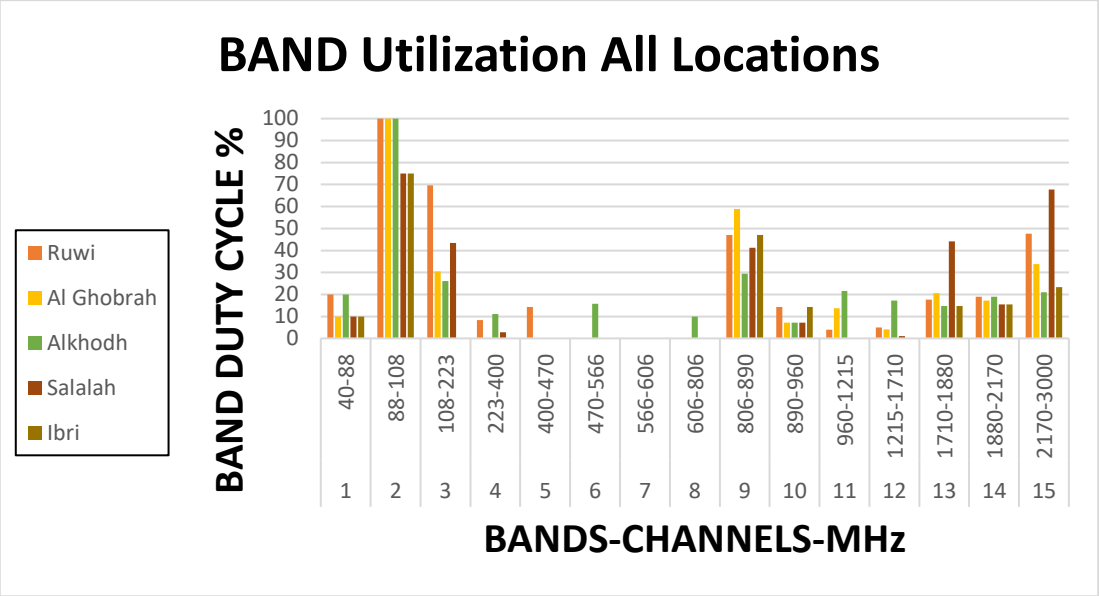


Figure 4-27. Band by Band Utilisation for all Locations and for all Times

4.3.9 Duty Cycle-1

Now the final question to be asked, how much really is the utilised channels are in operation. Are they operating 100% of the duty cycle? In fact, the duty cycle of the occupied channels is very low. The table and figure below depict that. The numbers range between 7% in Ruwi down to 4% in Ibri. This is really good news for the Regulators.

Location	Utilised Channels Duty Cycle % (Duty Cycle-1)
Ruwi	6.5%
AlGhobrah	6.2%
AlKhodh	7.1%
Salalah	4.2%
Ibri	4%

Table 4-7. Utilised Channels Duty Cycle % in All Locations – Duty Cycle -1

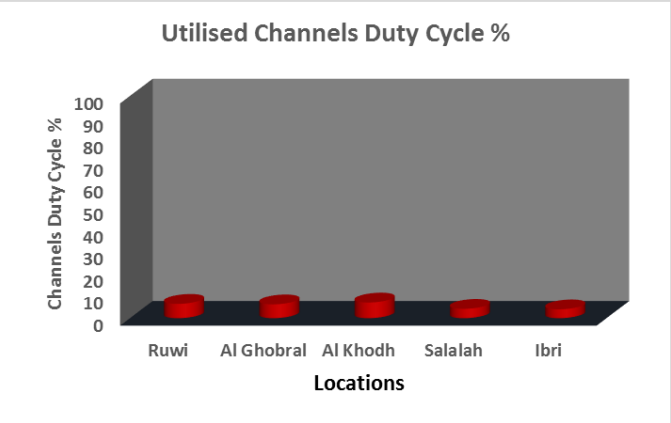


Figure 4-28. Utilised Channels Duty Cycle % in All Locations – Duty Cycle -1

4.4 SPECTRUM OCCUPANCY FORECAST

In our spectrum survey, we have collected spectrum occupancy data for five locations for two weeks each. Furthermore, we have analysed and presented the findings for each location. Although two weeks' data seems to be enough to draw a conclusion of the spectrum occupancy behaviours, it is by no means that the traffic would remain the same for longer periods. To obtain more spectrum occupancy data for the same location to study and analyse the spectrum behaviours over eight weeks, we must generate the data using one of the forecast and prediction algorithms. Thus, we have used Exponential Smoothing Algorithm that evaluates previous observations. The algorithm uses exponentially decreasing weightiness as the observation get older to predict future values thus, current observations are given more weightiness in predicting than the older observations. In the case of affecting averages, the weights given to the observations are identical and are equal to 1/N. In exponential smoothing, though, there are one or more smoothing constraints to be determined and these selections govern the weights given to the observations. Therefore, we will apply the Exponential Smoothing (ETS) algorithm for each location's data collected using MS Excel 2016 built in a tool [100].

Excel 2016 offers a new tool named Forecast Sheet that inevitably computes and plots the upper and lower forecast limits constructed on the anticipated level of confidence, and this tool is intelligent enough to estimate and integrate seasonality into the upper and lower

boundary estimates. The tool uses the FORECAST.ETS.CONFINT function and we will be using it to predict the spectrum trends for six weeks using the two weeks' real data. Applying the function's syntax will return a confidence interval for the prediction value at the quantified goal data. A confidence interval of 95% indicates that 95% of forthcoming points are predicted to be within this range from the result FORECAST.ETS predicted (with typical distribution). Using confidence interval can promote the accuracy of the predicted model. A smaller interval would indicate more confidence in the prediction for this precise point [101].

The syntax is:

FORECAST.ETS.CONFINT(target_date, values, timeline, [seasonality], [data_completion], [aggregation]). Where:

- **Target date:** the date point for which to predict a value**.**
- **Values …...:** the historical values to forecast the subsequent points.

- **Timeline**: the range of numeric date (independent array). The date's array in the timeline should have a consistent period between them and should not be zero. The FORECAST.ETS.CONFINT will sort the timeline automatically.
- **Confidence level:** this is **o**ptional. It is a numerical value between 0 and 1 and it indicates a confidence level for the intended confidence interval. For instance, for a 90% confidence interval, a 90% confidence level will be calculated (90% of upcoming points are to fall inside this radius from prediction). The default value of the confidence level is 95%.
- **Data completion:** this is another **o**ptional variable. It is used to fill up to 30% missing data by automatically adjusting it. Setting the value to 0 instructs the function to replace missing points with zeros. When the value of 1 is set, the missing data will be completed by the average of the neighbouring points.

- **Aggregation** (optional): Although the timeline uses a constant step between data points, FORECAST.ETS.CONFINT will aggregate several points that have the same time stamp. The aggregation value is a numeric signifying which process will be used to aggregate many values with the exact time stamp. When this value is set to zero (default) it will use AVERAGE, and the other options are SUM, MIN, MEDIAN, MAX, COUNT and COUNTA.

After applying the function on the two weeks collected spectrum survey data to forecast six weeks' spectrum traffic in the 40-2800 MHz spectrum for all five locations, the system has produced more than 60K readings for the spectrum of (40-2800 MHz). That includes the original 15K reading span. And when calculating the channel duty cycle and compared to the original ones, it was surprisingly found to be equal to the original calculations.

We have obtained almost the same readings as the two weeks'. It seems that a large number of records started with (15K readings for each channel or a total of more than 8M readings) for each location have almost repetitive readings to derive the forecasted data from. Therefore, spectrum survey for two weeks is recommended for future spectrum occupancy survey unless there is a special reason or need. The figures below depict the eight weeks' data traffic and duty cycle forecast for the five locations.

4.4.1 Analysing the Forecasted Spectrum Occupancy

Table. 4-10 below compares the real two weeks' duty cycle with the forecasted six weeks for all five locations. The data also presented in Figure. 4-29.

Location	Real Two Weeks' Duty Cycle %	Forecasted Eight Weeks' Duty Cycle %	Difference %
Ruwi	21.8	21.2	0.6
AlGhobrah	16.9	16.2	0.7
AlKhodh	18.14	17.98	0.16
Salalah	23.96	22.69	1.27
Ibri	10.53	10.34	0.19

Table 4-8: **Two Weeks' VS Eight Weeks' Duty Cycle**

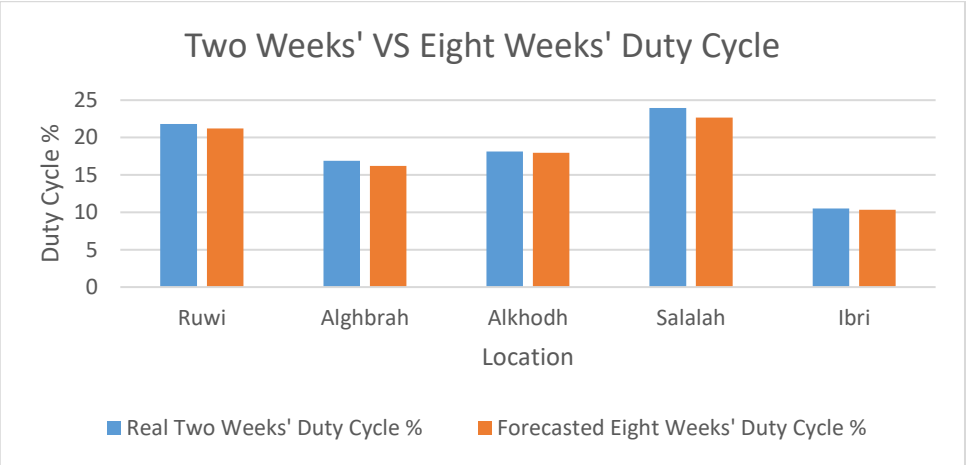


Figure 4-29: Two Weeks' VS Eight Weeks' Duty Cycle

It is noticed that the difference between the two periods ranges from %-0.16 to %-1.27 therefore, we conclude that the radio spectrum traffic has decreased slightly as time increase and this could be due to the accumulation of weekends traffic found in the 15K records. For the forecast to be more accurate, the spectrum occupancy survey should be taken for a longer period to cover all possible spectrum occupancies in all seasons. Alternatively, the data could be obtained from the Service Providers' historical traffic DBs.

4.5 CONCLUSION

The licensed radio spectrum has been found to be underutilised most of the time according to the recent spectrum occupancy measurements campaigns around the world, whereas the unlicensed radio spectrum is over utilised. To prove this concept, and in order to find out the radio spectrum occupancy for the lower 3 GHz spectrum as part of the problem identification for the research, the researcher has conducted similar measurement campaign for five cities in Oman. The campaign has confirmed that the spectrum of 40-2800 MHz is underutilised except that is being used for FM broadcasting and mobile communications, mainly 100, 900, 1800 and 2600 MHz. Further, the study has found that the spectrum of 470-780 MHz is almost idle for the elapsed time of the measurement. Additionally, eight weeks' spectrum traffic on the 40-2800 MHz has been generated using Exponential smoothing algorithm and utilising MS Excel 2016 function named "FORECAST.ETS.CONFINT" which has confirmed the initial findings collected by the

spectrum occupancy survey and the analysis; therefore, the findings will be added to the thesis document and will be utilised for the implementation of the proposed solution for the simulation in this research along with recommendations for the authority.

5. IMPLEMENTATION OF THE PROPOSED SOLUTION

The proposed solution for the research question is answered by simulating the implementation of the proposed solution using LTE-A operating on the TVWS.

5.1 INTRODUCTION

Radio spectrum measurements for the frequency of 40 MHz to 2800 MHz for five locations in Oman have been collected and analysed in the previous chapter. The data was filtered and grouped into 15 bands along with the services allocated to the table in chapter 1.

During the phase of the continues of the literature review and the publications read, it is observed that all researches and studies have been geared towards applying CR and TVWS technology to replace/complement existing traditional wireless technology (3G, 4G/LTE and WiMAX). Some experiments have been conducted to utilise the TVWS technology in order to connect two or more points and use Wi-Fi technology to provide local access to the Internet. Other experiments have been carried out to use TVWS technology to replace the existing traditional technologies. In other words, most of the experiments and studies on TVWS and CR technologies have been applied to a green field type of experiment. If this kind of studies and experiments lead to the development of hardware and customers start to use such technology, then we will be back to the same level of radio spectrum scarcity. This time in the TVWS spectrum, which used to be under-utilized.

The prospective TRA's regulations may decree that all channels listed in the DB are licensed for the WISPs. In this case, one vacant channel would be granted exclusively for one device's user at a time and must be marked as occupied in the DB so no other device can use the same. The TRA's regulations may stipulate that the channels are permitted to be opportunistically utilised. That means these channels are shared between PU and SU giving the PU the right of access at any time. In this case, the SU device must fetch two

vacant channels from the DB; one channel as the main and the second as the backup. For this situation, the SU must keep listening to the PU request for any of those two channels and should drop either one and fetch another for main/backup.

With reference to the Literature Review chapter and the related researches, it is clear that TVWS spectrum has many advantages over the traditional wireless broadband spectrum used for 3G, WiMAX and LTE /4G (900, 1800 and 2600 MHz). The primary advantages of the TVWS spectrum can be identified in terms of its excellent prorogation characteristics of the signal, amongst them being the long range of coverage and great obstacles' penetration [102].

In recent years—and in an effort to offer more spectrum to mobile wireless service providers—TVWS standards and regulations have been sanctioned to utilise the TV spectrum vacated after the switchover to Digital TV, as mentioned in the previous chapters. Accordingly, many research institutions and service providers, with regulators, conducted many different experiments centred on building TVWS networks. All of these experiments applied geolocation databases technique so as to decide whether or not an individual channel is vacant or utilised in a particular area and at a particular time; if not, the channel then can be employed as long as the owner or licensee has not asked for it. Otherwise, the secondary user has to vacate the channel, and it is declared vacant [103].

5.2 PROPOSED ALGORITHM

We are proposing a technique through our algorithm to balance the services provided by Service Providers by switching subscribers (Devices) to TVWS service if only the traditional wireless wideband services are congested. The algorithm can also be used where the traditional services are not available such as rural areas. Our algorithm will maximise the wireless broadband service availability, quality and speed and minimise interferences in the traditional broadband spectrum such as (3G, 4G/LTE and Wi-Max). It will utilise the geolocation TVWS database channels. The algorithm when is coded to the SPs'

controlling system will fetch one vacant channel for communication and mark it as occupied. When the connection terminated, the channel is released and the DB is updated to show that the channel is vacant now.

The algorithm along with the database will be installed centrally on the WISPs controlling system in each AP's system. The system will be checking the network traffic and interference by comparing the traffic with a fixed threshold of each AP. If the traffic reaches a point close to the predetermined threshold or it is causing interferences, then the algorithm/system will parent new subscribers to an AP operating on the TVWS and update the DB accordingly. This is taking into consideration that each location may have its own free TVWS channels.

In addition, from the point of view of the APs, the algorithm will check individual services on each AP to determine the overall performance of that AP for that specific service. If the performance degraded to a point close to the setup threshold, then the system will switch next coming subscriber to TVWS service in the same AP if a vacant channel is found. Otherwise, the subscriber will be put on a waiting list until a channel is found.

5.2.1 System Model

We assume that the number of APs is N and defined as $\{AP_0, AP_1, \dots, AP_n, \dots, AP_N\}$, where $n \in N$. Furthermore, we assume that the number of the databases equals to the number of Aps= $\{DB_0, DB_1, \dots, DB_N\}$, and $TCH_{DB_n,}$ is the total number of channels of any database DB_n (Number of records in the database) = $\{TCH_{DB_0,}, TCH_{DB_1,}, \dots, TCH_{DB_N}\}$.

$\boldsymbol{D_n}$ is the number of subscribers (devices) of any AP =$\{\boldsymbol{D_0}, \boldsymbol{D_1}, \dots, \boldsymbol{D_N}\}$, and $\boldsymbol{DEV_{x,n}}$ is any device in the $\boldsymbol{AP_n}$ = $\{\boldsymbol{DEV_{0,n}}, \boldsymbol{DEV_{1,n}}, \boldsymbol{DEV_{2,n}} \dots\dots, \boldsymbol{DE_{D_n,n}}\}$. We assume that each service m where $\boldsymbol{m \in M}$ has a specific maximum transmit power (i.e. threshold) $\boldsymbol{\lambda_{n,m}}$.

5.2.2 Algorithm – Decision Making Procedure

When a $\boldsymbol{DEV_{x,n}}$ requests a service $\boldsymbol{SAP_{n,m}}$ from $\boldsymbol{AP_n}$. First, $\boldsymbol{AP_n}$ will determine the transmission power $\boldsymbol{P_{n,m}}$ of that service, then compares it with $\boldsymbol{\lambda_{n,m}}$.If $\boldsymbol{P_{n,m}}$ is smaller than $\boldsymbol{\lambda_{n,m}}$, then $\boldsymbol{AP_n}$ accepts the requested traditional service and starts transmitting. Otherwise, $\boldsymbol{AP_n}$ must check its database ($\boldsymbol{DB_n}$) for a vacant channel and if there is available channel, then assign it to an the device and make it as occupied in the database. However, if there is no vacant channel, the $\boldsymbol{AP_n}$ will put $\boldsymbol{DEV_{x,n}}$ in the waiting queue.

5.2.3 Algorithm Flowcharts

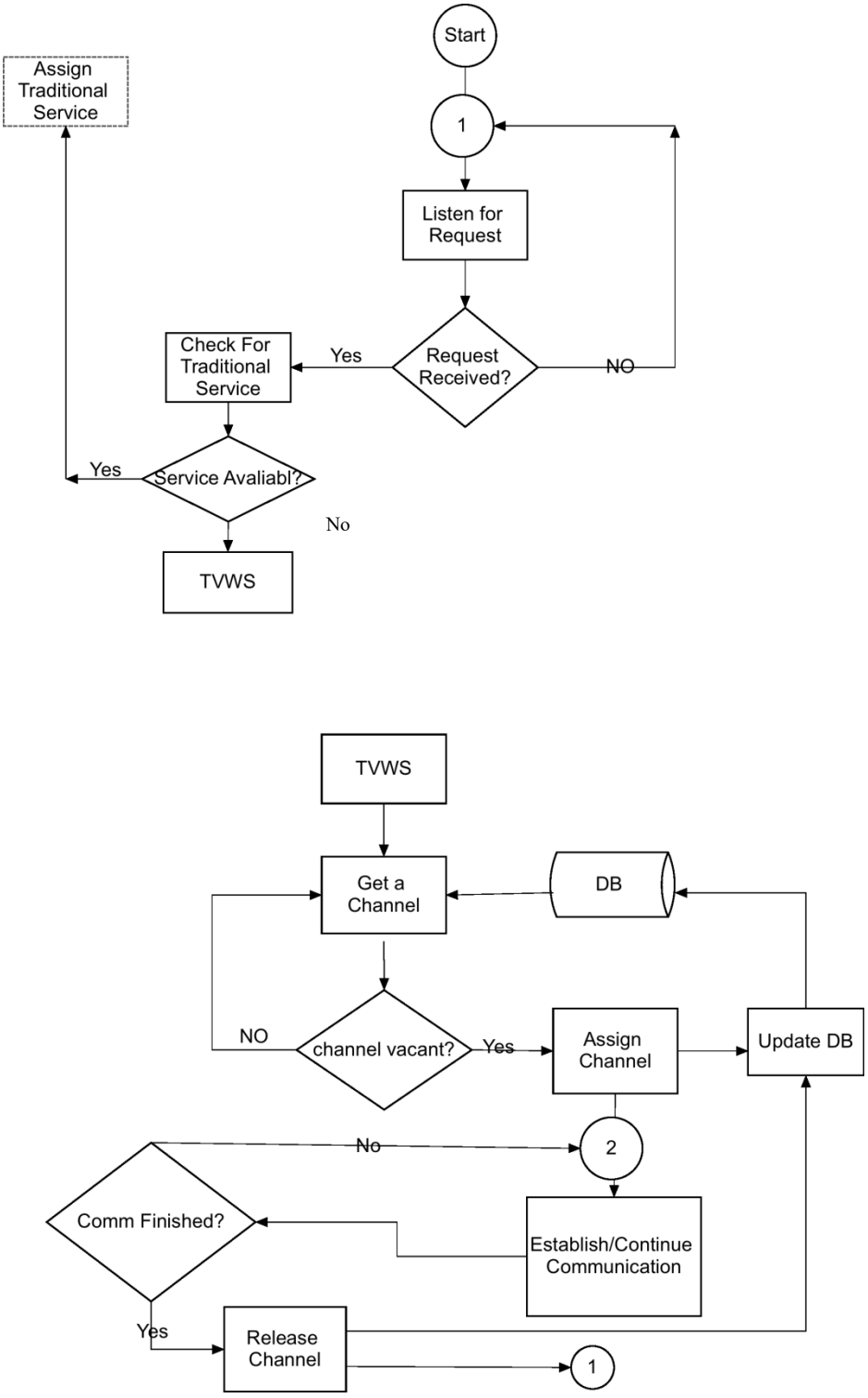


Figure 5-1. Flowchart of Algorithm

5.2.4 Algorithm1 Pseudo Code

Algorithm1- Assigning a TVWS service	
1	N is the number of Access Points = $\{AP_0, AP_1, \dots, AP_N\}$
2	M is the number of services provided by an AP = $\{SAP_{n,0}, SAP_{n,1}, \dots, SAP_{n,M}\}$, where $n \in N$
3	D_n is the total number of Devices of any AP_n= $\{D_0, D_1, \dots, D_N\}$
	$DEV_{x,n}$ is any device in the AP_n = $\{DEV_{0,n}, DEV_{1,n}, DEV_{2,n} \dots\dots, DEV_{D_n,n}\}$
4	$\lambda_{n,m}$ is the thrushold of any service in any AP
5	$P_{n,m}$ is the transmission power of m service of n AP
6	N is the number of databases $\{DB_0, DB_1, \dots, DB_N\}$
7	TCH is the total number of channels of any database (Number of records in the database) = $\{TCH_{DB_0}, TCH_{DB_1}, \dots, TCH_{DB_N}\}$
8	$DEV_{x,n}$ is any device in the AP_n = $\{DEV_{0,n}, DEV_{1,n}, DEV_{2,n} \dots\dots, DEV_{D_n,n}\}$
9	Assume the system is listening to a request for a service m from a device $DEV_{x,n}$
10	**if** the request from that device is valid **then**
11	AP_n is authorized to start processing the request
12	AP_n calculates $P_{m,n}$
13	Check the threshold of the $\lambda_{m,n}$
14	**if** $P_{m,n} \succ \lambda_{m,n}$ **then**
15	flag=0 : indicator
16	call TVWS call Algorithm2
17	**if** flag=0 **then**
18	put $DEV_{x,n}$ in waiting list queue
19	**else** assign ch_{c,DB_n} to $DEV_{x,n}$
20	**endif**
21	**else** start/continue transmitting
22	**endif**
23	**else** reject the request
24	**endif**
25	**Repeat** the algorithm for a new request

Figure 5-2. Algorithm1 Pseudo Code

5.2.5 Algorithm2 Pseudo Code

Algorithm2 – Finding a vacant TVWS channel in the database DB_n	
1	$TCH_{DB_n,}$ is the total number of the channels in this database, where the channels are $\{ch_{0,DB_n}, ch_{1,DB_n}, ch_{2,DB_n},, \dots, ch_{TCH_{DB_n},DB_n}\}$
2	$O_{ch_{y,DB_n}}$ Is the **status** of any channel of the database DB_n and equals 0 or 1 (0=not occupied, 1=occupied) and ch_y is any channel in the database DB_n
3	C=0: a counter
4	**fetch** ch_{c,DB_n}
5	**if** $O_{ch_{c,DB_n}} = 0$ **then**
6	The channel is found
7	$O_{ch_{c,DB_n}} = 1$
8	**update** DB_n
9	**else** c=c+1
10	**Goto** step4
11	**endif**
12	**return** to Algorithm1

Figure 5-3. Algorithm2 Pseudo Code

5.2.6 Algorithm Testing

To test the algorithm and obtain some results, we have used MS Excel 2016 to create APs, DBs and Devices. Nine BSs, nine DBs with 6 channels and 20 devices have been initialized. All DBs' channels are initially set up to zero indicating all are vacant before any ND request. When the twenty NDs first request a service from a BS, the system will consult its DB to assign a channel. Table.5-1 shows the initial DBs' channels statues (0=vacant).

DB	CH1	CH2	CH3	CH4	CH5	CH6
1	0	0	0	0	0	0
2	0	0	0	0	0	0
3	0	0	0	0	0	0
4	0	0	0	0	0	0
5	0	0	0	0	0	0
6	0	0	0	0	0	0
7	0	0	0	0	0	0
8	0	0	0	0	0	0
9	0	0	0	0	0	0

Table 5-1: Databases' Channels Initial Status

When we have executed the Run-1 of the code, all 20 NDs got connected to the BSs because all the DBs' channels are vacant. Therefore, 20 channels from most of the nine DBs have been assigned to the requested NDs consequently those channels have been

marked as occupied (status=1). Table.5-2 shows the connectivity of the devices with the BSs whereas Table.5-3 indicates the DBs' channel status after Run-1 whereas Figure.5-5 depicts the total NDs connected to each BS.

Device	DB	Channel
1	1	3
2	1	6
3	2	3
4	2	5
5	2	2
6	2	1
7	3	4
8	3	5
9	4	5
10	4	3
11	4	6
12	5	1
13	6	4
14	7	1
15	8	3
16	2	4
17	3	1
18	6	6
19	9	1
20	8	2

Table 5-2: DBs' Individual Occupied Channels After Run 1

DB	Status					
	CH1	CH2	CH3	CH4	CH5	CH6
1	0	0	1	0	0	1
2	1	1	1	1	1	0
3	1	0	0	1	1	0
4	0	0	1	0	1	1
5	1	0	0	0	0	0
6	0	0	0	1	0	1
7	1	0	0	0	0	0
8	0	1	1	0	0	0
9	1	0	0	0	0	0

Table 5-3: Databases' Channels Status After Run 1

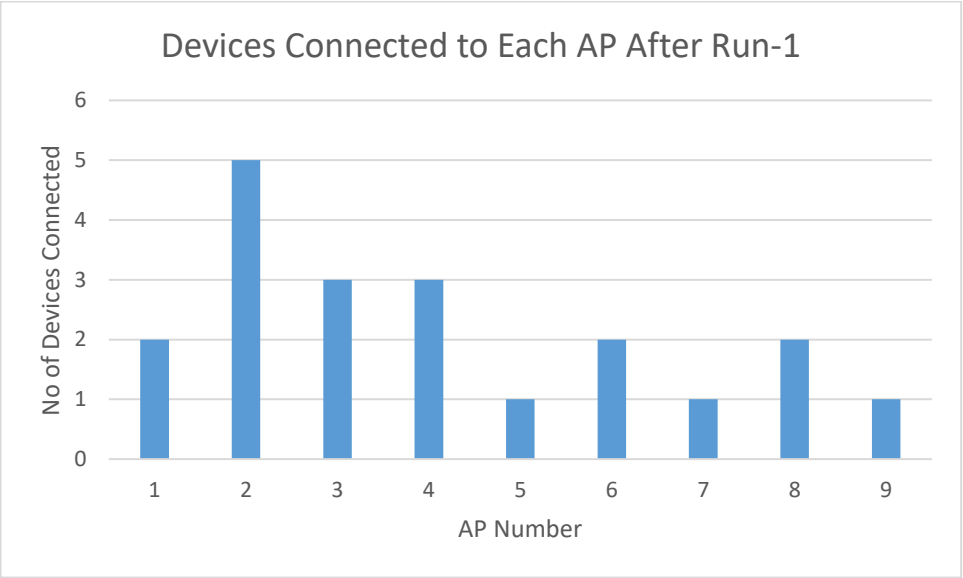


Figure 5-4: APs' Connected Devices After Run-1

In run-2 of the program, a few NDs would break communication with their patented BSs resulting in releasing of some channels in the DBs (status=0). In this case, six NDs have ceased their communication, therefore, releasing six channels from the DBs. Table.5-4 shows the main table devices that have broken their communication with their BSs whereas Table.5-5 shows the updated DBs' channel status. Noticeably, six channels from different DBs have been vacated per the six NDs connection termination. Finally, Figure.5-6 depicts the BSs with their connected device after RUN-2.

Device	DB	Channel
1	1	3
2	1	6
"======="		
4	2	5
5	2	2
"========"		
7	3	4
"========"		
9	4	5
10	4	3
"========="		
12	5	1
13	6	4
14	7	1
"=========="		
16	2	4
17	3	1
18	6	6
"========="		
20	8	2

Table 5-4: DBs' Individual Occupied Channels After Run 2

DB	Status					
	CH1	CH2	CH3	CH4	CH5	CH6
1	0	0	1	0	0	1
2	0	1	1	0	1	0
3	1	0	0	1	0	0
4	0	0	1	0	1	0
5	1	0	0	0	0	0
6	0	0	0	1	0	1
7	1	0	0	0	0	0
8	0	1	0	0	0	0
9	0	0	0	0	0	0

Table 5-5: Databases' Channels Status After Run 2

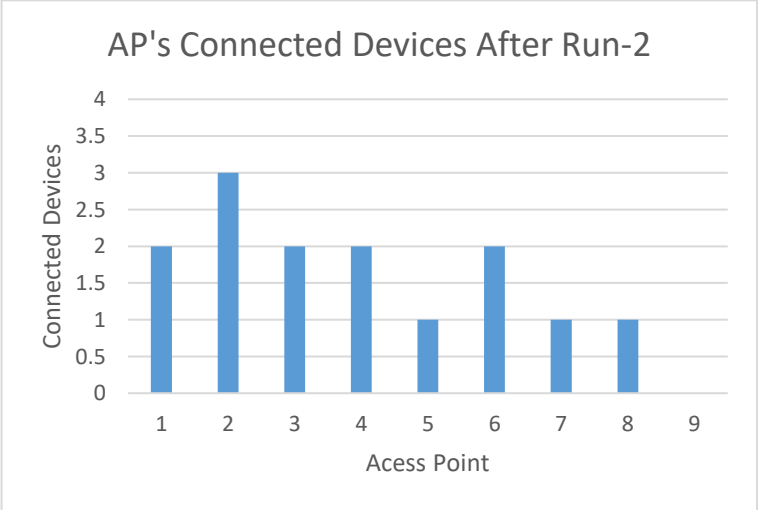


Figure 5-5: APs' Connected Devices After Run-2

This algorithm could be developed further to turn off any BS that is less utilised or turn on some others when the demand increases saving energy and maintenance cost.

5.3 THE SIMULATION

In order to begin our simulation, first, we will recap what we have learned about LTE-A Ver. 12 and its setup environment as follows:

The greatest performance for LTE-Advanced can be achieved to deliver a high peak data rate is by using 64QAM, 5/6 code rate, 8X8 antenna and 120 MHz Band Width (BW). The maximum throughput of this setup found to be 4.032 Gbps [82],[81]. We will use this setup for our proposed solution in order to get the maximum performance of the network including the data throughput. Figure. 5-6 portrays our high level proposed network topology.

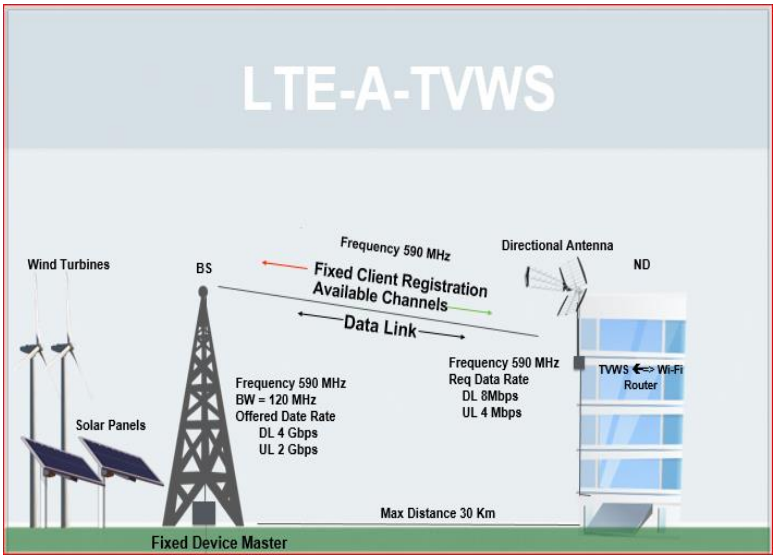


Figure 5-6: LTE-A-TVWS Network Resources and Demand

There are two networks to be simulated. One is an LTE-A operating on the TVWS spectrum, our solution, and the other is an LTE-A operating on the 1800 MHz spectrum. The two networks will be segregated and will operate independently but in the same locations as the BSs concerns except for Scenario-6 and Scenario-7. The main objective is to compare the two networks in terms of the required resources necessary to connect 5000

fixed Nodes (NDs) randomly located in the greater City of Salalah (800 Km^2. The NDs will be installed on rooftops, open areas, rural, urban, suburban, mountains, forests, deep valleys National Parks and other outdoor locations. One or more Wi-Fi routers will be physically connected to each ND to act as local Wi-Fi hotspots serving the community. The ND itself will wirelessly connect to one of the LTE-A-TVWS BS. Both the BS and the ND is powered by the main grid, wind turbine, and solar power—or one of them. Some of the BSs will be connected to fibre optic network or through a Microwave link as a gateway to the internet. As the Scenario-6 setup concerned, it will be as a form of data path link between two locations through a third one. This link will be utilised in Scenario-7 to provide a service to mobile NDs roaming around Ibri town.

5.3.1 The Simulation Methodology

The two networks will be deployed independently starting with the LTE-A-TVWS and the LTE-1800 at a later stage. The whole simulation will have eight scenarios, Seven scenarios will be for the LTE-A-TVWS network and the eighth scenario will be for LTE-A-1800 network. A brief description of the eight scenarios is given below whereas the real simulation description, execution and analysis are to follow later in the chapter:

Sceinario-1 will setup the global BSs' and NDs' parameters for LTE-A-TVWS network which are common to all the scenarios. Additionally, this will be the calibration and tuning of the simulation software

Sceinario-2 is the main simulation scenario which depicts the off tourism season by deploying 5000 NDs along with necessary BSs with specific configurations. In this simulation, we will make a few iterations to the network until most of the 5000 NDs are connected, with satisfactory service by adding/relocating BSs and sites.

Scenario-3: In this scenario, we will study the effect of changing some NDs' configuration parameters such as the antennas types from directional into omnidirectional in order to determine the impact on the network performance so one type could be adopted

for the implementation proved to be more effective.

Scenario-4: In this scenario will install 20000 NDs with different demands and time activity. The 20000 NDs will be grouped into six groups each group will have its unique requirements of DL, UL and time occupancy (activity%). This scenario represents the data traffic during tourist season when the traffic quadruples.

Scenario-5: Variable DL & UL Demands for 5000 NDs. This scenario will be the closest to real life scenario where there are many service demands and for a different type of activities. This scenario will have six types of ND groups. Their demand will vary from 4 Mbps DL, 2 Mbps UL, 100% active time for both to 24 Mbps DL, 16 Mbps UL with the activity of 40%-20%.

Scenario – 6: Long Range Connection Link (Data Path)

The main idea behind this scenario is to provide internet service to an area that is located at a long distance from the main Service Provider and with high terrains in between.

The link path consists of three distanced sites located in three different terrains. one site will have two BSs and will be installed on the 3000 Metres high summit of the Jabal Shams (the Sun's Mountain) to act as a convey site. The other site will be installed in Muscat area and presumably connected to the National fibre network. The third site will be in Ibri town, which is 300 Km west of Muscat will be connected to Muscat's site through Jabal Shams's site. This is data link path no NDs involved.

Scenario –7: Mobile LTE-A-TVWS

In this scenario, we will utilise the link built in Scenario-6 to serve 500 mobile NDs in Ibri town by one four-sectored site connected to Ibri's site created in Scenario-6.

Scenario –8: LTE-A-1800

This is the LTE-A operating on the 1800 MHz and will be installed on the same LTE-A-TVWS sites with the same number of BSs and would try to connect 5000 NDs located in the same fixed locations. Clearly, this network and its BSs and NDs configurations are different in the transmission frequency and the BW.

5.3.2 Global Parameters and Common Environment Set Up

In order to establish both network simulations, first, we have to set-up the global parameters for the Nodes (NDs) and for the Base Stations (BSs). The main common parameters for the BS are depicted in Figure 29 and explained in Table 13. The only two major differences are the transmission signal used and the bandwidth. The first one (LTE-A-TVWS) will use the 590 MHz as the centre transmission frequency with 120 MHz BW and 8X8 antennas. And the second will use the 1800 MHz spectrum with 5 MHz BW and 4X4 antenna arrays. We call this network LTE-1800.

Type	LTE-1800	LTE-A-TVWS
Signal	LTE-FDD	LTE-FDD
Modulation	Adaptive	Adaptive
Nominal PWR	20 w	20 w
Antenna Height & Gain	40 m 18 db.	40 m 18 db.
E.I.R.P (w)	1261 W	1261 W
Frequency	1800 MHz	590 MHz
Transfer BW (MHz)	5 MHz	120 MHz
Receive BW (MHz)	5MHz	120 MHz
Antenna Type	Directional 4X4	Directional 8X8

Table 5-6: BS Parameters for both networks

Next, the potential network zone is to be earmarked by selecting the area from the map. This procedure is called ‘Masking’ in the ICS Designer’s terms. Masking means specifying the portion of the digital map that is to be used for the network layout. Both networks will use the same mask. Figure 26 depicts the network location which is masked on the main digital map. The masked area can be saved for reuse by other simulation

seminaries, such as calculating the coverage area, determining the best locations for the BSs, and other related procedures. The simulation steps for both networks are in this order:

- search for the best locations for BSs so they can reach and be reached by NDs.
- install BSs on best possible locations.
- Create (generate in the ICS terms) NDs on randomly selected locations on the mask.
- specify the NDs' required services in terms of DownLink (DL), Up Link (UL) data rate demand.
- connect each ND to the best BS (parenting in the ICS terms) by the simulator.

Finally, the simulator, accordingly, will calculate the QoS in the form of provided data throughput compared to the demanded each ND. The simulation will calculate the distance from the BS and adjust azimuth and the tilting of the patented ND's antenna to the best possible direction to the BS. The azimuth of the antenna will be adjusted to face the parent BS, and tilting will be adjusted according to the ND with respect to the parent BS elevation. If the ND located higher than the BS's location, then the tilting will be in negative number. For the antenna azimuth, it will be adjusted to the direction of the BS as possible. This will be done only for directional antennas. For Omnidirectional, azimuth and tilt adjustment is not required nor the gain power (0) obviously.

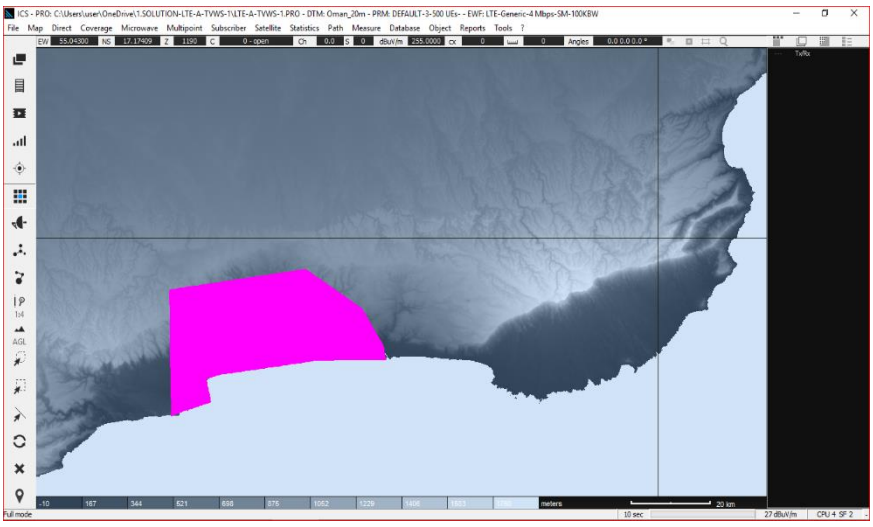


Figure 5-7: **Global Potential Networks' Area (Mask)**

The next phase in the common environment setup of the simulation is to identify the most likely location/s for the BSs that would be reachable by clients' nodes (NDs). The simulation would consider the different clutters of the map, including height, obstacles and other physical surroundings.

5.3.3 LTE-A-TVWS Network (Our Solution)

In the Novel LTE-A, when the code rate is set to 2/3, the throughput level of the system is enhanced and also now the throughput of Novel LTE-A with network transmission capacity=120 MHz is 3.2 Gbps. The optimum code rate could be used with 64QAM is 5/6 which gives the very best throughput. The throughput of Novel LTE-A is 4.032 Gbps with 120 MHz network transmission capacity [82]. As a result, the code rate is straight proportional to the throughput of the system utilising 64QAM as well as the best code rate for the system with 8x8 MIMO is 5/6. The results show that when the code rate is set to 2/3, it is clear that the throughput degree of the system is enhanced and now the throughput of Novel LTE-A with channel bandwidth=120 MHz is 4 Gbps. As an outcome, the code rate is straight proportional to the throughput of system modulated using 64QAM and the most effective code rate for the system with 8x8 MIMO is 5/6 [82].

5.3.3.1 Sceinario-1: Calibrating and testing the Simulator

Before we build the two networks in the simulator, first we will examine the reliability of the simulator by building a small network with one BS and 100 Nodes (NDs)

and analyse the results. We call this procedure the calibration of the simulation. This calibration will be done using LTE-A-TVWS (our solution). The implementation of the calibration network simulation will be as follows:

- search for the best locations for BSs so they can reach and be reached by NDs.
- specify the NDs required services in terms of DownLink (DL), Up Link (UL) demand.
- Create (generate in the ICS terms) 100 NDs on randomly selected locations on the mask with the required services.
- Install the fours BSs (4 sectors 90 degrees spacing) on best possible locations with the configuration listed below.
- Run the simulation to connect the NDs (parent) them to the BSs.

In this step, we will create the ND general parameters as described in the Table.5-7:

Nodes' Parameters'	
Communication frequency	590 MHz
transmission power	2 w
Antenna Type	Directional
Antenna gain	6 w
Initial Tilt	0
Initial azimuth	0
Demanded DL	8 Mbps
Demanded UL	4 Mbps

Table 5-7: LTE-A-TVWS Nodes' Parameters

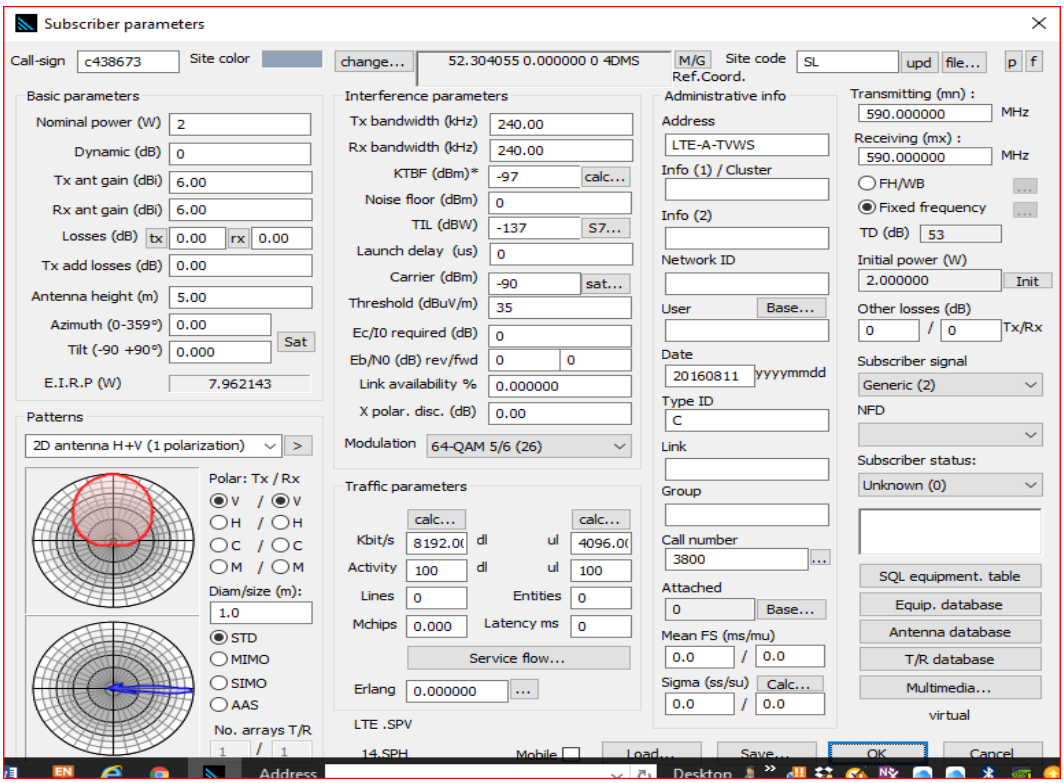


Figure 5-8: **LTE-A-TVWS Nodes' Parameters Setup Screen**

Now we will ask the simulator to generate 100 NDs with these configurations and randomly locate them on the mask in the designated clutters.

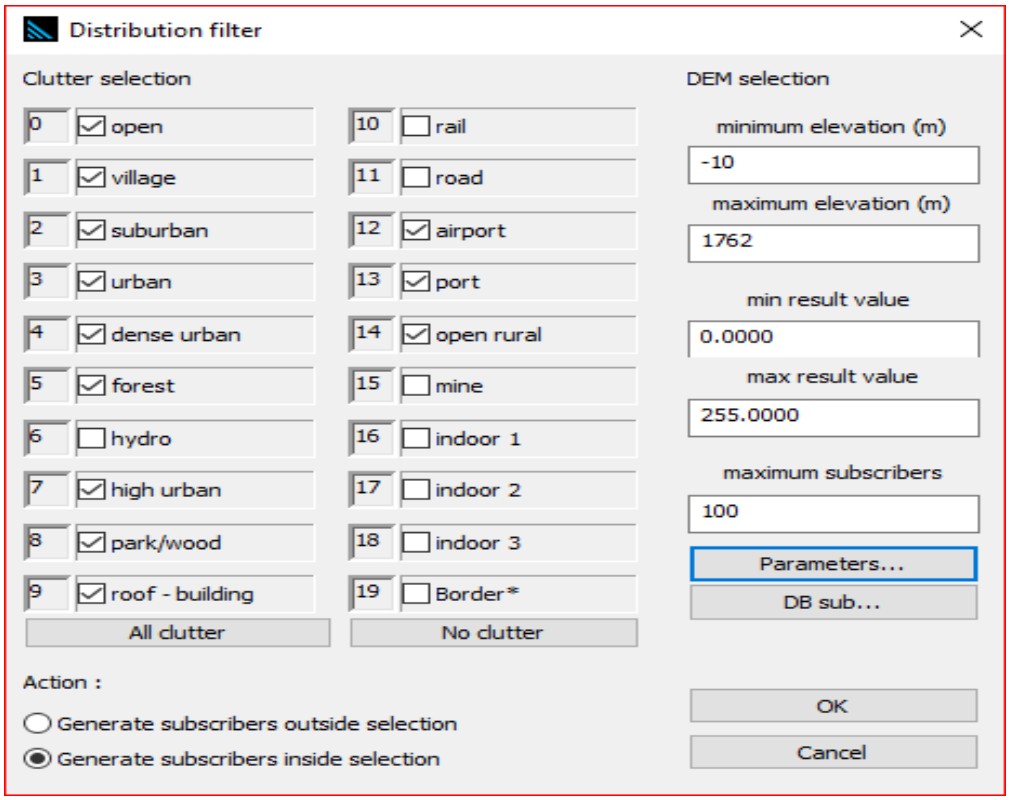


Figure 5-9: **Nodes' Area Locations Selections**

After generating the 100 NDs, the mask will look like Figure. 5-10, with antennas azimuth set to the North (0 degrees) and zero tilting.

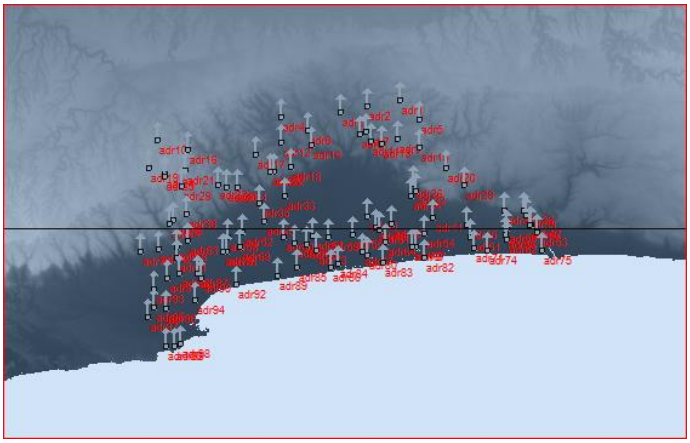


Figure 5-10: The Map After Creating 100 NDs

At this stage, we have created 100 NDs in different clutters of the mask. They are randomly located. The next step is to create one BS with the parameters in the Table.5-8 and then duplicate to the other three sectors with 90 degrees spacing:

Base Station Parameters'	
Communication frequency	590 MHz
transmission power	20w
Antenna gain	18 w
Tilt	0
azimuth	0, 90, 180, 270º
Offered DL	4 Gbps
Offered UL	2 Gbps
Antenna	8X8

Table 5-8: BS Configuration

There are four categories of the configurations that must be setup. They are General, Pattern, Channel, Site and advanced.

The main screen setup is the 'General' where you assign frequency, Bandwidth (BW) power, antenna height and type antenna gain. The figure below depicts the general configuration. The pattern configuration screen is where the BS's antenna type, direction, numbers (8X8), azimuth and tilt. Additionally, the 'Site' screen would display the exact location of the BS along with any available maps. And the last setup screen is the

'Advanced' which is concerned with the type of the BS, signal type and modulation. For the LTE-A ver. 12, the DL is 4 Gbps and the UL is 2 Gbps. in this screen, we set up the DL and UL data rate to those values.

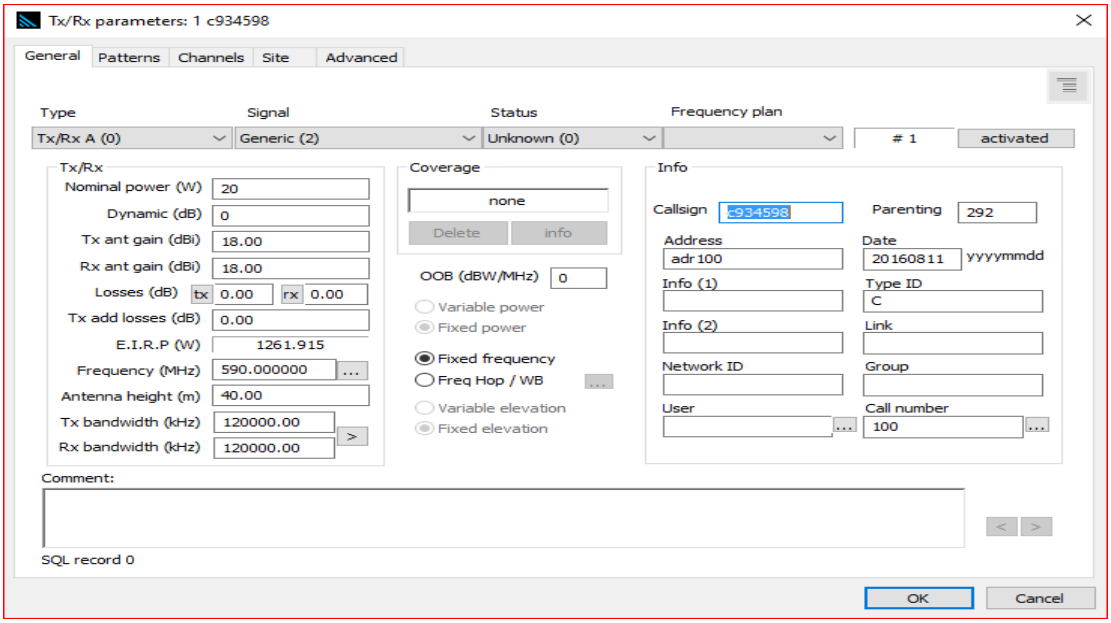


Figure 5-11: The General BS Setup Screen

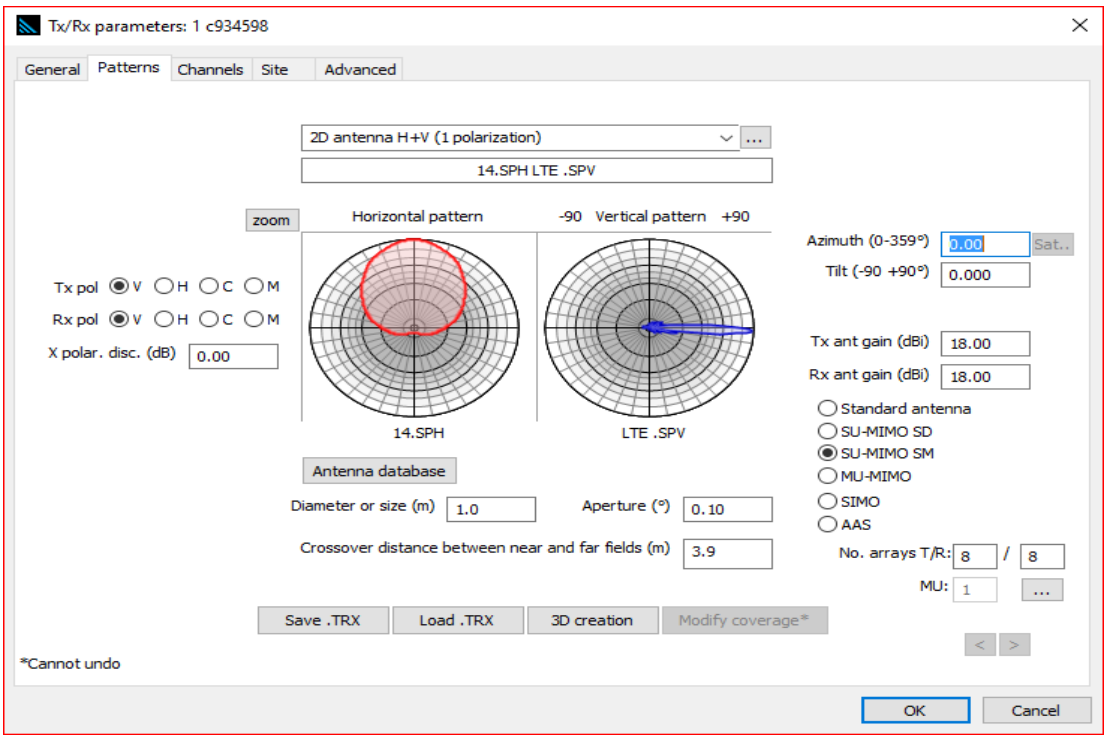


Figure 5-12: BS's Antenna Setup Screen

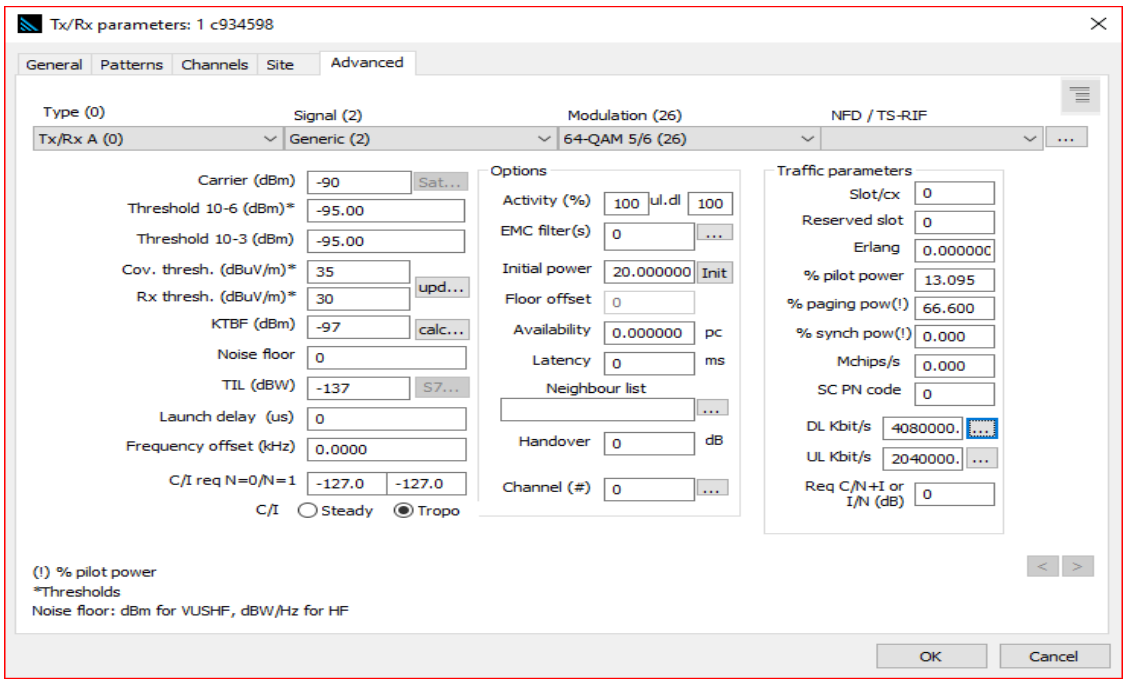


Figure 5-13: The Advanced Setup BS's Screen

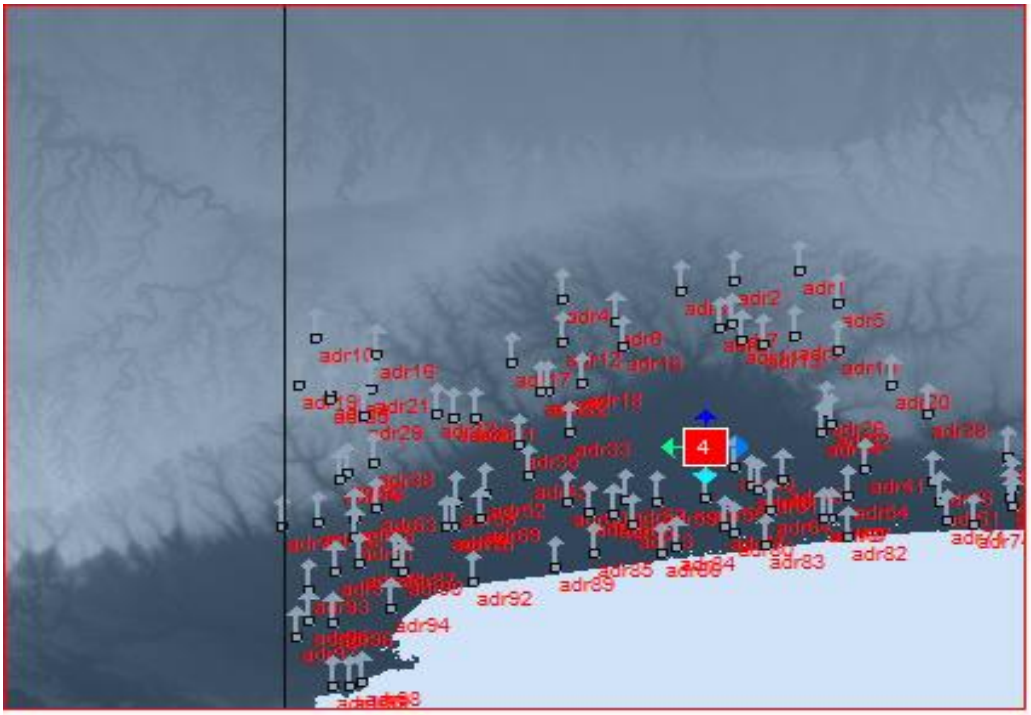


Figure 5-14: The Map after 100 NDs and one site with four BSs are Created

5.3.3.1.1 Parenting the Nodes

Following the creation of the 100 Nodes and one four sectored sites, we attempt to connect the maximum possible NDs to the site. Different NDs will be connected to each

sector's BS.

SUBSCRIBER BEST SERVER C/N+I DL - Pr>=Threshold UL

BST	#	Mbits DL	Mbits UL	Remain DL	Remain UL	CPE(s)	CPE UL act %	CPE DL act %
c0000001	1	376.8318	188.4159	3703.1687	1851.5844	46	100.00	100.00
c0000002	2	57.3440	28.6720	4022.6565	2011.3282	7	100.00	100.00
c0000003	3	90.1120	45.0560	3989.8884	1994.9442	11	100.00	100.00
c0000004	4	32.7680	16.3840	4047.2324	2023.6162	4	100.00	100.00

Table 5-9: **Connected NDs Summary**

Examining the connected and unconnected nodes, we can see that 68 NDs have been successfully connected and have been provided 100% DL and UL of their requirements. More specifically, BS-1 has connected 46 NDs and provided them with 100% of their requirements. The BS offered more than 4 Gbps DL and only 376 Mbps has been utilised by the connected Nodes (8192 Kbps X 46 = 376 Mbps) the remaining 3.7 Gbps service has not been utilised. BS 2, 3 and 4, have connected and provided 100% of the required service to 7, 11 and 4 Nodes. This network has been set for testing and calibration purpose only, in real, otherwise, this is a waste of valuable resources undoubtedly.

The most distant connected node was Node 98 and it was more than 29 Km away from the site with -64.9 dBm received power and 32 dB Signal to Noise Ratio (SNR).

Now we examine the map after parenting the 68 nodes. First, we notice that the azimuth of the connected Nodes is directed to the site, for example, those are connected from the north their azimuth has changed to point south, and those on the east of the site have been changed to point to the west and so on and so forth.

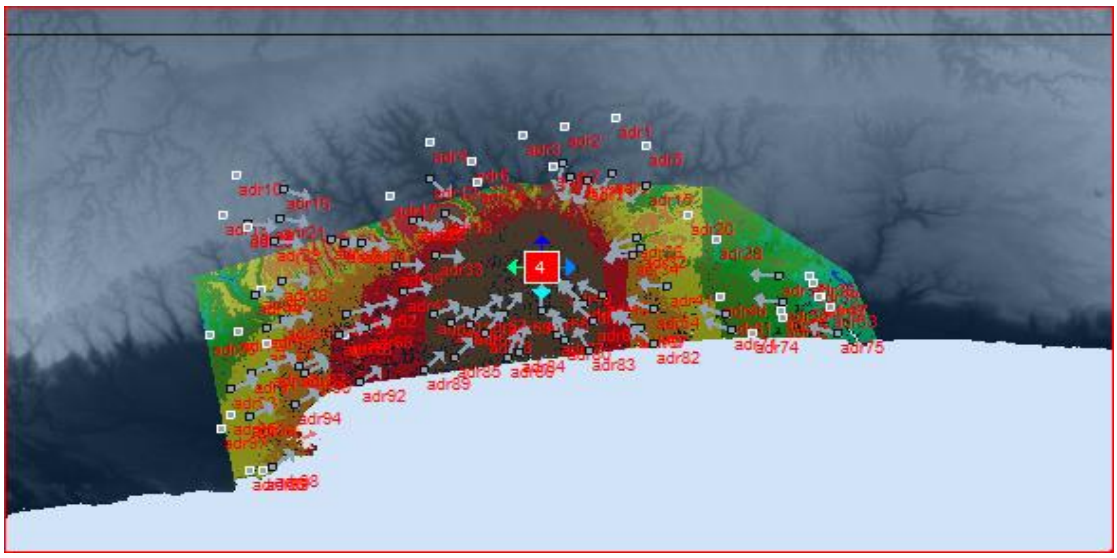


Figure 5-15: The Map After Parenting

For example, the antennas azimuth of Node 13 which is on the north-east of the site is now on a higher ground got its azimuth changed to point 205 degrees' south-west and its azimuth has changed to -2.9 degrees to point downwards to the BS. The figure depicts the changes.

5.3.3.2 *Scenario-2: Main Network Deployment and Analysis (Off-peak tourism Season)*

This scenario will simulate a sample of the internet service demand during off-Peak truism season (Oct-May) in the Greater Salalah City. In this scenario, our proposed network will be created (LTE-A-TVWS). All the global/common parameters had been set up in the beginning of this chapter which included the planned network location (mask). The BSs' and NDs' parameters have also been setup. Furthermore, one four-sectored (BSs) has been created. The same steps would be taken in order to deploy, test and verify our proposal. These steps are:

- loading the same mask
- searching the mask for the best possible locations for the BSs.
- Setting up the BS and the Node Parameters
- Create One site with four BSs (sectors) and 500K randomly located NDs.
- Using the 'Prospective Planning' to predict/suggest the number of BSs

that are able to connect a maximum number of NDs and determine the best possible QoS on the best effort method.

- Searching the map for best locations of the sites

We have set up the simulation environment which included the creation and randomly located 5000 NDs on the map in the same mask. Using the same site in the same location, we executed the simulation of parenting as many NDs as possible, given that each sector (BS) can provide more than 4 Gbps for DL and more than 2 Gbps for UL. The maximum NDs that can be connected and fulfil their 100% of their requirements will be around 500 NDs for each sector or a total of 2000 NDs for the site. In other words, how many NDs with 8 Mbps DL and 4 Mbps demand can a 4 Gbps sector/BS support with the maximum possible QoS? The answer is 2000 NDs if the ideal conditions are present in the environment. That means if the transmission signal between BSs and NDs is strong enough and SNR is high too.

After executing the simulation, we have found that the total connected NDs were 1992, or 498 NDs connected to one sector (BS). This is in line with our expectations.

SUBSCRIBER BEST SERVER C/N+I DL - Pr>=Threshold UL

BST	#	Mbits DL	Mbits UL	Remain DL	Remain UL	CPE(s)	CPE UL act %	CPE DL act %
c0000001	1	4079.5925	2039.7963	0.4078	0.2039	498	100.00	100.00
c0000002	2	4079.5925	2039.7963	0.4078	0.2039	498	100.00	100.00
c0000003	3	4079.5925	2039.7963	0.4078	0.2039	498	100.00	100.00
c0000004	4	4079.5925	2039.7963	0.4078	0.2039	498	100.00	100.00

Table 5-10: Connected NDs to the Four BSs

The next step is to add one more site and try to connect the maximum number of NDs but first, we must disconnect (orphan) the previously connected (parented) NDs so we give a chance to the new site along with the first to connect all NDs with strongest received signal regardless of their distance and topography.

The distance of the mask from left to right is about 54 Km, so we will re-locate the first site 18 Km away from the right edge of the area but in the same location that

suggested by the simulator, and the second will be located 18 Km from the left border of the mask again it is in the same suggested area.

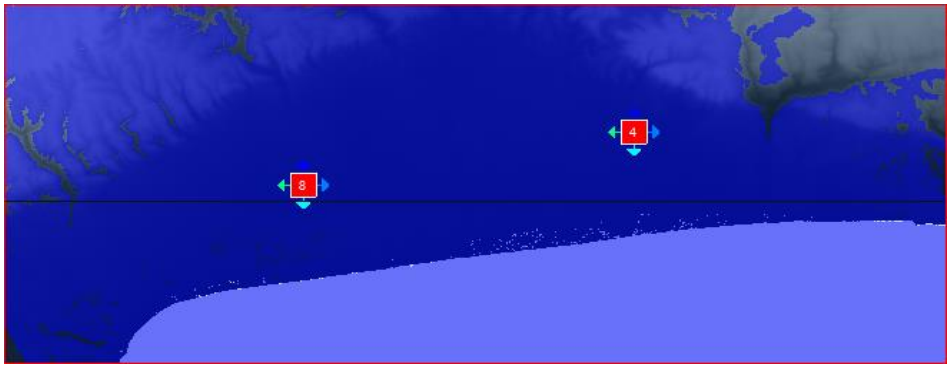


Figure 5-16: The Map with Two Sites

Now we will attempt to connect the NDs to the BSs. The expected connected NDs this time is around 4000.

After the running the simulation with two sectored-sites (8 BSs), only 3984 NDs were connected, the reason for that may have been not enough NDs with strong received signal due to one reason or another related to their locations' topographies.

SUBSCRIBER BEST SERVER C/N+I DL - Pr>=Threshold UL

BST	#	Mbits DL	Mbits UL	Remain DL	Remain UL	CPE(s)	CPE UL act %	CPE DL act %
c0000001	1	4079.5925	2039.7963	0.4078	0.2039	498	100.00	100.00
c0000002	2	4079.5925	2039.7963	0.4078	0.2039	498	100.00	100.00
c0000003	3	4079.5925	2039.7963	0.4078	0.2039	498	100.00	100.00
c0000004	4	4079.5925	2039.7963	0.4078	0.2039	498	100.00	100.00
c0000005	5	4079.5925	2039.7963	0.4078	0.2039	498	100.00	100.00
c0000006	6	4079.5925	2039.7963	0.4078	0.2039	498	100.00	100.00
c0000007	7	4079.5925	2039.7963	0.4078	0.2039	498	100.00	100.00
c0000008	8	4079.5925	2039.7963	0.4078	0.2039	498	100.00	100.00

Table 5-11: Connections after Two Sites Deployed

After this step, someone may conclude that one more site with three BSs should be adequate to connect the rest of the NDs (1016 NDs) if one BS can serve close to 500 NDs. But this could not be the case because some of the remaining NDs are out of reach from any point in the mask so we may have to re-locate all sites but in the same areas suggested by the simulator. In our case, we will add one sectored-site with four BSs and attempt to connect the 5000 NDs keeping in mind that every time we make a new connection attempt, we have to disconnect (orphaned) all connected (parented) NDs so to give a chance to the new communication environment.

Having finished the execution of the simulation with three sites, we noticed that the last site couldn't connect more than 321 NDs due to the fact the remaining NDs are located either in deep canyons or blocked by solid object line hills or mountains. Now the total connected NDs are 4305 NDs or 86%.

SUBSCRIBER BEST SERVER C/N+I DL - Pr>=Threshold UL

BST	#	Mbits DL	Mbits UL	Remain DL	Remain UL	CPE(s)	CPE UL act %	CPE DL act %
c0000001	1	4079.5925	2039.7963	0.4078	0.2039	498	100.00	100.00
c0000002	2	4079.5925	2039.7963	0.4078	0.2039	498	100.00	100.00
c0000003	3	4079.5925	2039.7963	0.4078	0.2039	498	100.00	100.00
c0000004	4	4079.5925	2039.7963	0.4078	0.2039	498	100.00	100.00
c0000005	5	4079.5925	2039.7963	0.4078	0.2039	498	100.00	100.00
c0000006	6	4079.5925	2039.7963	0.4078	0.2039	498	100.00	100.00
c0000007	7	4079.5925	2039.7963	0.4078	0.2039	498	100.00	100.00
c0000008	8	4079.5925	2039.7963	0.4078	0.2039	498	100.00	100.00
c0000009	9	401.4078	200.7039	3678.5928	1839.2964	49	100.00	100.00
c0000010	10	1097.7288	548.8644	2982.2717	1491.1359	134	100.00	100.00
c0000011	11	999.4246	499.7123	3080.5759	1540.2880	122	100.00	100.00
c0000012	12	122.8800	61.4400	3957.1204	1978.5602	15	100.00	100.00

Table 5-12: Connections after Three Sites Deployed

We noticed that sector 12 has only 15 NDs to service, in real life this would be a waste of resources.

To determine the cause of not being able to connect one ND, we have studied the path between the ND-788 and any BS, in this case BS 12 (profile), although the distance is within the limit (7 Km) but we found that the ND is located on the top of 138-metre-high hill blocked by 250-meter hill which blocked signals from all BSs (Figure.5-18).

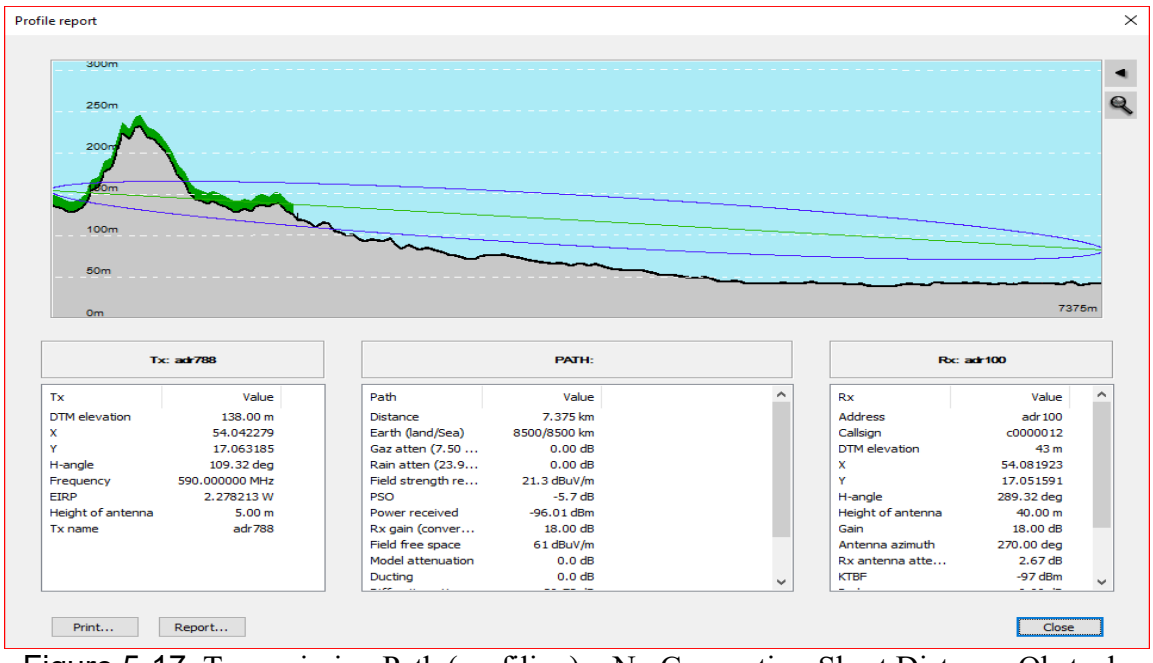


Figure 5-17: Transmission Path (profiling) – No Connection-Short Distance-Obstacle

Now we will take the case where the ND has located farther away from BS but still connected. In this case, we take ND-4193 which is connected to BS-9 and although the distance is large (22 Km) but still the ND has connected with the BS due to the fact there are no obstacles in between (Figure.5-20).

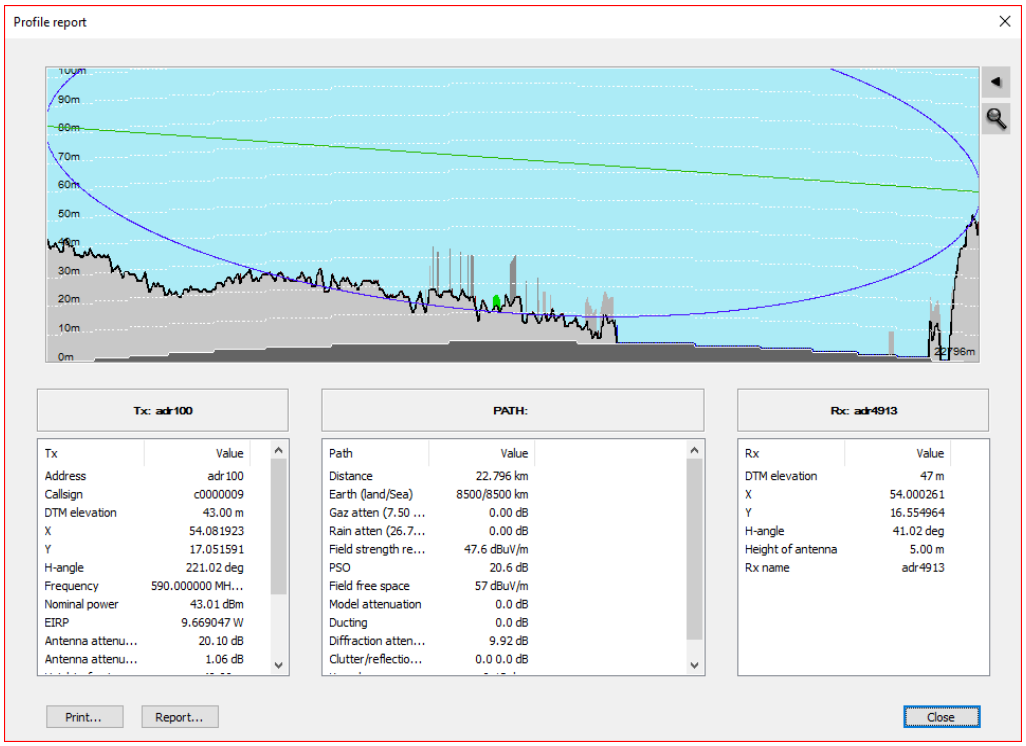


Figure 5-18: Transmission Path (profiling) –Connection-Long Distance

The last case we are examining is the case where there is an obstacle between an ND and BS but they got connected due to the unique characteristics of the TVWS spectrum amongst them is the good optical penetration. We examine the radio path of ND 736 with its parent BS-3 and we notice that there is a high hill between them but they still got connected regardless of the big distance of 12 Km (Figure.5-22).

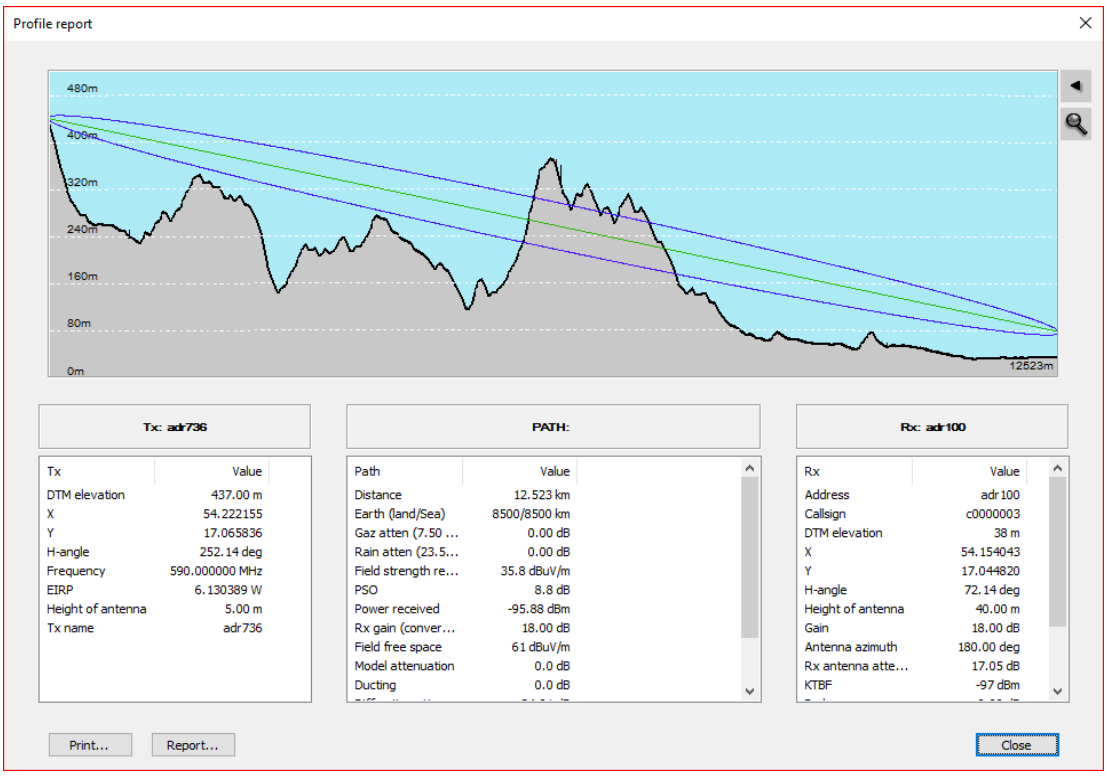


Figure 5-19: Transmission Path (profiling) – Good Connection-Long Distance with Obstacle

At this point in the simulation, we have created 5000 NDs, three four-sectored sites and connected 4305 NDs or 86% of the NDs with 100% QoS for the connected ones. Because some NDs have not been connected due to their location in respect to the sites (BSs), and because some of the BSs are underutilised, therefore we have to either add more BSs close to those unconnected NDs or change some of the BSs antennas' by tilting a few degrees upward. We first tried tilting some of the BSs' antennas but that had little effect on the connection so we added one-sector site where there was a blind spot. Having done that, more NDs were connected now and the total connected NDs is 4615 NDs or 92% with QoS of each connected ND is 100% for DL.

Table.5-13 along with Figures.5-24 and 5-25 illustrate the BSs' connected NDs, DL and UL capacities and NDS' demanded DL, UL data throughput.

BSs #	Reference modulation	Ref. capacity DL (Mbits/s)	Ref. capacity UL (Mbits/s)	Traffic DL (Mbits/s)	Traffic UL (Mbits/s)	Demand DL (Mbits/s)	Demand UL (Mbits/s)	NDs connected	Percentage connected
1	64-QAM 5/6	4080	2040	4079.62	2039.81	4079.62	2039.81	498	10.79
2	64-QAM 5/6	4080	2040	3907.58	1953.79	3907.58	1953.79	477	10.34
3	64-QAM 5/6	4080	2040	4079.62	2039.81	4079.62	2039.81	498	10.79
4	64-QAM 5/6	4080	2040	4079.62	2039.81	4079.62	2039.81	498	10.79
5	64-QAM 5/6	4080	2040	4079.62	2039.81	4079.62	2039.81	498	10.79
6	64-QAM 5/6	4080	2040	4079.62	2039.81	4079.62	2039.81	498	10.79
7	64-QAM 5/6	4080	2040	4079.62	2039.81	4079.62	2039.81	498	10.79
8	64-QAM 5/6	4080	2040	4079.62	2039.81	4079.62	2039.81	498	10.79
9	64-QAM 5/6	4080	2040	745.47	372.74	745.47	372.74	91	1.97
10	64-QAM 5/6	4080	2040	663.55	331.78	663.55	331.78	81	1.76
11	64-QAM 5/6	4080	2040	2408.45	1204.22	2408.45	1204.22	294	6.37
12	64-QAM 5/6	4080	2040	253.95	126.98	253.95	126.98	31	0.67
13	64-QAM 5/6	4080	2040	1269.76	634.88	1269.76	634.88	155	3.36

Table 5-13: Offered VS Demand Data Rate

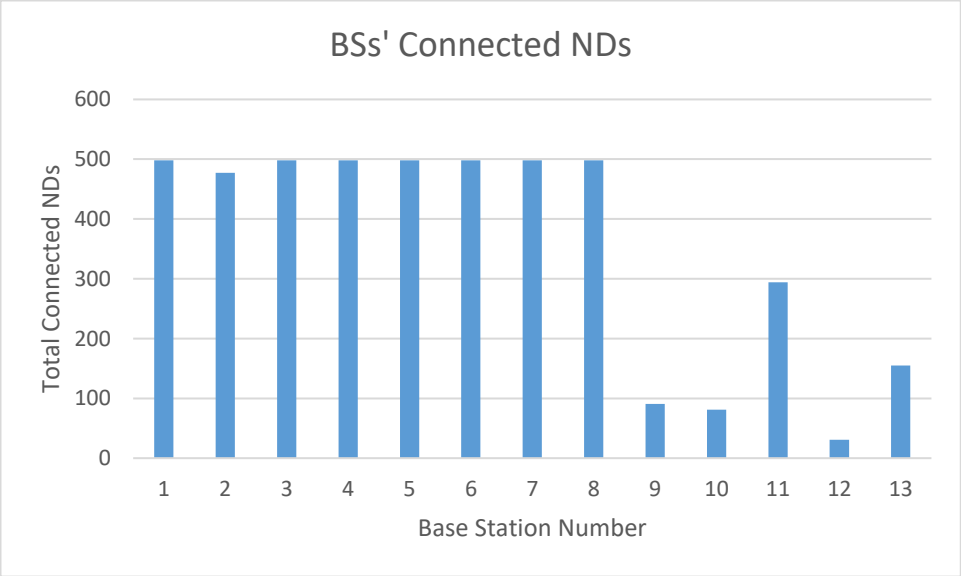


Figure 5-20: Base Station Connected NDs

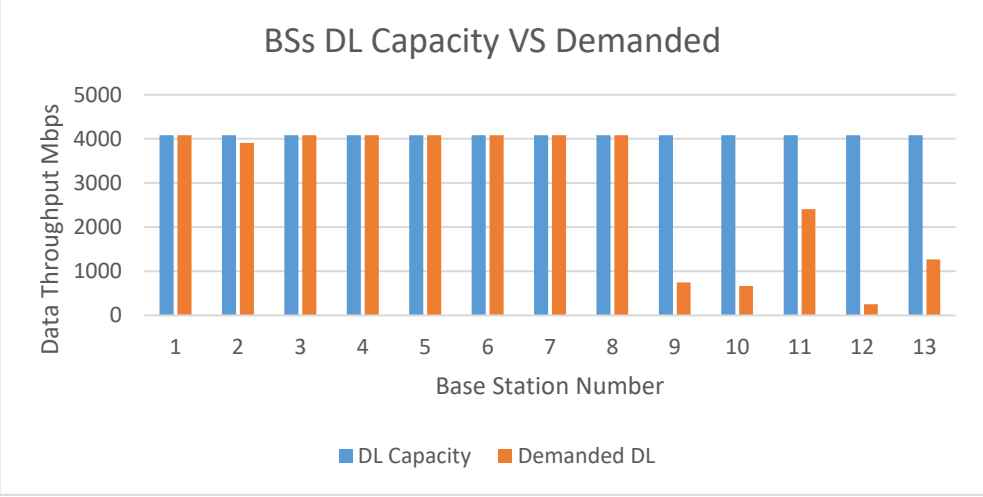


Figure 5-21: DL Capacity VS Demanded DL

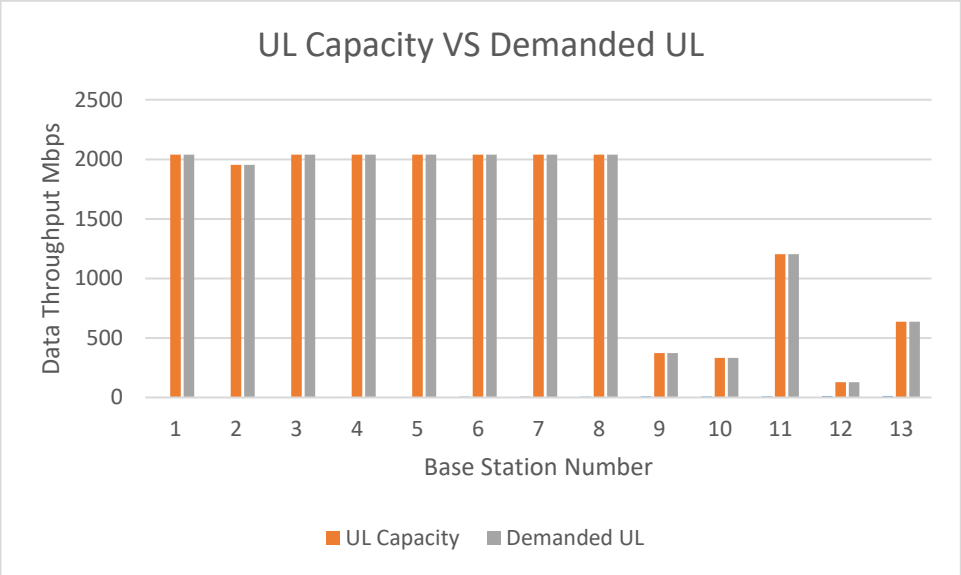


Figure 5-22: **UL Capacity VS Demanded UL**

5.3.3.2.1 Analysing the Network Traffic and Behaviours (Scenario-2)

With reference to the network created in the previous section, now we have a complete functional LTE-A-TVWS network with four sectored-sites and 13 BSs. The network is serving just below 5000 Nodes located on rooftops, open areas, rural, urban, forests, airports and ports. The uptime of the BSs was set to be 100% (24/7/365). Additionally, the NDs are set to be operational 100% of the time all year around. The NDs are communicating with the BSs on the TVWS spectrum as a backhaul to the internet. Whereas the NDs acting as local Wi-Fi routers/Hot Spot to serve local users. We have taken the best case scenario in respect of fulfilling the demand. That means every ND will be delivering the maximum obtainable data throughput from its parent BS to its local Wi-Fi users.

Although the network has connected 92% of the NDs and delivered 100% QoS, we have not tested the transmission quality in terms of received power, Signal to Noise Ratio (SNR), the range of coverage and connected NDs. This analysis will determine what is the Max, AVG and Min of each category mentioned.

Power Received: this measurement will measure the BSs to NDs transmission power; it is noticed that the maximum power received a BS and an ND was –14 dB this indicates there was an excellent possibility of connection between them provided that SNR (explained next) is a high number; while the average power was -64 dB which indicates that those NDs that have obtained a power level close to this had a good chance to be connected (if SNR is good); finally the minimum was found to be –80 dB which indicates that the communication between BS and ND was almost impossible because it is very close to the noise floor.

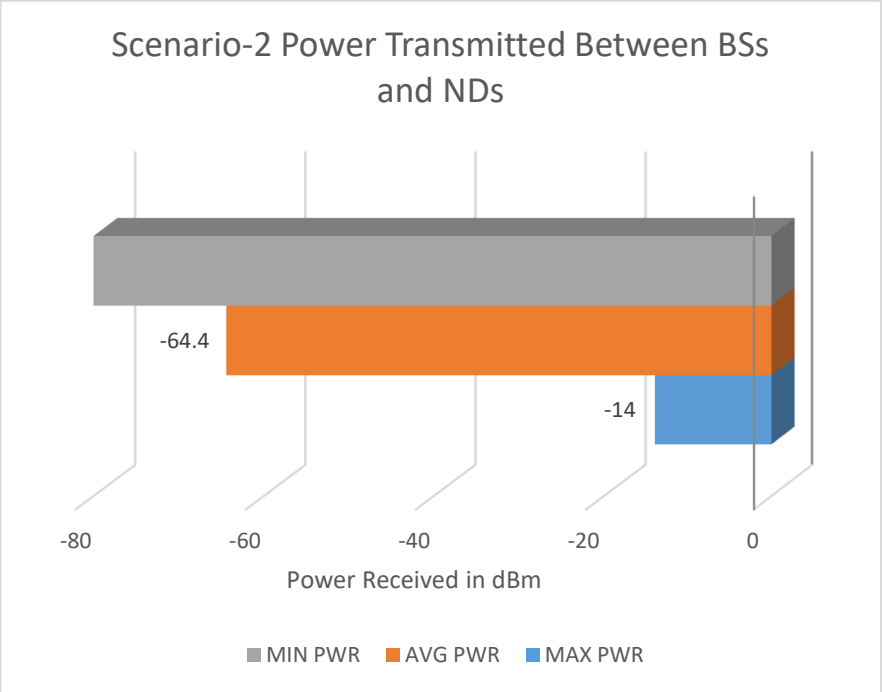


Figure 5-23: Power Received by Connected NDs

Signal to Noise Ratio (SNR): Signal to Noise Ratio, usually written S/N or SNR, is a measure of signal strength in relation to background noise. The ratio is often measured in decibels (dB) using a signal-to-noise ratio technique. If the received signal strength in microvolts is V_s, and the noise level is also in microvolts, is V_n, then the SNR in decibels is given by the formula: $SNR = 20 \log_{10} (V_s/V_n)$.

If $V_s = V_n$, then SNR= 0. In this instance, the signal is on boundaries and is unreadable, because the noise level severely struggles with it. In digital communications,

this may cause a decrease in data throughput due to recurrent errors that require the transmitting source to resend some of the lost data.

In an ideal world, V_s is larger than V_n, so a high signal-to-noise ratio is positive. As an example, assume that V_s = 15.0 microvolts and V_n = 1.00 microvolt. Then:

$S/N = 15 \log_{10}(15.0) = 17.6$ dB.

This results in the signal are visibly readable. But if the signal is considerably weaker but still above the noise, for example, 1.1 microvolts then:

$S/N = 20 \log_{10}(1.1) = 0.83$ dB.

There could be a dramatic reduction in data rate under this. When V_s is less than V_n, the SNR is will be negative, signifying a low SNR. For this type of condition, reliable communication is generally not possible unless measures are taken to raise the signal level and/or reduce the noise level at the end point (receiving) device [104].

We have calculated the Max, Ave and Min SNR in our network. All readings are well beyond the noise level. The maximum SNR had been found to be 83 dB; the average was 32 dB and the minimum was 17 dB. As a result, most of the NDs had been connected and received good service from their patented BSs. Figure 47 depicts the calculated SNR for the whole LTE-A-TVWS network with 4 sites, 13 BSs and 4615 connected NDs.

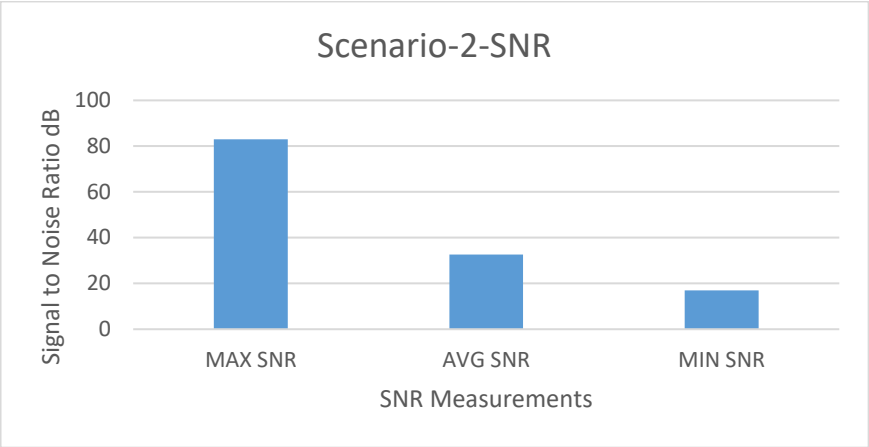


Figure 5-24: SNR of the Network

After we had created the network with its sites and nodes and after connecting most of the nodes, we are now about to examine the span of the network in terms of maximum, average and a minimum distance of the connected NDs and their BSs.

For the calculated distance, we have found that the farthest connect ND was more than 29 Km away from its parent BS. This indicates that there was a clear path (in terms of power strength) between both. ND 3501 which is parented to BS–3 was the most distant ND of its parent with 29000 meters away (29 KM), while the nearest connected ND to its parent BS found to be ND 3094 which is connected to BS-6. Here we notice that the signal received was the maximum in all the NDs (-14 dB) and the SNR is also the maximum (83 dB) for obvious reasons.

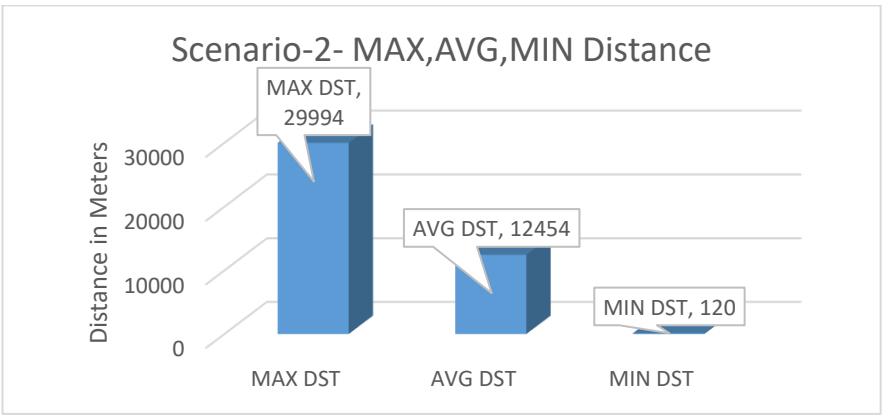


Figure 5-25: Distance of the Connected NDs

Down Link (DL) and Uplink (UL): DownLink (DL) and Uplink (UL) Data

Throughput was calculated and found to be satisfying the requirements of the connected NDs with a QoS reading 100%.

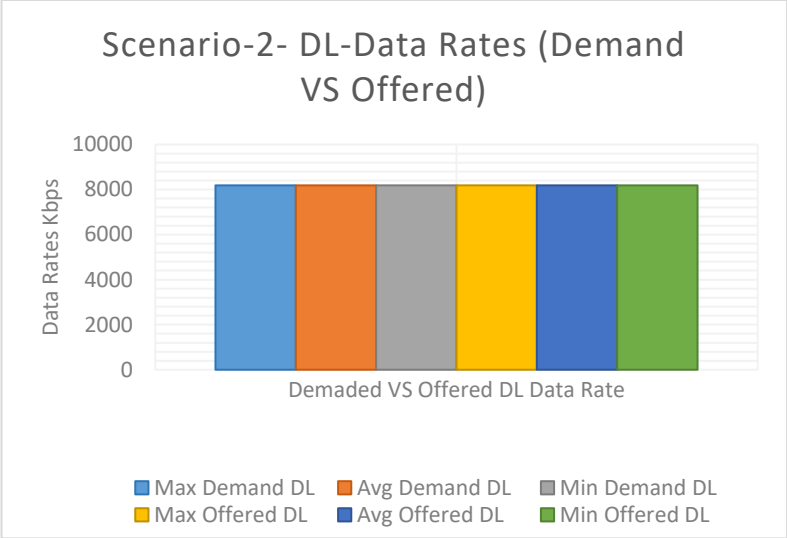


Figure 5-26: DL Data Rates of Connected NDs

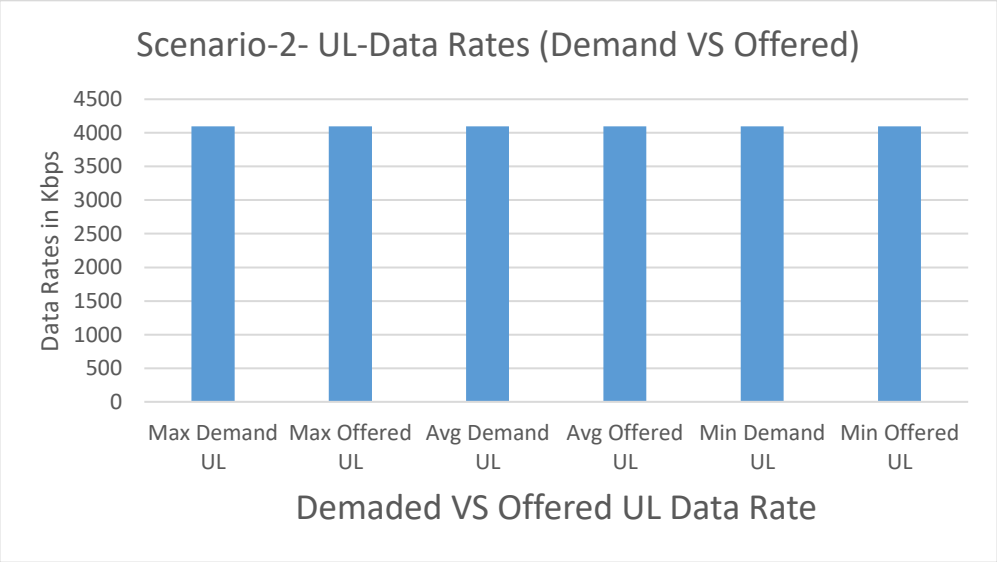


Figure 5-27: Scenario-2- UL-Data Rates (Demand VS Offered)

5.3.3.2.2 Summary Analysis of the Network-Scenario-2

In our deployed network with its elements and their configurations, we have proved that the network is capable of providing reliable services to around 4700 NDs with very minimum hardware cost and good QoS. The network has been deployed in a very big area, around 800 Km^2 which is greater than most of the major cities in the world. The

network elements used were ideal in their configurations especially for the BSs and NDs. The NDs' antennas were directional antennas with tilting and azimuth are mechanically adjusted with respect to their parent BS.

5.3.3.3 Scenario-3: Changing Configuration of NDs' (antennas into Omnidirectional)

The aim of this scenario is to examine the effect of modifying some NDs configurations on the performance of the network; in this case we have opted to change the NDs' antennas types from directional into omnidirectional and left everything else the same as the previous scenario such as their locations, required services and their parent BSs. There is no change applied to the BSs' including locations and offered service either. Having executed the simulation with omnidirectional NDs' antennas, we could connect 4338 NDs out of the 5000 NDs or 87%, that is short of the previously executed scenario by 277 NDs or 6% less than scenario-2. This is almost half the capacity of one BS. Now we will analyse the new scenario outcome.

Although there was very close number connected as the previous one, and although the farthest connected ND is the same as the previous one, the maximum power received was -20 dB compared to –14 in Scenario -2, and the maximum SNR was 77 dB compared to 83. It is concluded that there is a great impact on the network performance by changing the NDs' antennas' configuration from directional into omnidirectional. Accordingly, we recommend the use of directional antennas in all NDs and BSs deployment.

SUBSCRIBER BEST SERVER C/N+I DL - Pr>=Threshold UL

BST	#	Mbits DL	Mbits UL	Remain DL	Remain UL	CPE(s)	CPE UL act %	CPE DL act %
c0000001	1	4079.5925	2039.7963	0.4078	0.2039	498	100.00	100.00
c0000002	2	2400.2542	1200.1271	1679.7461	839.8730	293	100.00	100.00
c0000003	3	4079.5925	2039.7963	0.4078	0.2039	498	100.00	100.00
c0000004	4	4079.5925	2039.7963	0.4078	0.2039	498	100.00	100.00
c0000005	5	4079.5925	2039.7963	0.4078	0.2039	498	100.00	100.00
c0000006	6	4079.5925	2039.7963	0.4078	0.2039	498	100.00	100.00
c0000007	7	4079.5925	2039.7963	0.4078	0.2039	498	100.00	100.00
c0000008	8	4079.5925	2039.7963	0.4078	0.2039	498	100.00	100.00
c0000009	9	1105.9208	552.9604	2974.0796	1487.0398	135	100.00	100.00
c0000010	10	630.7838	315.3919	3449.2166	1724.6083	77	100.00	100.00
c0000011	11	1015.8086	507.9043	3064.1917	1532.0958	124	100.00	100.00
c0000012	12	212.9920	106.4960	3867.0085	1933.5043	26	100.00	100.00
c0000013	13	1613.8258	806.9129	2466.1746	1233.0873	197	100.00	100.00

Number of connected subscriber(s): 4338 / 5000

Table 5-14: Connected NDs using Omnidirectional Antennas (Scenario-3)

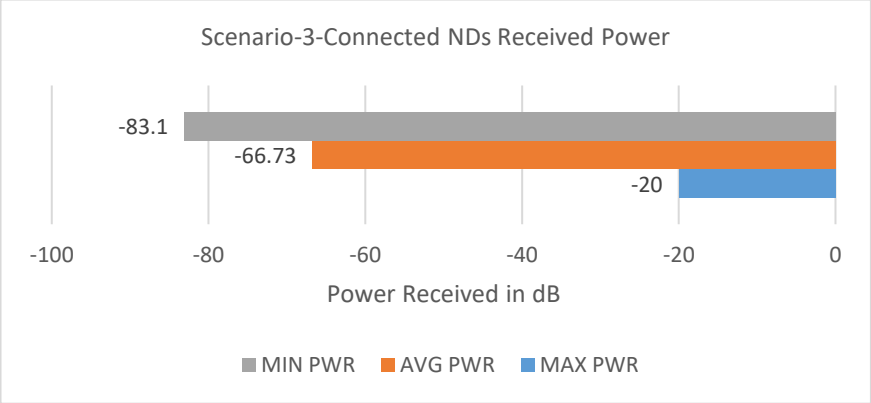


Figure 5-28: Transmission Power Between NDs & BSs using Omnidirectional Antennas

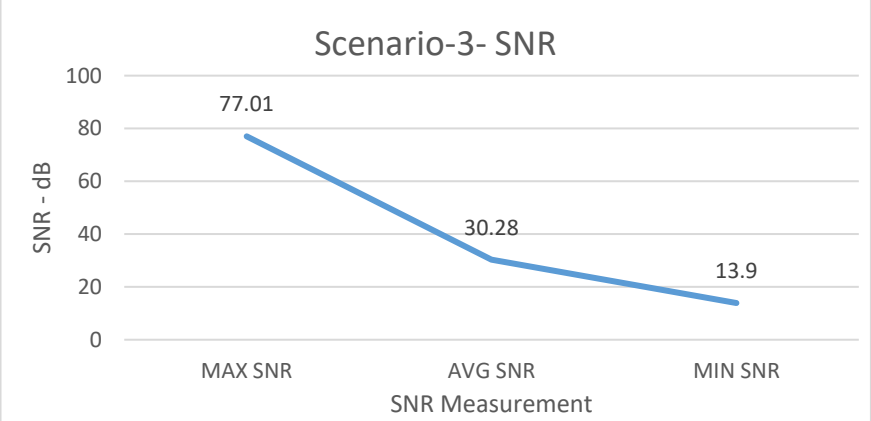


Figure 5-29: SNR Power Between NDs & BSs using Omnidirectional Antennas

5.3.3.4 Scenario-4: Increasing the Service Demand (Peak Season)

This network scenario has simulated a sample of the greater city of Salalah during off tourism peak season, and all the network elements and behaviour acted almost

perfectly. Now, what happens if we simulate the peak truism season traffic using the same network. The demanded service quadruples during the three-month monsoon season (June-September) when the population is three times as the local inhabitants.

In the next scenario, 20,000 NDs with directional antennas and with same previous configurations will be created in the same area. Additionally, the same five sites will be kept in their original place. Before we start the deployment and examination, one will anticipate that because we are increasing the demand by four times either the provided service will be downgraded to 25% (2 Mbps DL & 1 Mbps), or, 25% of the NDs would be connected (1,250 NDs). To verify that, we originate the simulation and analyse the results in the next few paragraph.

SUBSCRIBER BEST SERVER C/N+I DL - Pr>=Threshold UL

BST	#	Mbits DL	Mbits UL	Remain DL	Remain UL	CPE(s)	CPE UL act %	CPE DL act %
c0000001	1	4079.6919	2039.8459	0.3083	0.1541	1992	25.00	25.00
c0000002	2	4028.4895	2014.2448	51.5108	25.7554	1967	25.00	25.00
c0000003	3	4079.6919	2039.8459	0.3083	0.1541	1992	25.00	25.00
c0000004	4	4079.6919	2039.8459	0.3083	0.1541	1992	25.00	25.00
c0000005	5	4079.6919	2039.8459	0.3083	0.1541	1992	25.00	25.00
c0000006	6	4079.6919	2039.8459	0.3083	0.1541	1992	25.00	25.00
c0000007	7	4079.6919	2039.8459	0.3083	0.1541	1992	25.00	25.00
c0000008	8	4079.6919	2039.8459	0.3083	0.1541	1992	25.00	25.00
c0000009	9	741.3737	370.6869	3338.6267	1669.3134	362	25.00	25.00
c0000010	10	550.9122	275.4561	3529.0881	1764.5441	269	25.00	25.00
c0000011	11	2342.9067	1171.4534	1737.0936	868.5468	1144	25.00	25.00
c0000012	12	333.8243	166.9122	3746.1763	1873.0881	163	25.00	25.00
c0000013	13	1220.5996	610.2998	2859.4006	1429.7003	596	25.00	25.00

Number of connected subscriber(s): 18445 / 20000

Table 5-15: Connected NDs and Obtained QoS – 20K NDs

After running the simulation, we notice that 18,445 NDs out of 20,000 were connected (92%) which is the same as the previous one except that the provided service was reduced to 25% of the demanded. Further, the SNR noted that it ranges from 17% to 84% which is

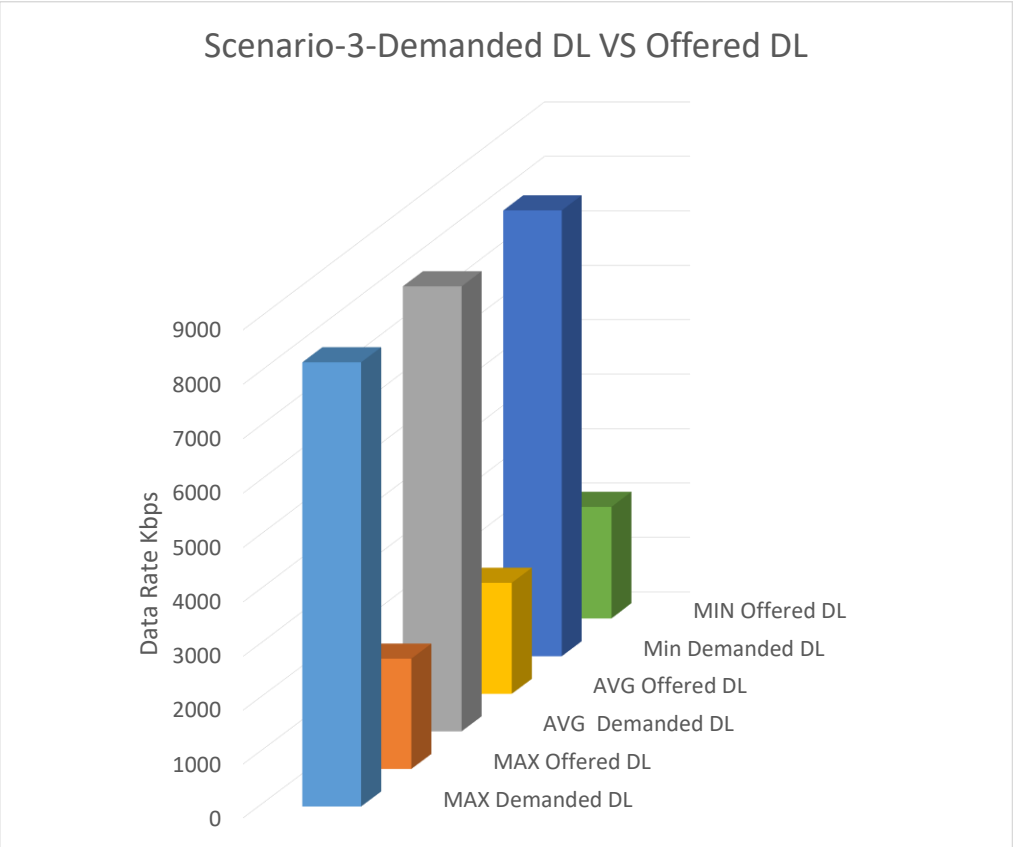


Figure 5-30: Demanded DL VS Offered DL Data Rate

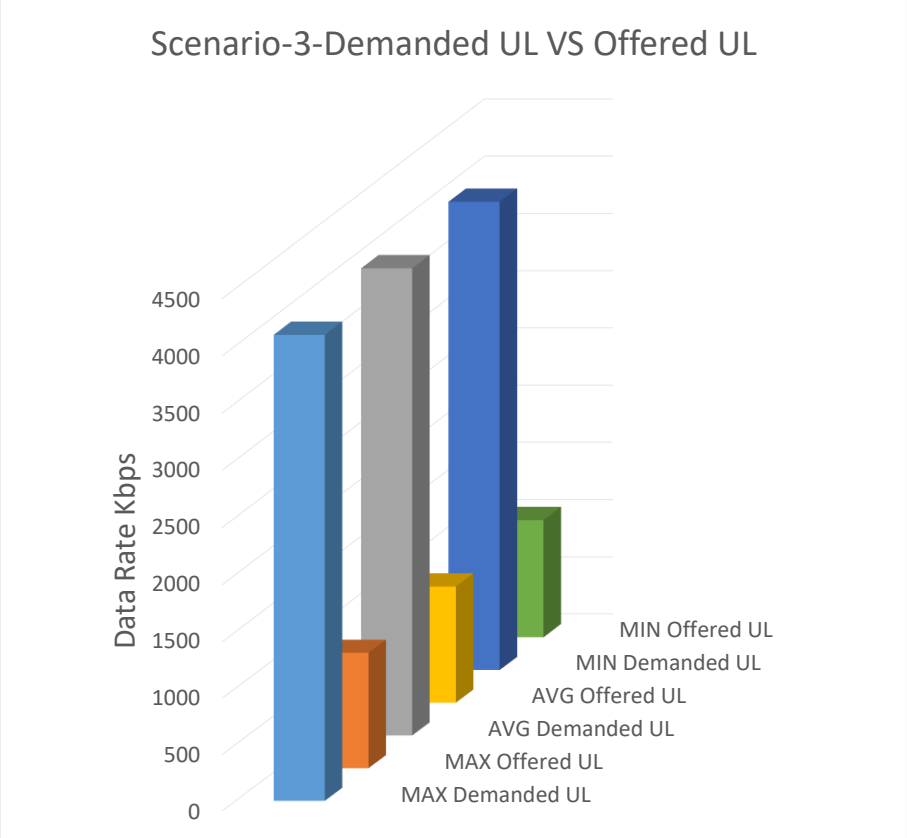


Figure 5-31: Demanded UL VS Offered UL Data Rate

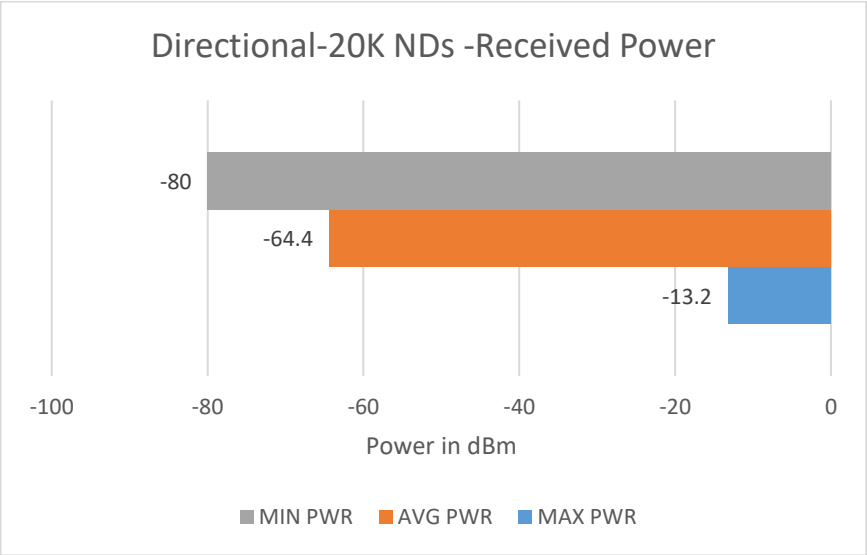


Figure 5-32: Transmission Power between NDs & BSs –20K NDs

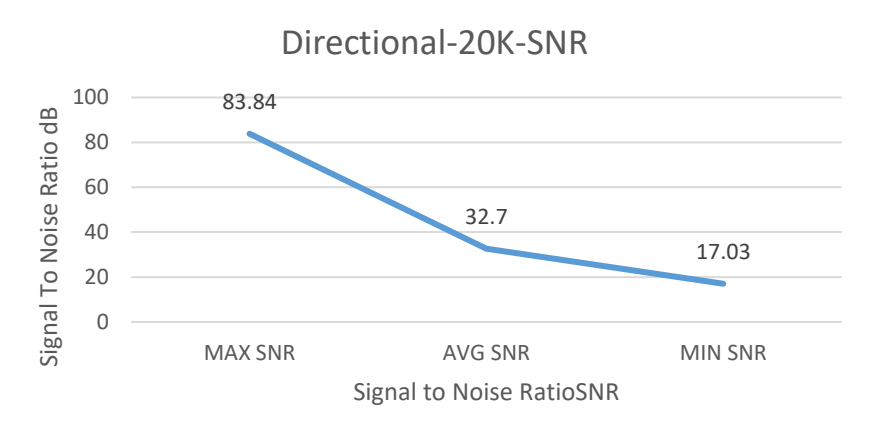


Figure 5-33: SNR for the 20K NDs Network

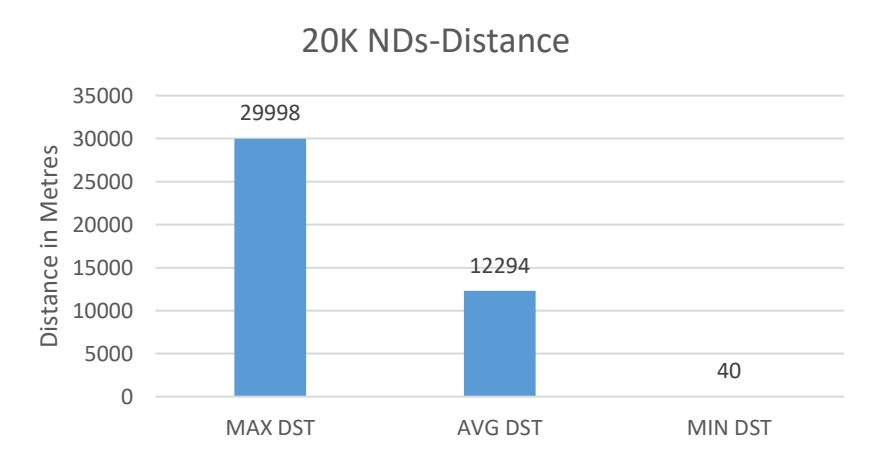


Figure 5-34: Connected NDs Distance from their BSs- 20K NDS

5.3.3.5 Scenario-5: Mixed DL & UL Demands for 5000 NDs

As described in chapter 3 (methodology), this scenario represents a similarity of real life internet service demand where not all subscribers have the same demand throughout their connection session. In this scenario (5) of the simulation, some of the subscribers' or NDs' configurations would be changed according to the following table. The configurations include the required DL and UL data throughput, the percentage of each ND's activity, and other set-ups. Secondly, we will use the same previously network's BSs on the same sites. After reconfiguring the 5000 NDs' parameters, the simulation will be run in an attempt to connect as many as possible of the NDs (parenting). The simulation will produce a report in the form of a spreadsheet, which will detail the connected NDs and the real QoS of each connected ND. The report will specify the exact UL and DL granted to each connected ND. The same report also will determine the distance of the ND from its parented BS, along with the signal strength and SNR.

Using the same ND parameters created in the previous scenario, and by applying the configuration parameters in the following table, we created 5000 NDs. Table. 5-16 below provides a summary of the NDs' database, comprising of six groups of NDs.

Group No	No Users	DL Mbps	% DL Activity	UL Mbps	% UL Activity
1	600	8	100	4	100
2	2400	8	60	4	40
3	600	12	100	6	100
4	600	12	40	6	20
5	400	24	100	8	100
6	400	24	40	8	20
TOTAL	5000				

Table. 5-1 Six NDs' Groups Demand and Activity

- 600 users with 8 Mbps DL, 4 Mbps UL, 100% DL activity and 100% UL activity.

- 2400 users with 8 Mbps DL, 4 Mbps UL, 60% DL activity and 40% UL activity.
- 600 users with 12 Mbps DL, 6 Mbps UL, 100% DL activity and 100% UL activity.
- 600 users with 12 Mbps DL, 6 Mbps UL, 40% DL activity and 20% UL activity.
- 400 users with 24 Mbps DL, 8 Mbps UL, 100% DL activity and 100% UL activity.
- 400 users with 24 Mbps DL, 8 Mbps UL, 40% DL activity and 20% UL activity.

5.3.3.5.1 Steps for Setting up and Executing the Simulations of Scenario-5

The initial common NDs variables have been set-up to the same previous NDs. The main differences between them are the following:

The demanded DL and UL for the first group of 600 NDs are set to be 8 Mbps and 4 Mbps and their activity is 100% of the time. The DL and UL for the second group of 2400 ND are set too to be 8 Mbps and 4 Mbps but their activity is lowered to 60% for UL and 40% for DL of the time.

The demanded DL and UL for the third group of 600 NDs are set to be 12 Mbps and 6 Mbps and their activity is 100% of the time whereas, the DL and UL for the fourth group of 600 NDs are set too to be 12 Mbps for DL and 6 Mbps for UL but their activity is dropped to 40% for UL and 20% for DL of the time.

The demanded DL and UL for the group five of 600 NDs are set to be 24 Mbps and 8 Mbps and their activity is set to be 100% of the time. Finally, the DL and UL for the last group of 600 NDs are set to be 24 Mbps and 8 Mbps; however, their activity is lowered to 40% for UL and 20% for DL of the time.

From the results, we notice that, out of 5000 NDs, 4539 NDs have been connected to the BSs or 91% of the 5000 NDs. In fact, some sectors have parented very few NDs; those can be removed to free some resources or can be degraded to a point where they provide close to the demanded service. For example, Sector 11 and Sector 12 have less than 20

NDs, whereas sectors 1-7 have more than 440 connected NDs each. The QoS have ranged from 63-93% because the offered service now distributed between different demands by NDs. For example, a BS with 4 Gbps service may have 100 NDs with 24 Mbps DL demand and 100 NDs with 12 Mbps DL and 200 NDs with 8 Mbps DL. This is (100 X 24 + 100 X 12 + 200 X 8) = 5.2 Gbps. Obviously, this is beyond the BS's capacity. In this case, the BS's 4 Gbps is distributed fractionally between the NDs which yields lower QoS than the previous scenarios.

SUBSCRIBER BEST SERVER C/N+I DL - Pr>=Threshold UL

BST	#	Mbits DL	Mbits UL	Remain DL	Remain UL	CPE(s)	CPE UL act %	CPE DL act %
c0000001	1	4078.7886	2039.3943	1.2118	0.6059	645	71.50	57.27
c0000002	2	3176.8540	1318.9114	903.1463	721.0888	336	67.38	54.23
c0000003	3	4072.2556	1932.9146	7.7448	107.0856	571	65.32	51.21
c0000004	4	4056.6792	1823.5485	23.3210	216.4516	552	63.95	48.66
c0000005	5	4076.3362	2038.1681	3.6640	1.8320	744	66.88	50.32
c0000006	6	4077.1694	1941.1052	2.8308	98.8949	517	67.39	55.01
c0000007	7	4079.6033	1681.8209	0.3970	358.1793	420	67.48	54.67
c0000008	8	3168.6653	1212.4178	911.3350	827.5823	238	77.90	68.57
c0000009	9	2223.3098	825.7537	1856.6906	1214.2465	152	81.18	73.03
c0000010	10	1645.7737	583.6797	2434.2266	1456.3206	88	91.36	87.27
c0000011	11	127.7952	43.4176	3952.2051	1996.5826	6	93.33	90.00
c0000012	12	192.5120	79.0528	3887.4885	1960.9474	19	70.53	57.89
c0000013	13	2085.6843	911.7696	1994.3159	1128.2306	251	68.61	54.98

Number of connected subscriber(s): 4539 / 5000

Table 5-16: Connected NDs Mixed Demand

5.3.3.6 Scenario – 6: Creating Long Range Data Link (Path)

After having created, tested and analysed five scenarios that have proven to adequately serve a large number of NDs in a big area with good QoS using very nominal BSs, it is now time to expand our simulation by creating a new scenario that involves the establishment of a connection between two distanced sites through a third one. This setup will validate/invalidate the possibility and the quality of communication link path that could be utilised to carry out an internet service from a site connected to the national fibre network grid to any remote site that lacks the service through another site located in between.

The link path consists of three distanced sites located in three different terrains. One site will have two BSs (BS-1 & BS-2) and will be installed on the 3000 Metres high summit of the Jabal Shams (the Sun's Mountain) to act as a convey site. The second site with one BS would be installed in Muscat area 110 Km northeast of Jabal Shams and one site with one BS would be installed in Ibri town 80 Km west of the mountain's site. The Muscat's site would be connected to one of the mountain's BS (BS-1) whereas Ibri's BS would be connected to the other mountain's BS (BS-2). All BSs will have the configurations listed in Table.5-20 which are mainly like Scenario-1 except for the signal transmission power and antennas' heights which are set to 40 w and 60 m respectively. The signal power strength has increased to 40 w to boost the signal transmission distances to the other sites.

Base Stations' Parameters	
Communication Centre Frequency	590 MHz
Bandwidth	120 MHz
Signal Transmission Power	40 w
Antenna gain	18 w
Tilt	Automatic
azimuth	Automatic
Offered DL	4 Gbps
Offered UL	2 Gbps
Antenna	8X8

Table 5-17: Scenario-6- Base Stations' Parameters

The idea behind this simulation is to connect Ibri's site to Muscat's through Jabal Shams's to eventually provide Ibri's NDs (in Scenario-7) with internet service by circumventing all obstacles. In a real implementation of this type of link paths, it is anticipated that it will result not only in dramatic financial savings but a swift deployment time. Figure5-32 depicts the three-site network deployment generated by the simulator. Again, this setup is only to provide two-way high speed and reliable connection between Muscat's and Ibri's sites through Jabal Shams's.

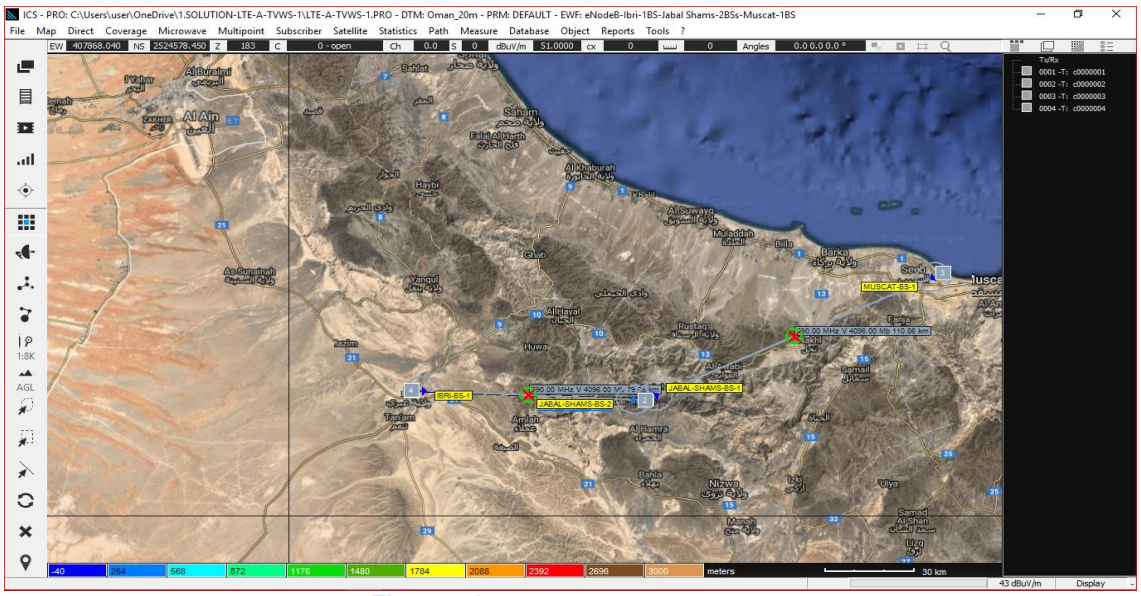


Figure 5-35: Three-Site Network Link

5.3.3.6.1 Calculating the Coverage Area

To determine the maximum coverage area with reasonable signal power strength that is slightly above the threshold (43dBu), we have executed the simulation to calculate the signal power strength up to 300 Km radius and plot the results on the map. After executing the simulation, the signal was found to be traceable as far as 250 Km if no obstacles on the path, otherwise, the signal found to be susceptible to high mountains. The signal coverage areas and the power strength of all three locations are shown in the Google's Earth map in Figure.5-33 below.

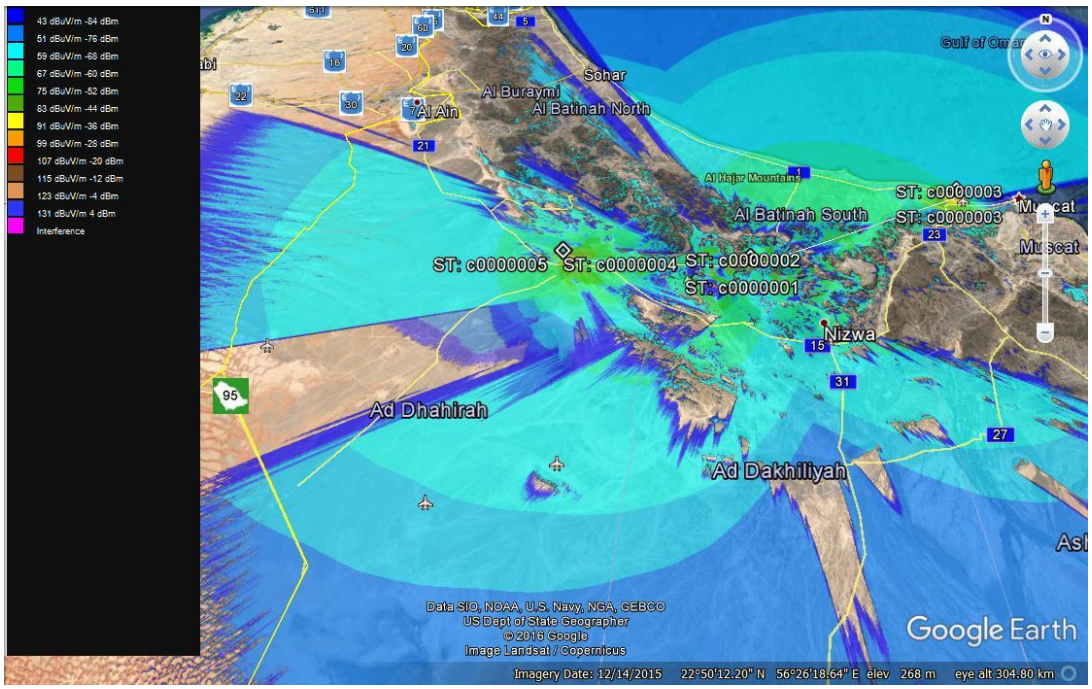


Figure 5-36: Signal Coverage Area and Power Strength

The total coverage area of all 4 BSs has been found to be 54000 Km^2. This is not the mask which would be created in the next scenario, this is the actual coverage area by all sites. It is noticed that the Jabal Shams' two BSs could cover a wider area on both directions since the site is located at a high elevation (3000 M) whereas the other two sites' coverage areas are much less than the Jabal Shams's. Table 5-21 shows the exact individual BS's exclusive coverage areas in Km^2 whereas Figure. 5-40 depicts such data.

Base Station #	Exclusive Service Area km^2
Jabal Shams (BS-1)	24823.7
Jabal Shams (BS-2)	26843.54
Muscat (BS-3)	799.63
Ibri (BS-4)	2092.95

Table 5-18: individual BS's exclusive coverage areas in Km^2

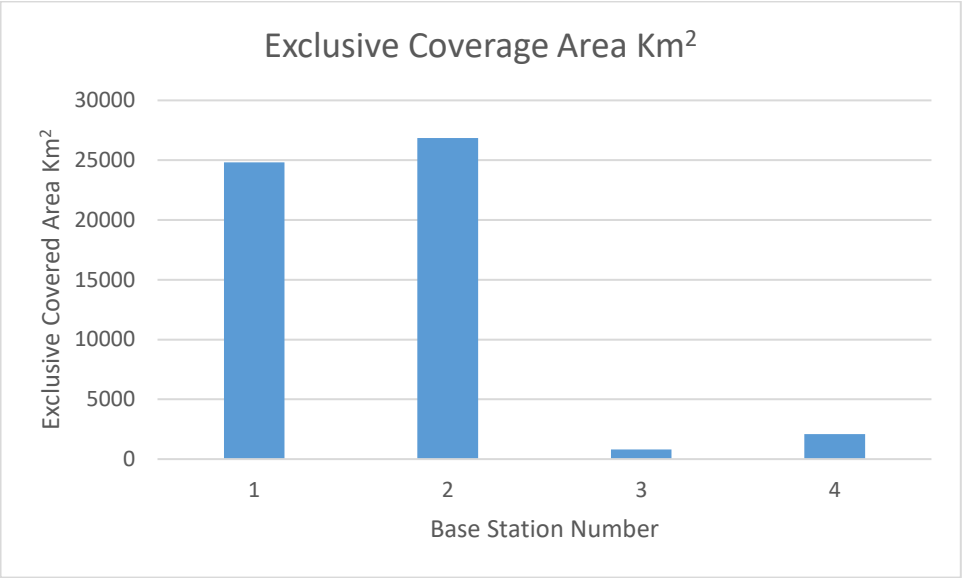


Figure 5-37: individual BS's exclusive coverage areas in Km^2

From both Table.5-21 and Figure.5-40, we read that Jabal Shams's BS-1 could cover close to 25000 Km^2, while BS-2 could cover more than 27000 Km^2 because the site has a clear view on the south, west and northeast.

When we consult the table and the figure, we noticed that Muscat's could cover around 800 Km^2 because it is located on the coast with narrow clear path between mountains to the west (as shown in the profiling diagram in Figure. 5-41), while Ibri's relay BS could hardly cover more than 2000 Km^2 because it is located on the edge of the mountains and has a narrow window to the east towards Jabal Shams as shown in the profile diagram depicted in Figure. 5-42.

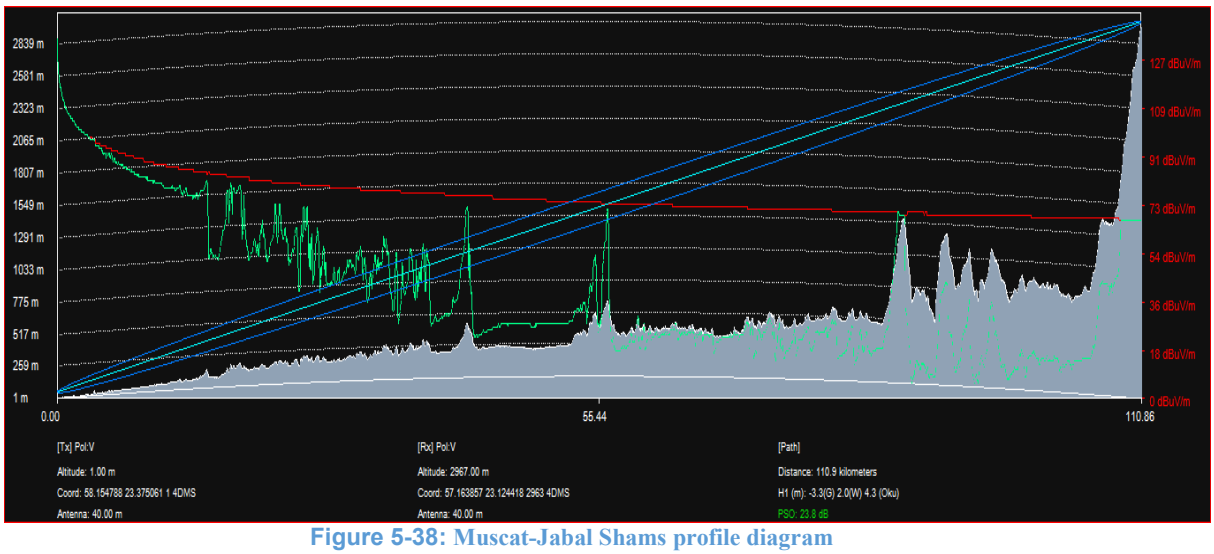


Figure 5-38: Muscat-Jabal Shams profile diagram

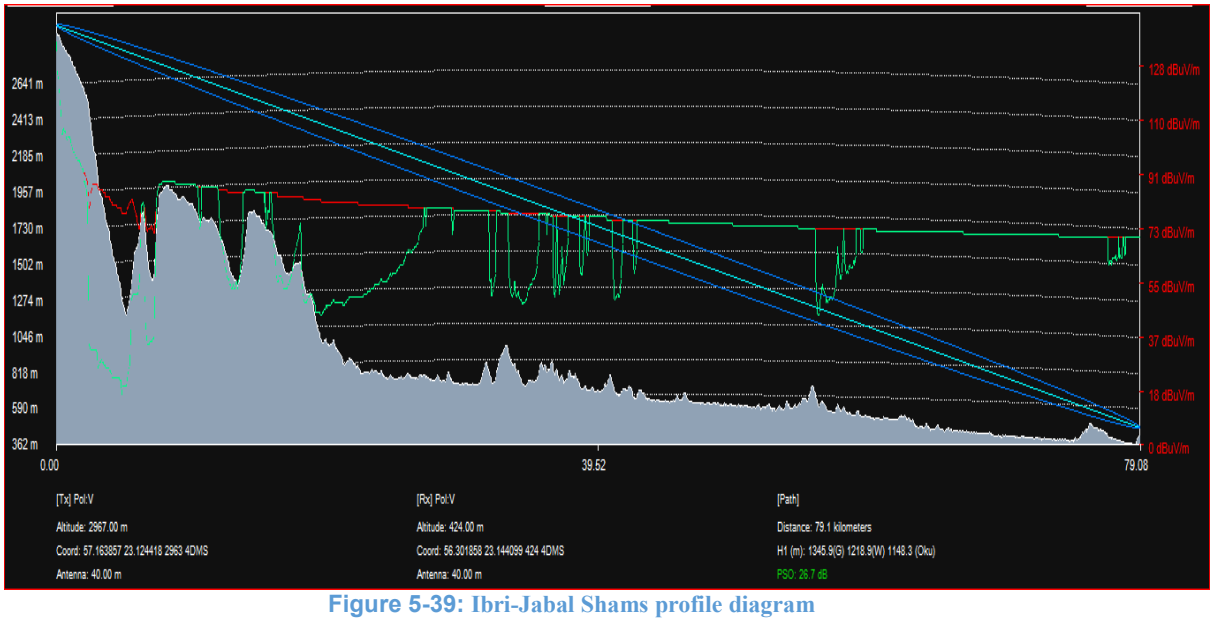


Figure 5-39: Ibri-Jabal Shams profile diagram

This scenario only concerned with the two-way high-speed connection between two sites through a middle one. Creating, installing and connecting NDs with the network service would be done in the following scenario (Scenario-7).

5.3.3.6.2 Simulation Analysis

The Muscat's site (one BS) has been installed and presumably connected to the main National fibre grid which in turns establishes two-way communication with the Jabal Shams's site, then the Jabal Shams's second BS has established a two-way communication link with Ibri's BS.

5.3.3.6.3 Analysing Signal Propagation

Although a total of more than 54000 Km^2 could be covered by the three sites, the quality of the signal propagated couldn't be determined from the table. To determine the quality of the signal propagation power we examine Table.5-22 and Figure.5-43 that show close to %48 of the total covered area (54000 Km^2) has the signal propagation of 52 dBu which is higher than the threshold (43dBu). The next signal propagation power level is 61 dBu and it has a cover area of %26 of the total area followed by the 43 dBu coverage area with %23 of the total propagation area. The last two examined areas are the 70 dBu and 79 dBu with values of %4 and less than %1 respectively.

	Min value found	Percentage covered
1	43	22.79
2	52	47.76
3	61	25.52
4	70	3.26
5	79	0.55
6	88	0.1
7	97	0.02
8	106	0
9	115	0
10	124	0

Table 5-19: Three Sites' Signal Area Propagation Model

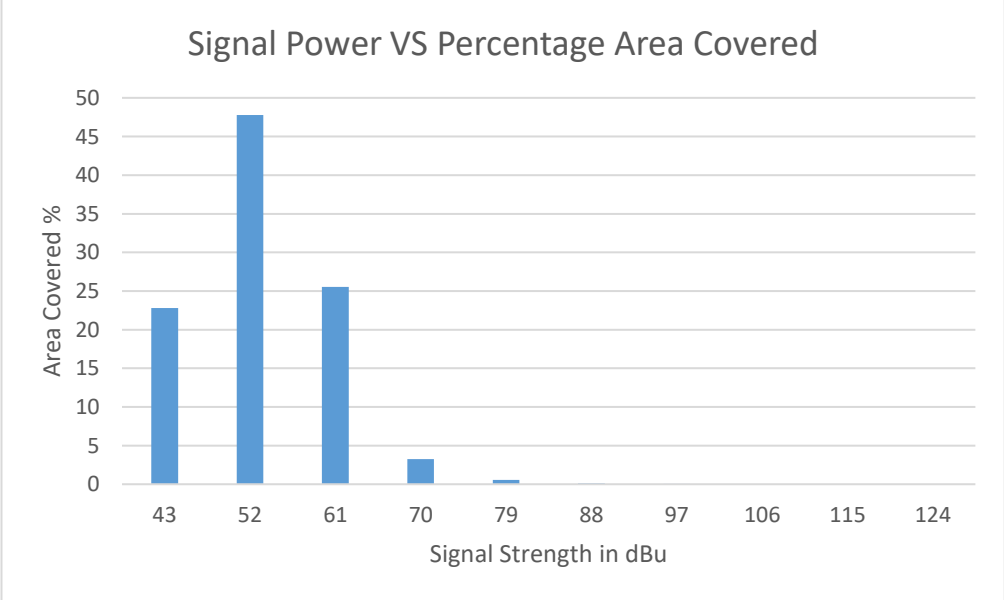


Figure 5-40Signal Area Propagation Percentage Compared to Total Area Covered

After we have analysed the readings in the table and figures above, we conclude that this type of data path link could be set up to deliver internet service to a remote location that is far from the main internet service providers coverage area. In this case, the link has extended the service to 190 Km distanced site. This scenario has proved that there exists a reliable communication link to build our proposed network that uses very minimum resources to provide, enhance or extend internet service to a distanced/remote location that has limited or no internet services (Scenario-7).

5.3.3.7 Scenario-7 (Mobile LTE-A-TVWS)

In all mobile radio networks, NDs or User Equipment (UEs), send a signal to BS for different reasons amongst them is decision making. It may be used for improving downlink scheduling, uplink scheduling, cell selection, handover, calculation of uplink and downlink path loss for power control, multipath propagation, Uplink interference and for location based services. This is accomplished by parameters called Signal to Interference Noise Ratio (SINR), Received Signal Strength Indicator (RSSI), Reference Signal Received Power (RSRP**)**, Reference Signal Received Quality (RSRQ) and Reference Signal Time Difference (RSTD).

SNIR is the ratio of total signal power to the entirety of total noise power and total of interference power at the receiver. It is a better-received signal power quality indicator than SNR.

RSRP is the average power received by ND from a single cell exact reference signal resource element divided over the entire bandwidth. It is computed by the ND for cell selection, handover and for path loss calculation for power control. The range of RSRP reported by ND are between -140 dBm to -44dBm [105], [106].

RSSI is a measurement of just how well an ND can hear a signal from a BS. This

value is important for determining if the ND has enough signal to get a good connection. Because an RSSI value is drawn from the client ND, it is not the same as transmit power from a BS, it is the sum of all received signal power from all sources. Unlike the RSRP, RSSI is by no means reported by ND to BS, but it is used as an input to calculate the RSRQ [107].

RSRQ is also used for cell selection, reselection, and handover. It is only used when RSRP is not adequate for making a decision. It is mathematically defined as (N*RSRP)/RSSI, where N is the number of Resource Blocks (RB) of the LTE carrier RSSI measurement bandwidth. In order to calculate RSRQ, the numerator and denominator should be made over the same set of RBs. Because calculation of RSRQ uses RSSI, it allows the joint reporting of signal power strength and interference. RSRQ values ranges from -19.5dB to -3dB [108].

In the LTE networks, a node must detect and monitor the existence of various cells and make cell reselection to guarantee that it is located on the best suitable cell. A node located on a specific cell will monitor the System Information and Paging of that cell, but it is essential to continue to monitor the quality and strength of other different cells to determine whether cell reselection is necessary. Table.5-23 summarises the above-mentioned parameter's expected values that indicate the quality of the connection and transmission between NDs and parented BS along with the proximity of the NDs to the site cell.

RF Conditions	SNIR	RSSI	RSRP	RSRQ
Excellent	>=20	>= -32	>= -80	>= -10
Good	13 to 20	-32 to -58	-80 to - 90	-10 to -15
Middle	0 to 13	-58 to -96	-90-100	-15 to -20
Week	<=0	< -96	< -100	< -20

Table 5-20: RF Standard Conditions' Values

The main objective of this scenario (Scenario-7) is to utilise the link created in

Scenario-6 to provide internet service to 500 mobile NDs roaming around Ibri town. To do so, we will earmark (mask) an area of approximately 600 KM^2 around Ibri and install one four-sectored site on the mask and randomly deploy the 500 roaming NDs with the same configurations as the Scenario-1's NDs' in Table.5-24 except for the antennas' types which now are omnidirectional rather than directional.

Nodes' Parameters'	
Communication frequency	590 MHz
transmission power	2 w
Antenna Type	Omnidirectional
Antenna gain	6 w
Demanded DL	8 Mbps
Demanded UL	4 Mbps

Table 5-21: Ibri Mobile NDs' Configurations

These four BSs would be connected to the Ibri's BS that is already connected to Jabal Shams's site. Figure. 5-44 shows the network connected to the previous three sites which act a link path to Muscat's main service provider through Jabal Shams's site.

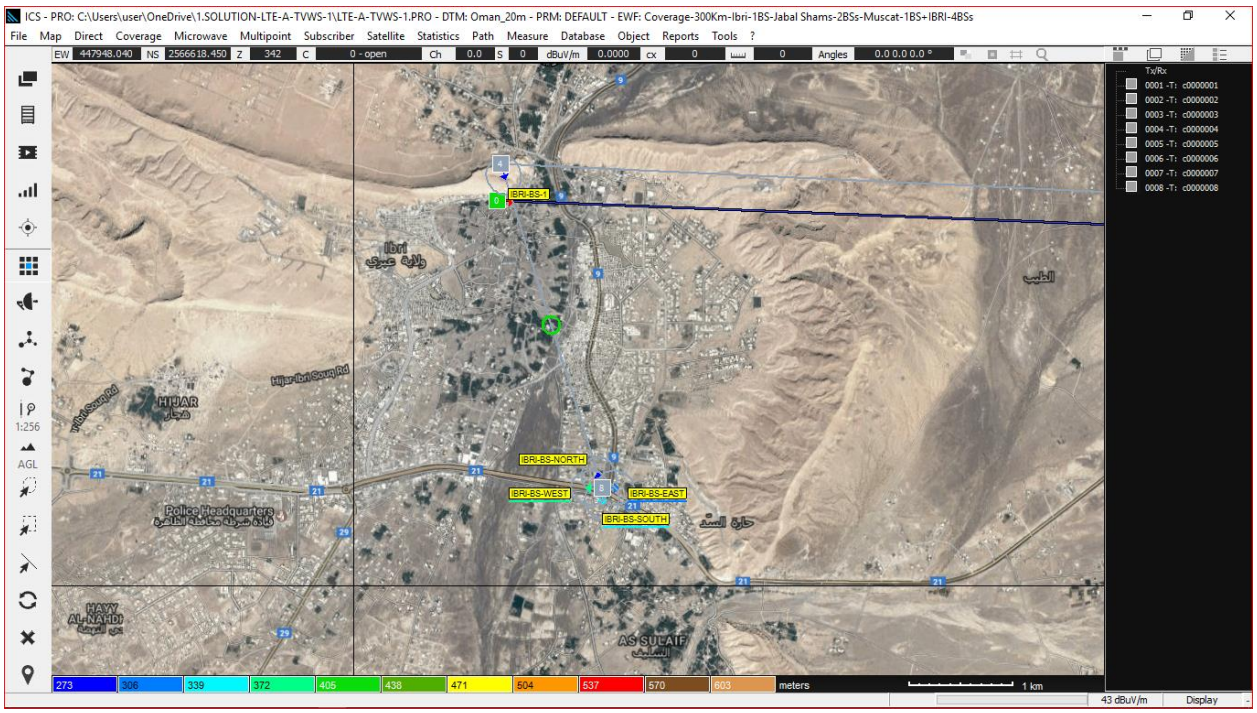


Figure 5-41: Ibri's Mobile Network Layout Topology

Before we start our simulation, we will introduce some terms that are necessary for our later reports and analysis of the simulation.

After having created and connected the connectable number of the mobile NDs, the simulator produced a snapshot of the connection status in a form of a report. The report includes SNIR, RSSI, RSRP and RSRQ. This report is summarised in Table.5-23 below and analysed later in this section.

	SNIR dB	RSSI dB	RSRP dB	RSRQ dB
Minimum	35.00	-60.30	-91.10	-9.40
Average	57.20	-38.03	-68.93	-9.40
Maximum	78.70	-16.60	-47.40	-9.40

Table 5-22. Ibri's RF Computed Condition Values

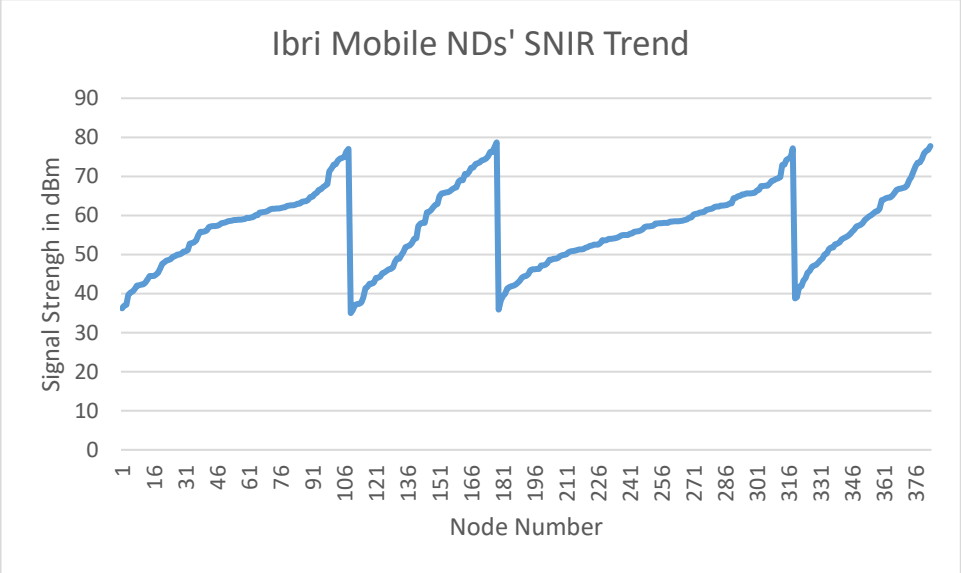


Figure 5-42: Ibri Mobile NDs' SNIR Trend

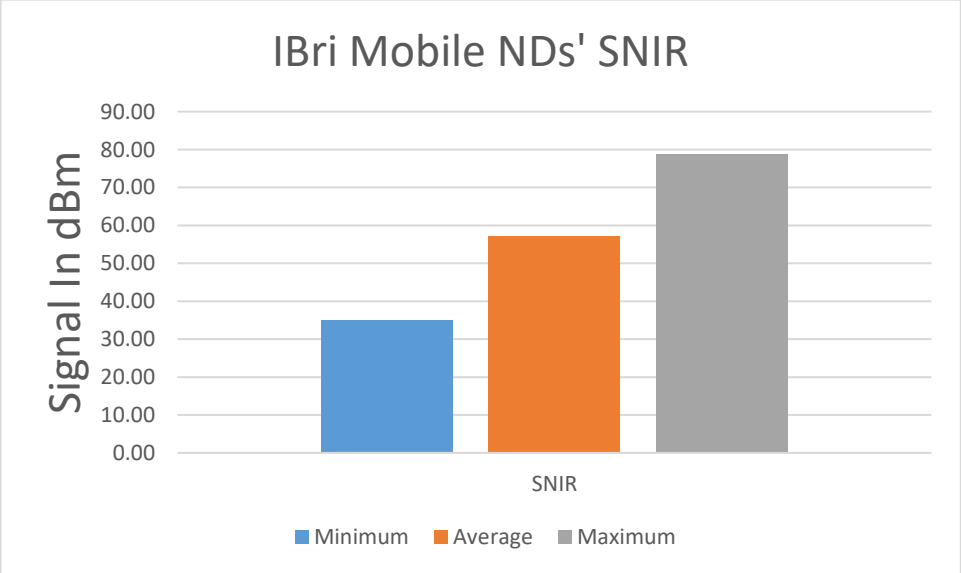


Figure 5-43: Ibri Mobile NDs' SNIR (MIN, AVG and MAX)

From Figure 5-43 we can see the SNIR values range from 0 dBm (Strongest) to -120 dBm (weakest). Consulting with Table. 5-23 reveals that the signal received at the NDs indicates that SNIR values range from 35 dBm to 78 dBm which indicates the mobile NDs have excellent connection to the current parent BS.

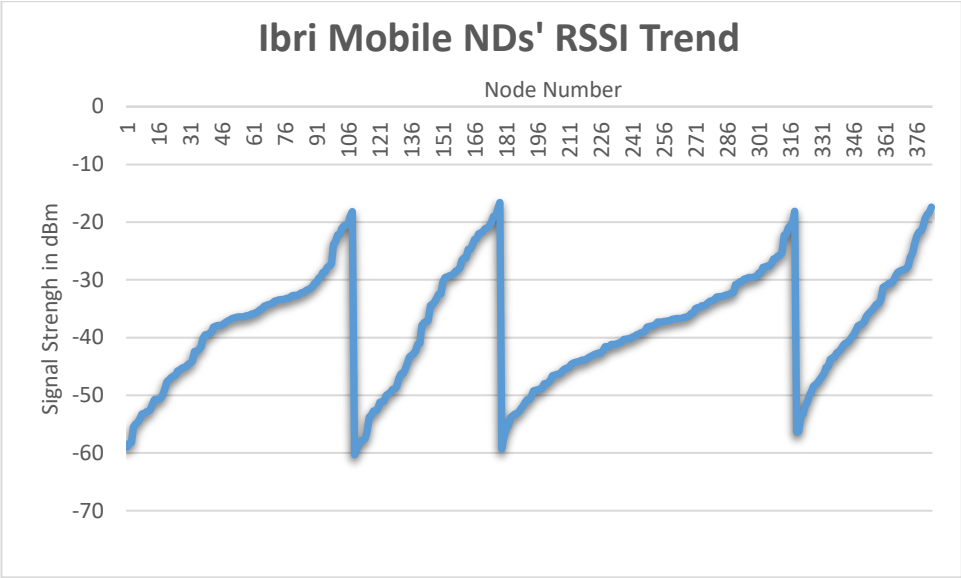


Figure 5-44: Ibri Mobile NDs' RSSI Trends

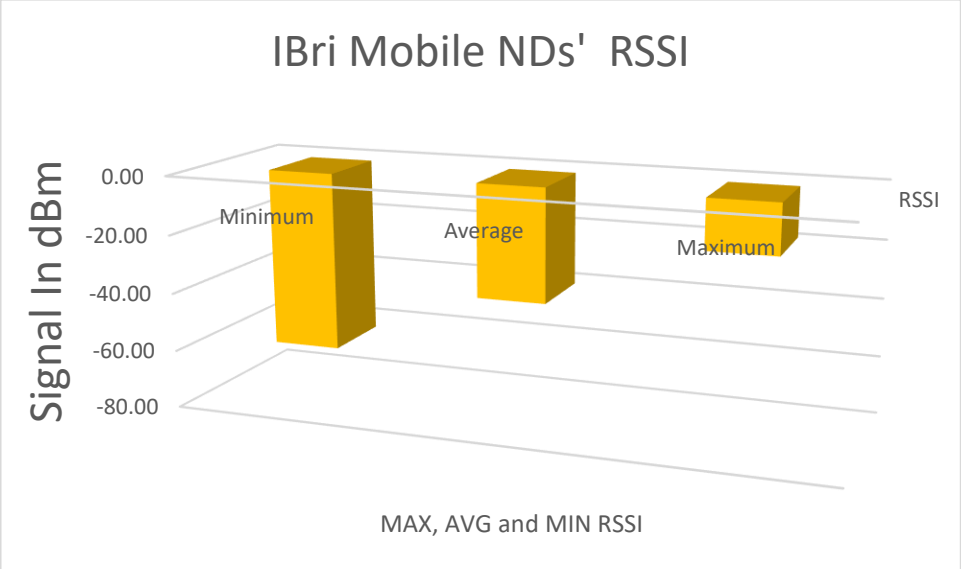
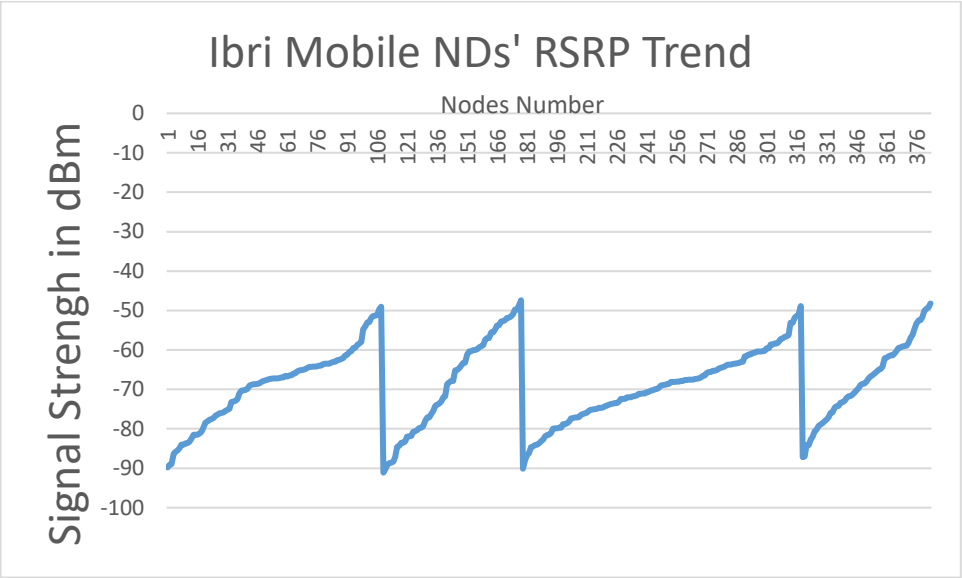


Figure 5-45: Ibri Mobile NDs' RSSI (MIN, AVG and MAX)

Regarding Ibri's mobile network RSSI values, it shows that they range from -60 to -17 with an average of -38 dB (Figures. 5-44 and 5-45) which indicates that the most of the NDs are willing to receive a good service from the parent BS.



IFigure 5-46: Ibri Mobile NDs' RSRP Trend

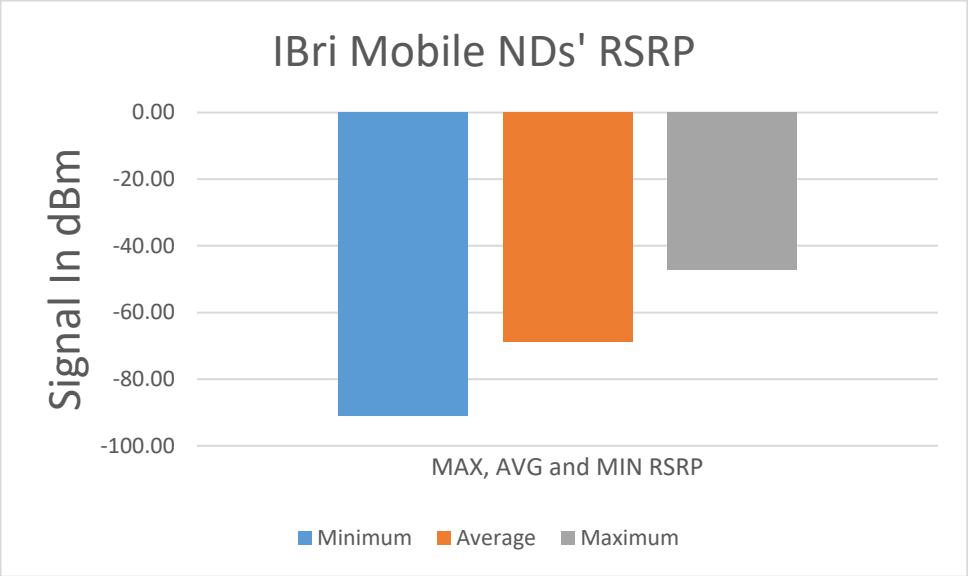


Figure 5-47: Ibri Mobile NDs' RSRP (MIN, AVG and MAX)

In order to have a really good connection with the BS, the ND calculates the RSRP to determine how well it can hear a signal from a BS. The computer values have been found to be in the range of acceptable values. These values range from -47 to -91 dBm which indicates that most if not all of the NDs can hear a good signal from their parent BSs (Figures. 5-46 and 5-47).

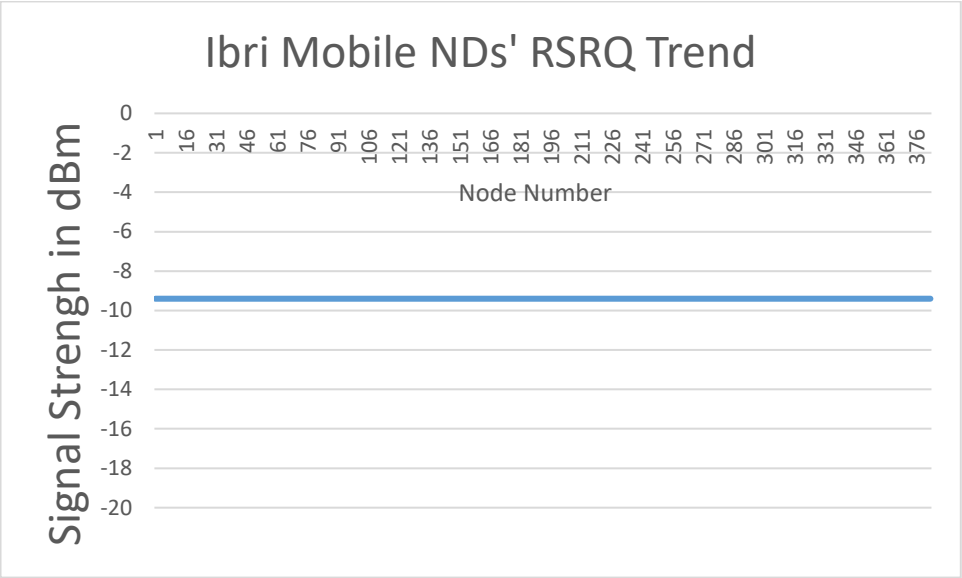


Figure 5-48: Ibri Mobile NDs' RSRQ Trend

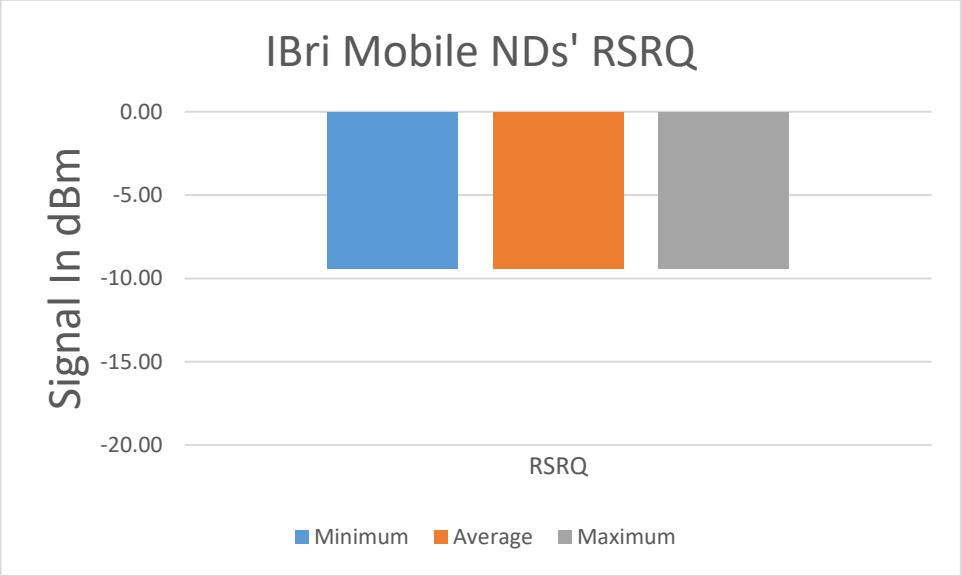


Figure 5-49: Ibri Mobile NDs' RSRQ (MIN, AVG and MAX)

RSRQ is used for cell selection, reselection, and handover and it should range from -19.5dB to -3dB, in our simulation the calculated RSRQ value, was found to be -9.4 dBm for all NDs indicating that not only the NDs could get a good connection and service from their parent BSs but also can select, re-select and handover to other BSs (Figure. 5-48 and 5-49).

5.3.3.8 Scenario- 8 (LTE-1800 Network)

To compare the performance of LTE-1800 and LTE-A-TVWS (our solution), first we

had created and analysed our network with 5000 NDs (Sceinario-2); now we will deploy the LTE-1800 with the same configurations except for the transmitting frequency and the bandwidth (Table.5-1). The transmitting frequency will be the 1800 MHz and the BW will be 5 MHz. As the clients' (NDs) configurations concerns, the same frequency will be used and a directional antenna would also be used. The BSs will be installed on the same previously selected sites and the whole LTE-A-TVWS network will be disabled along with their BSs and NDS. This is important so we can isolate the two networks. In the LTE-1800 network, we will create 5000 NDs and the system will randomly select a location for each. The NDs configuration entry screen and the DBs configuration screens can be seen in the following figures (Figures. 5-50 to 5-53).

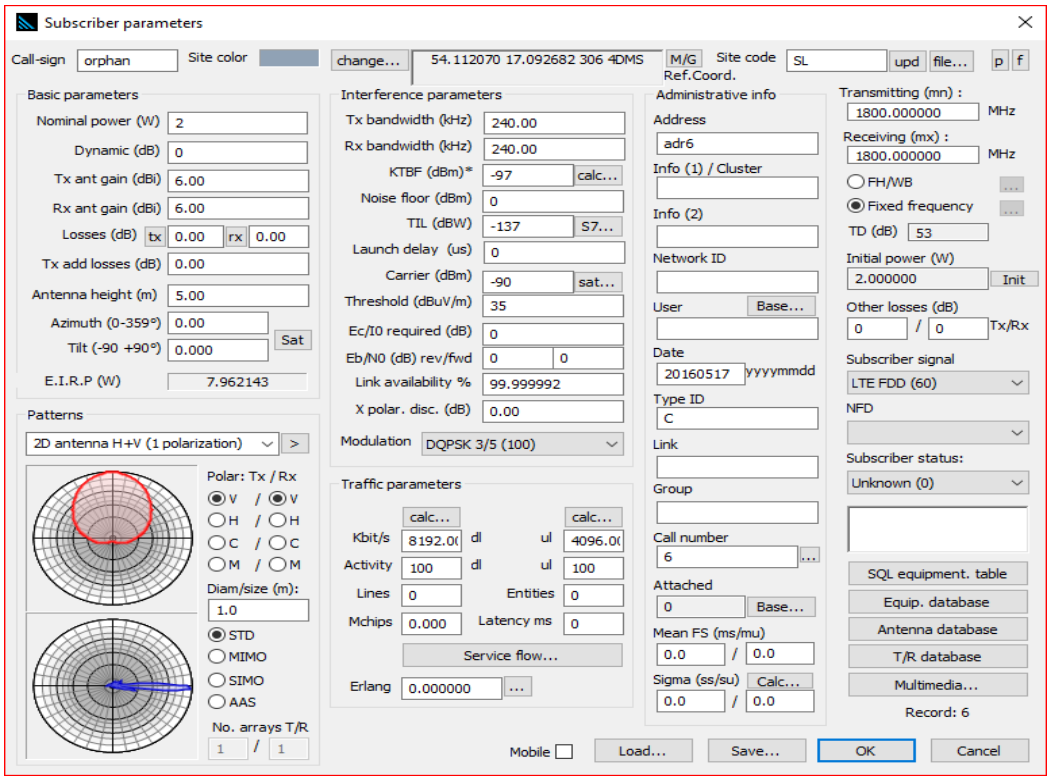


Figure 5-50: LTE-1800 ND's Setup Screen

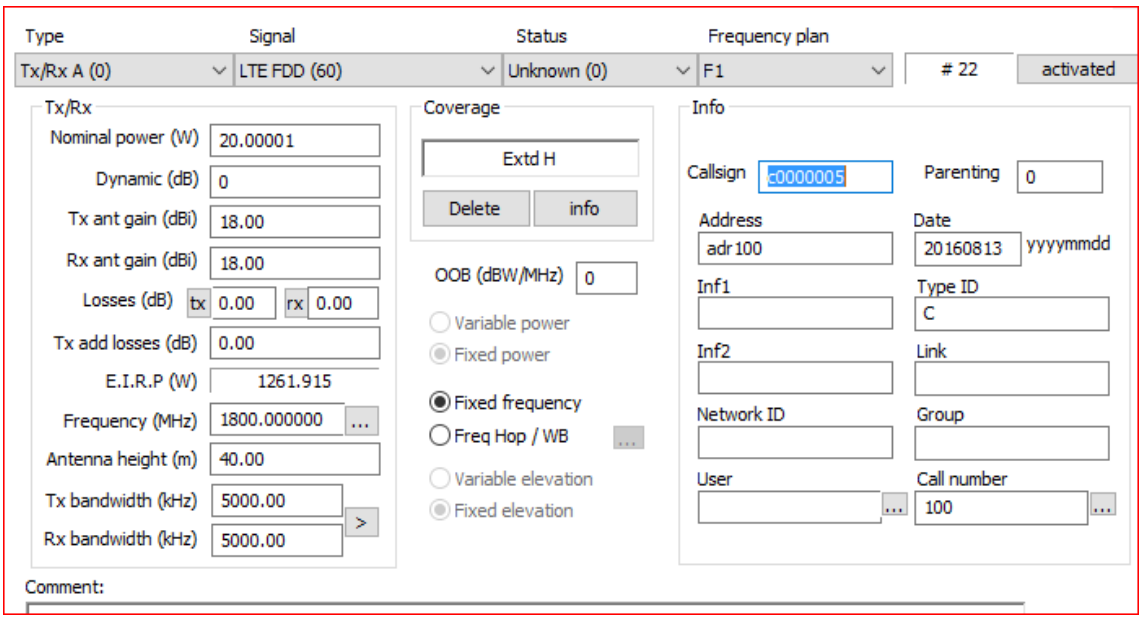


Figure 5-51: LTE-1800 BS's Setup Screen (General)

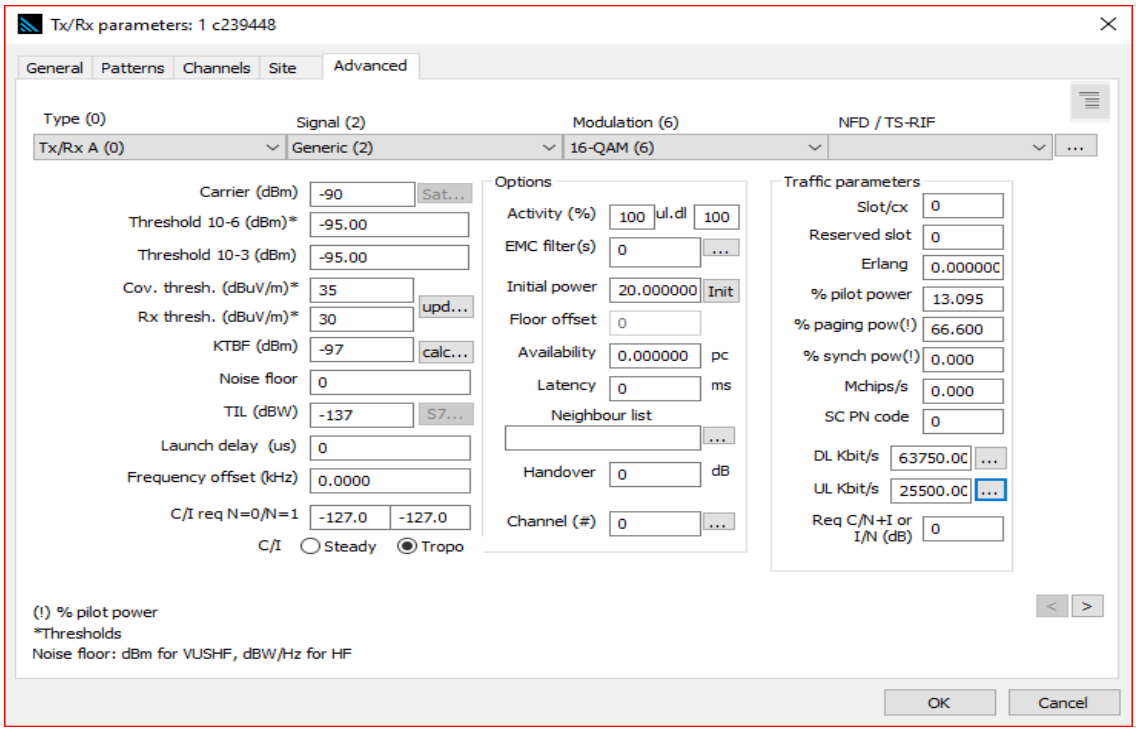


Figure 5-52: LTE-1800 ND's Setup Screen 'Advanced'

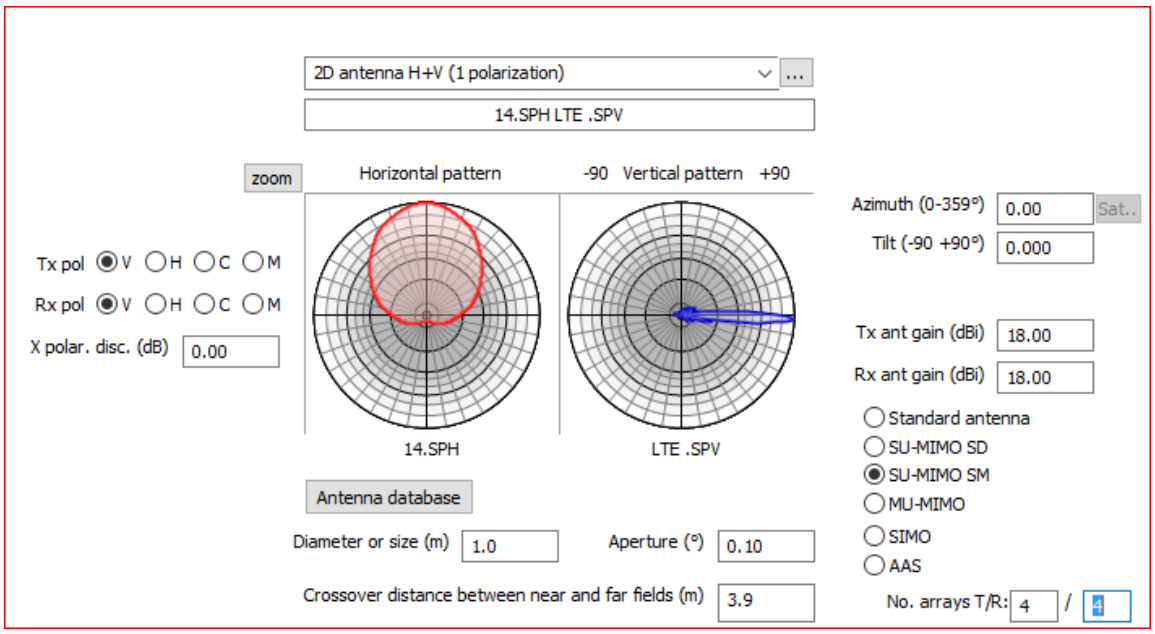


Figure 5-53: LTE-1800 BSs' Antenna Setup Screen

After we had created the four sites with 13 BSs on the same locations and the 5000 NDs on randomly selected locations, we executed the simulation and it could connect 556 NDs out of the 5000 NDs (less than 11%) because the signal couldn't propagate outside the LTE-1800 allowable distance, (up to 3 Km). Figure.5-54 depicts the connected NDs compared to total NDs. Additionally, those connected NDs had obtained 100% QoS since they are located within a small cell (3 Km). Figures. 5-55 to 5-558 depict the LTE-1800 performance which includes power, SNIR, distance and data throughput.

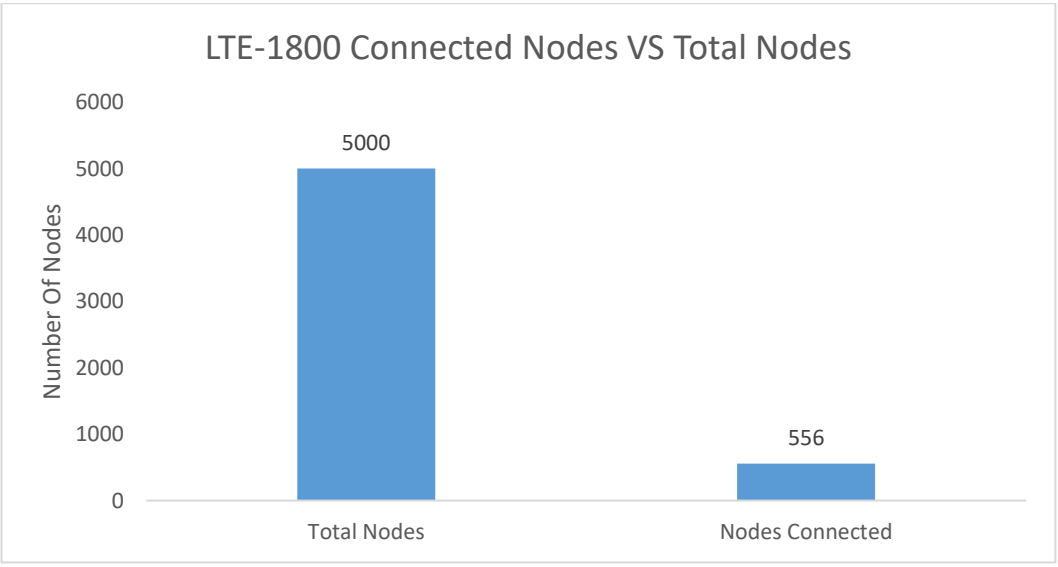


Figure 5-54: LTE-1800 Connected NDs Compared to Total

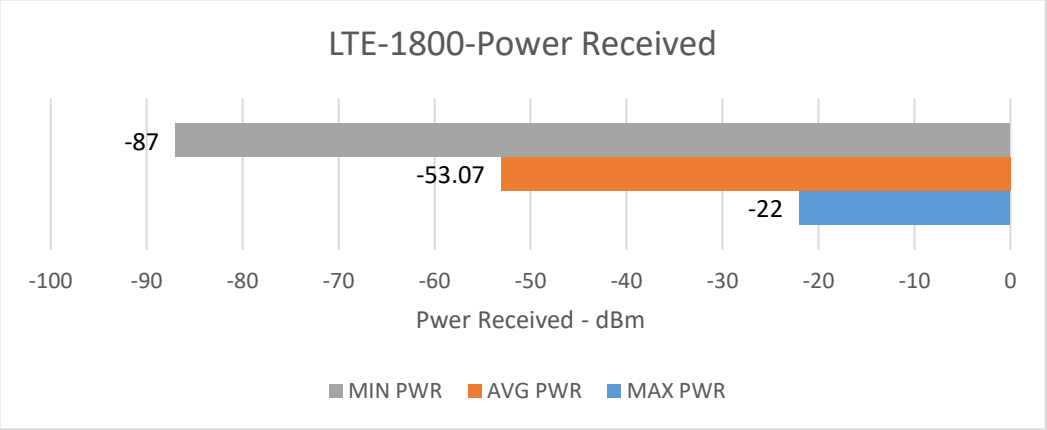


Figure 5-55: LTE-1800 Received Power

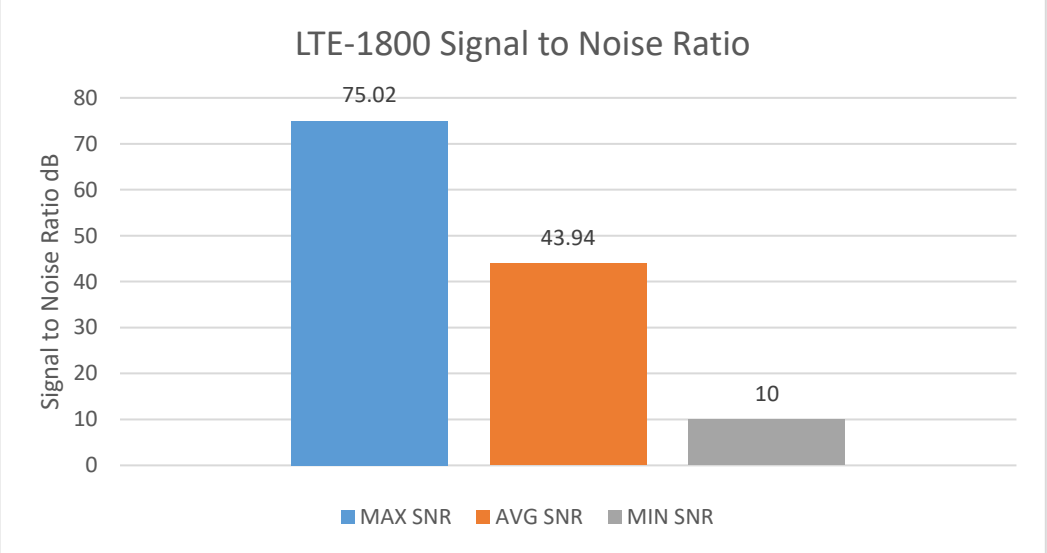


Figure 5-56: LTE-1800 Signal to Noise Ratio (SNR)

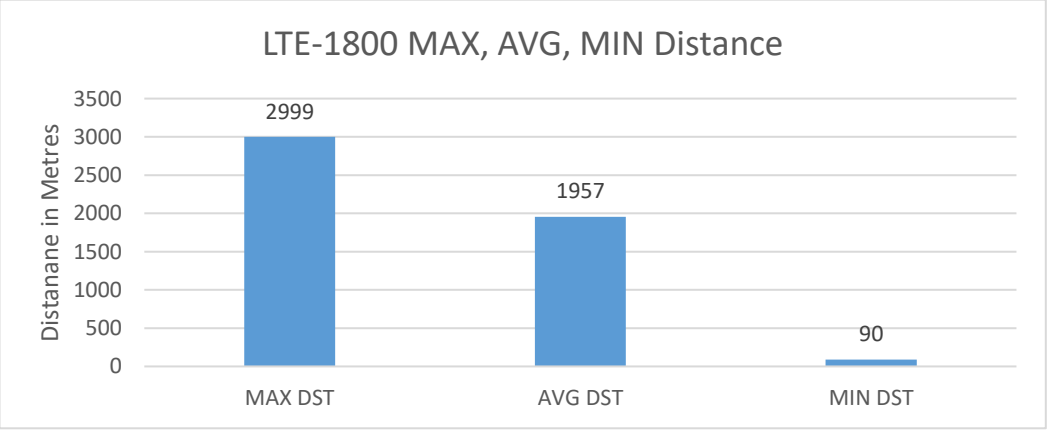


Figure 5-57: LTE-1800 Distance Between BSs and Connected NDs

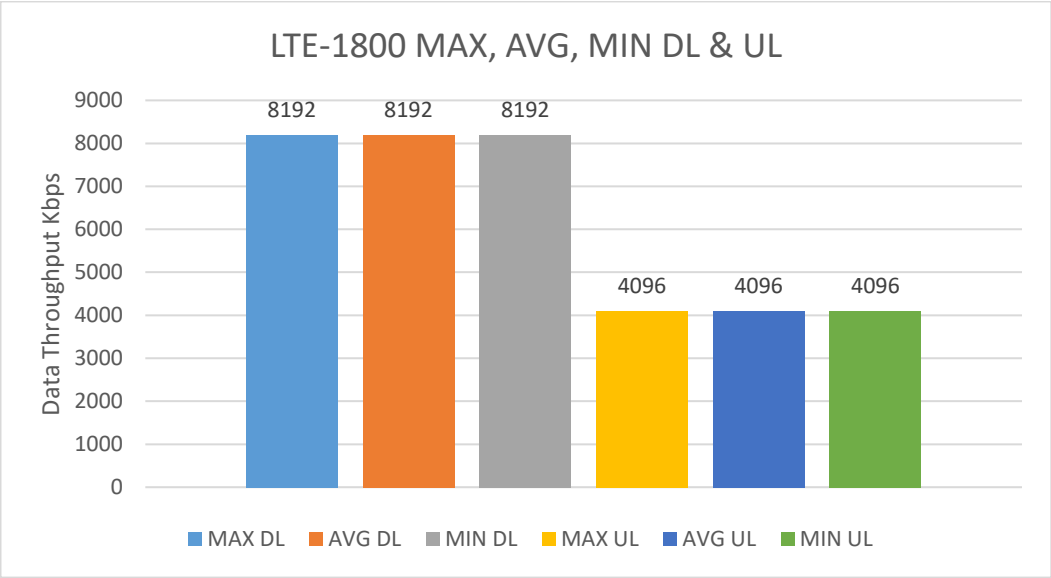


Figure 5-58: LTE-1800 Data Throughput of Connected NDs

5.4 COMPARISON AND CONCLUSION

During the simulation and the analysis of the results of the two networks, it has been noticeable that the LTE-A-TVWS is undoubtedly superior to the LTE-1800 (Scenario-8) network in all aspects. First, the connected NDs are far greater in the first network. The LTE-A-TVWS's BS could deliver very high data throughput and could cover very large area and server very big number of NDs. When we compare Scenario-2 with Scenario-8 in the capacity of the 5000 NDs connection, LTE-A-TVWS could connect 92% of the NDs whereas the LTE-1800 could not achieve more than 11%. It would take more than nine times to deploy an LTE-1800 network compared to the LTE-A-TVWS to achieve %92 of connection level and that would require a big investment for purchasing, installing and maintaining the network hardware in addition to manpower.

To answer the thesis's stated question, this research has endeavoured to find a solution to the limited broadband shortage in Oman by reviewing and stating the cause of the problem, therefore, we have investigated and reviewed many similar problems and their potential solutions in the world. All the solutions suggested, have not met our requirements and eventually eliminated from our list of choices. Nonetheless, after deeper study, we have finally found a potential technology that can solve our problem by enhancing it further. Thus, LTE-A Ver. 12 and above operating on the TVWS is our solution. To

implement it, we have simulated the problem along with LTE operating on the 1800 MHz spectrum. After having done the simulation and analysis, we have concluded that our proposed system would enhance the broadband service in Oman and similar countries with minimal financial burden.

From the two networks' simulations, our solution is superbly over weigh the current LTE-A-1800 in all aspects. While both networks use similar technologies, ours differ mainly on the spectrum usage and the bandwidth. It uses the TVWS spectrum with 120 MHz BW whereas the other uses 1800 MHz with 5 MHz BW. TVWS spectrum has many advantages over the other radio spectrums on the higher frequency bands. It can propagate through long distances and penetrate through obstacles including forests and high hills. This solution will help to introduce the broadband internet service to new areas and enhance the service in areas where it is limited or shortage in the service.

As the financial cost concerns to deploy our solution compared to the other one, it would be much less than the other due to the fact that our solution uses very much less hardware, manpower and can use the existing communication towers including the analogue TV stations'.

5.5 SUMMARISING THE TWO NETWORKS' PERFORMANCE

The following table (Table. 5-24) summarises the two networks performance (Scenario-2 of LTE-A-TVWS and of the LTE-1800 (Scenario-8) per their offered services, connected NDs, QoS of the connected NDs and the number of BSs. The data is presented in the Figures.5-59 and 5-60

Category	LTE-A-TVWS	LTE-1800 MHZ
No Sites	5	5
No. BSs	13	13
Connected Nodes out of 5000 Nodes	4615	556
Average Demanded DL Kbps	8192	8192
Total Offered Data DL Throughput Mbps	52000	52000
Total Utilised DL Mbps	36920 (71%)	4448 (8%)
Total Unutilised DL Mbps	15080 (29%)	47552 (92%)

Table 5-23: LTE-A-TVWS & LTE-1800 Performance Comparison Table

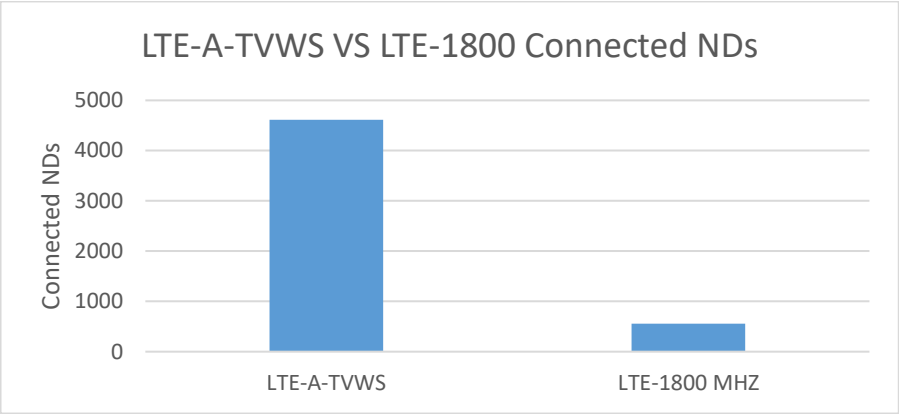


Figure 5-59: LTE-A-TVWS VS LTE-1800 Connected NDs

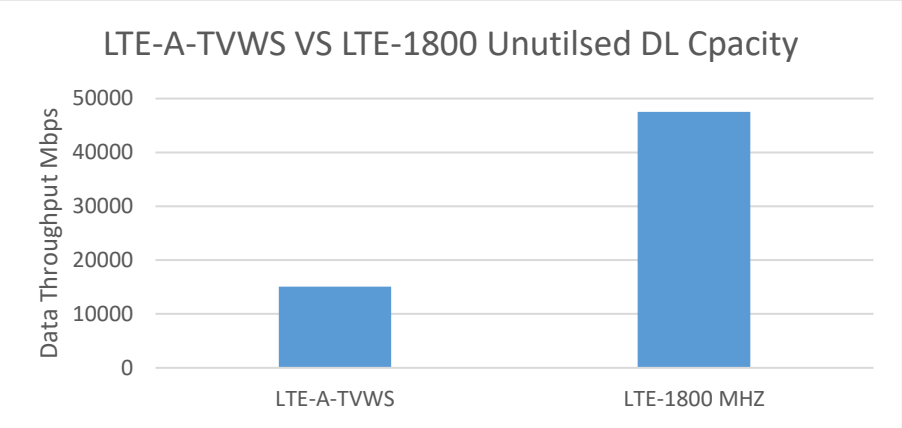


Figure 5-60: LTE-A-TVWS VS LTE-1800 Unutilised DL Capacity

5.5.1 What is required to Bring the LTE-1800 to the LTE-A-TVWS Service Level?

In order to bring up the level of the LTE-1800 to the LTE-A-TVWS level we need to consult the table below: the number of sites in the new LTE-1800 have to be increased by ten times and the BSs also have to be increased by ten times in order to cover the same NDs that our LTE-A-TVWS network is covering. The LTE-1800 should have 50 sites with 130 BSs to cover and provide the same QoS of our LTE-A-TVWS network which has 4 sites and 13 BSs. This new setup would inflict a tremendous amount of money, labour, time and of course recurrent financial burden (Table.5-25). Therefore, LTE-A-TVWS is the preferred solution by great leap.

	Simulated Networks		
Category	LTE-A-TVWS	LTE-1800 MHZ	Requirements of the LTE-1800 to Bring to current LTE-A-TVWS Level
No Sites	5	5	50
No. BSs	13	13	130
Number Connected Users	4615	556	4615

Table 5-24: The requirements needed of the new LTE-1800 to bring to current LTE-A-TVWS Level

The requirements to bring up the LTE-A-TVWS to cover 20,000 NDs will focus on providing more resources such as BSs, Sites and connection to the internet gateway. From our previous scenario-2, we concluded that one BS with 4 Gbps DL and 2 Gbps UL can serve 500 NDs under the best circumstances. Therefore, how many BSs are required to cover 20,000 NDs with 8 Mbps DL demand and 2 Mbps UL demand if the total demand is 163 Gbps? The answer is 41 BSs. The next question could be asked; how many sites are required to install these 41 BSs? The question can be answered in the following manner. Now we have proved that an LTE-A-TVWS can reach and successfully connect NDs more than 30 Km away, therefore, we conclude that increasing the NDs by four times doesn't mean that we must quadruple the site number. In the best case, we will need ten sectored-sites with four BSs each. In fact, LTE-A-TVWS sites can be brought closer to each other in the same area saving a great amount of money and manpower. That means, one site could have six-sectored BSs (60°) in different corners of the site to minimise interferences between six BSs.

Finally, as can be seen from the simulation and the analysis, we can conclude that our proposed solution overweighs the existing technologies' benefits to solve our stated problem with minimal financial cost and time. Although this technology's hardware is still under development, it is of the opinion the challenge of developing such hardware will be mostly as of a regulatory issue not a technical one.

6. CONCLUSIONS AND RECOMMENDATIONS

6.1 INTRODUCTION

The absence/shortage of fixed and mobile broadband internet service across the rural areas of Oman, as an effect of difficult environment and terrains, and the limitation of the existing technologies to meet the required service with reasonable complexity, investment and minimal implementation time, acted as a driver for the researcher to complete this research, specifically in mind of investigating technologies that can be implemented in the country with the aim of improving the service and solving the problem with minimum financial cost and with reasonable time of implementation.

The studies investigated in the literature review, combined with the radio spectrum occupancy measurement campaign carried out by the researcher, also revealed that most of the licensed radio spectrum is underutilised, especially in the lower 1 GHz bands. The literature review has revealed that the potentially evolving Cognitive Radio (CR) technology and TV White Space (TVWS) is very promising technology to meet the objectives of the research. This has enlightened the researcher in investigating a technology that is capable of utilising this underutilised spectrum.

In its purest and classical form—and by using many radio spectrum sensing methods and techniques—CR is promising to permit any radio spectrum user to temporarily utilise any unused spectrum in order to solve the congestion of the radio spectrum and when complete, the user must vacate the spectrum. Due to its overwhelming complexity, this type of technology remains in its embryonic stage as it requires tremendous development; therefore, the researcher, with the consultation of his supervisor, disregarded this type of technology as a proposed solution to the problem. In the meanwhile, an alternate or workaround technique was developed in

order to make use of the underutilised TV spectrum, which is still being licensed or earmarked to some kind of radio services, such as TV broadcasting and microphones. TVWS database solution was mainly concentrated on maintaining all licensed TV channels. Most of the channels are exclusively licensed to users on the basis of the telecommunication authority guaranteeing that no interferences from other NDs as long as the licensee is paying the right dues. During our research, we have looked into and examined the TVWS database technology, which, at first, appeared to be a promising solution. We analysed the TVWSDB technology and found that this type of solution was very limited in both the data throughput and the coverage area; therefore, we eliminated this from our possible proposed solution.

Throughout the continuous literature review stage—and in mind of establishing the real spectrum occupancy in the lower 3 GHz of the spectrum—a radio spectrum occupancy measurement campaign was carried out in five major cities and towns. The study also discovered that the TV spectrum was underutilised; therefore, the next step in the research was to look for and examine a new or upgraded 4G/LTE technology that could provide wider coverage areas and higher data throughput. Following an in-depth investigation, we found that the Long Term Evolution – Advanced (LTE-A) Ver. 12, which was sanctioned in March 2015, could fulfil some of the requirements. According to the standard, using the 64QAM could deliver the greatest performance for LTE-Advanced V.12, and when the code rate of 5/6 is used along with 120 MHz BW and 8x8 MIMO antenna, the system could deliver a high peak data rate of 4.032 Gbps. There have been many experiments and simulations for such technology. Most have used the existing 4G/LTE spectrum and bandwidth, but some simulations have used the TV spectrum (698–746 MHz) or 48 MHz BW and (746–806 MHz) or 60 MHz BW. The data rates and coverage areas could not be proven to be adequate for

our needs. Therefore, in our simulation, we have used the 470-710 MHz spectrum (120 MHz BW for DL, 120 MHZ BW for UL) and 8X8 antenna. All scenarios could connect NDs more than 30 Km away from the BS. The maximum BSs' offered service was 4.032 Mbps DL and 2.016 Mbps UL.

6.2 PROPOSED DRAFT FRAMEWORK FOR TVW REGULATIONS

In this section, we propose a framework for TVWS regulations. Concerning the Radio Spectrum Occupancy Measurement Campaign carried out by the researcher, it is very clear that most analogue TV channels are not operating at present. The TRA and Radio and TV Authority (RTA) indicate that most, if not all, of the residents of the country, are using satellite receivers, and although the country has not officially changed to digital TV broadcasting, the RTA has stopped maintaining the analogue TV broadcasting equipment according to RTA.

Before any new telecommunication services are introduced, clear regulations and policies have to be drafted and sanctioned, which must be in line with the Telecommunications Regulatory Act and the National Frequency Allocations and Assignment Plan. It is suggested that the authority seeks public consultation to obtain feedback and input from industry and service providers before formulating TVWS regulations.

6.3 THE PROPOSED TVWS REGULATION FRAMEWORK

The possible uses of TVWS are still being considered by the market; therefore, there remains some degree of uncertainty concerning exactly what sort of TVWS accessibility will be critical to allow the technology to be deployed. The coexistence framework is developed so as to allow as much use as works with a low likelihood of destructive interference and, therefore, allows greater powers at closer distances for devices that will trigger less interference. The availability analysis carried out on

programmes most likely use cases for a good percentage of the country.

As established throughout the previous chapters, the growing number of wireless devices has put greater demands on the radio spectrum to deliver current and new services. It is also clear that the dynamic management of frequencies, along with intelligent devices that are aware of their position, allows freeing up valuable low-frequency spectrum, which is never or rarely used, by permitting access in areas and at times that others are not utilising it [56], [109].

Concerning the Spectrum Occupancy Measurement Campaign, as detailed in Chapter 4, and to stimulate innovation, the researcher is recommending that the some of the available radio spectra be freed up on a license-exempt basis. The radio spectrum potentially available is the spectrum that will be left over by Digital Terrestrial Television (DTT) and Programme-Making and Special Events (PMSE) use as TV white spaces (TVWS). It is recommended that access to most of the TVWS made available on a license basis (SPs) were some other is recommended for exempted use by devices that meet minimum technical specifications.

The researcher recommends reassigning the unutilised parts of the 470 MHz–790 MHz by allowing SPs controlled dynamic sharing of the available spectrum for database access. It is recommended that a careful approach is applied in mind of managing the risk of harmful interference to current users when the exempted devices get access to the licensed spectrum. Furthermore, it is recommended that the devices accessing the spectrum be aware of their location, and the DBs are also aware of where the existing services to be used so that services can coexist by sharing the spectrum [56], [110].

Database-controlled dynamic spectrum access is a recent notion to spectrum

sharing that has not yet been completely verified with a high volume of users. The use of White Space Devices (WSDs) is still principally at a very early phase of development, and whilst there is a harmonised basis and a minimum technical specifications and requirements of the equipment will be specified in order to run in WS, it is not yet known exactly what the real features of mainstream consumer WSD will be. Likewise, we do not yet know what the real use cases and volumes of use will certainly be. All this provides a high degree of uncertainty concerning the use of WS, and the marketplace in WSDs, and how such use will establish; for this reason, we have taken the view that, to begin with, we need to set our protection requirements within a traditional method [111].

It is recommended that some use of TVWS spectrum by WSDs is to be license-free and that the Authority is to set up license-free regulations and specifications, including minimum technical requirements for the TVWSDs. The rules and specifications should include the transmit bands and the conditions of the transmission. Additionally, it is recommended that such devices ensure that they use the WS license-free with a low probability of harmful interference to current users. Finally, it is recommended to make special arrangements with DB providers to manage and operate the DBs, and the Authority is to provide data to the DB providers, which, in turn, should provide WSDs with available channels and power levels accurately [112].

6.4 ADDRESSING THE RESEARCH QUESTION

As mentioned in Chapter 1, this thesis seeks to answer the question, ‘How can broadband service be introduced/enhanced in the Sultanate of Oman’s major urban, suburban and rural areas, inducing minimum financial costs whilst achieving high coverage and speed?’

Importantly, this question was answered by reviewing and analysing current technologies through the completion of a literature review, as well as with consideration to the findings and analysis of the radio spectrum occupancy measurement campaign in five major parts of Oman and by the simulation and its findings and analysis.

6.5 ACHIEVING THE OBJECTIVES OF THE RESEARCH

The following paragraphs will briefly explain how the research's objectives have been met.

- **To analyse the currently licensed radio spectrum utilisation/occupancy in some major cities and rural areas:** this has been achieved by the literature review and radio spectrum occupancy measurement campaign for five major areas of Oman which was carried out and analysed in Chapter three of the project. The study has revealed that most of the TV spectrum is underutilised most of the time and the reasons were given in that chapter.

- **To evaluate the current mobile broadband internet limitations and obstacles inherent in the main towns and rural areas**: From the researcher's knowledge and experience as a citizen and from the studies that have been carried by the TRA (Chapter 1), it has been obvious that there is an absence/shortage of fixed and mobile broadband internet service across the rural areas of Oman. The reasons for that were given in Chapter one.

- **To review the current solutions available in the literature and related work,** and technologies that can help to improve the current domain of broadband internet: Chapter two (literature review) has deeply investigated the current ongoing wireless broadband solutions which included CR, TVWSDB, 3G 4G/LTE along with LTE-A Ver. 12.

- To find the most efficient technology that is capable of meeting Oman's requirement which could be useful in improving the sector under examination: During the literature review stage, LTE-A Ver. 12 operating on the TV spectrum was selected for the solution technology.

- **To implement the proposed technology using one of the wireless network simulators and analyse the results:** ICS Designer from ATDI has been evaluated and used as the project simulation software. The results were analysed with help of the MS Excel of MSOffice 2016.

- **To develop TVWS recommendations and regulations framework for telecommunication authority and service providers**: Proposed policies and regulations based on the International undergoing TVWS policies are stated in this chapter (6).

6.6 RESEARCH CONTRIBUTIONS AND NOVELTY

This research executed with the support of the main telecommunication authorities and businesses throughout Oman is the first study to concentrate on the TVWS, LTE-A technology and TVWS policies in the Sultanate. From the initial point of present technologies, practices and constraints, it provides an ideal vision associated with introducing the TVWS and LTE-A (ver. 12 and above) to extend, enhance and offer broadband internet service to the countryside areas in the Sultanate. The thesis has identified the main difficulties facing the limited access to fixed and mobile broadband in the rural areas of Oman. This problem was identified by the researcher conducting substantial radio spectrum measurement occupancy in the 40 MHz to 2800 GHz, plus interviews and workshops with telecommunication authorities and businesses. Through the thesis, this pragmatic information, together with the researcher's understanding and know-how of the circumstances, might be shared for

the advantage of telecommunication authorities and businesses so as to improve the general, overall context of the wireless broadband in the Sultanate, as well as amongst other similar countries. The research study focused on improving the existing traditional broadband technologies of the telecommunications market by taking it to a greater level with the TVWS and LTE-A and very big radio spectrum BandWidth (BW).

Being the first effort in this field, context reference material, such as research studies, radio spectrum measurement surveys and paperwork concerning the existing circumstances essentially are non-existent in the Sultanate thus far. Radio spectrum occupancy measurements that are carried out in the project, and the associated analysis, was driven from such measurement contributes to the global radio spectrum occupancy map, and, as per the author's knowledge, this could be the first campaign of its kind to have been carried out in Oman, if not in the whole region. The main goal of this study was to develop and propose a solution and methodology for enhancing the fixed and mobile internet service in rural areas of Oman and similar countries in addition to introducing and expanding the service to new areas.

Additionally, the simulation through its different scenarios, executions, tweaking and analysis has confirmed that LTE-A operation on the TVWS spectrum is the ideal solution to most of the rural areas' limited internet service in Oman and similar countries. The simulation has proven that wider areas with scattered population located in different topographical locations can be provided with the broadband internet service with good QoS service and very small number of BSs and with minimum financial burden.

The project would help in reducing the cost of extending wireless broadband in Oman by reducing the hardware required to build communication towers, taking in

mind that TVWS requires less investment in infrastructure owing to the fact that TVWS can travel longer distances and cover wider areas than 3G, 4G and WiMAX.

The research has examined and proven—through the ICS Designer simulation—that an LTE-A technology operating on the TVWS spectrum can bring about/enhance broadband internet to a vast area in Oman and similar countries, with minimum hardware costs, through the use of existing infrastructure compared to the current 3G and 4G/LTE (900MHz/1800 MHz). Therefore, the LTE-A on TVWS potentially can facilitate introducing broadband internet service to rural areas in Oman, and accordingly, improves the existing wireless mobile network.

Taking into consideration the young and educated population of the country—who notably are working in major cities and towns and who make temporary migration to their villages and countryside during weekends and holidays—and also in consideration to the shortage of broadband internet service, this research addresses the need for broadband service in people's hometowns by proposing a novel method of implementing a Wide Wireless Network that offers a broadband internet service; this is achieved using an improved method of LTE-A operation on the TVWS spectrum.

To summarise the contributions and novelty:

- Radio Spectrum Occupancy Measurement (adding to the world spectrum map). This type of measurement has identified four types of the duty cycle.
- Addressing the broadband internet limitation.
- Addressing social, demographic and business aspects.
- Proposing and testing an ideal solution for the problem.
- This research is the first of its kind to use LTE-A ver. 12 on TVWS spectrum,

even on the simulation level.

- Using most of the existing analogue TV infrastructure.
- The solution is cost effective (few BSs to serve many NDs).
- Addresses the gaps between LTE recent solutions by:
    - Introducing an improved method of implementation (120 MHz Bandwidth, wider area coverage, better data throughput).
    - Extending LTE network to cover big areas.
    - Using existing analogue TV infrastructure such as broadcasting towers.

6.7 LIMITATIONS OF THE RESEARCH

As has been seen throughout the course of this thesis, the LTE-A Ver. 12 remains still under device development not mentioning that the LTE-A Ver. 12 on aggregated TVWS spectrum also is in its early stages. Therefore, implementing the proposed solution in real life extends beyond the scope of this work at this stage.

6.8 CONCLUSION

As mentioned in previous chapters, Oman is a mid-sized country with a small and scattered population, yet is both young and educated. The national regulator and service providers face major obstacles in providing broadband internet services to rural areas. The government has established a national company named Oman Wide Band Company (OWC) in mind of providing a broadband network for major urban and suburban areas in the country. The fibre network has begun to reach some of the population; this network will not reach rural areas shortly. There is the suggestion that satellites services be used in order to reach such areas. It is of an opinion, based on solid fact, that satellite services are extremely costly. From the above we can see there is limited fixed and mobile broadband coverage in some Omani's villages and

suburban combined with growing demand by young educated population. Thus, if nothing is to be done in mind of improving the recent services and meeting futuristic demands, the problem will only worsen on a daily basis.

It is clear from the implemented solution, as demonstrated through simulation in the research, that LTE-A technology operating on the TVWS is capable of providing such services to rural areas, saving the country tremendous amounts of money, as well as time.

Finally, the thesis significantly contributes to elevating the broadband service in Oman by introducing a new technology that confidently would extend the service to rural areas that remain with no or limited broadband internet services. The greatest beneficial impact of the project will be that, from a social perspective, as it would bring the internet to rural villages and countryside, and accordingly, would ease the congestion on the current service in major urban and suburban areas where the service is limited or altogether non-existent. Concerning the proposed TVWS regulation framework, along with other recommendations made in the thesis, a contribution is made to national radio spectrum regulations, which can be utilised to implement such technology.

6.9 FUTURE WORK

The researcher has been in good contact with the national telecommunication authority (TRA) and service providers throughout the entire research period. Therefore, it is recognised as important that their assistance and approval be sought before experimenting with this technology in the future. Additionally, the proposed algorithm could be installed at the BSs DB which to balance the services provided by WISPs by switching subscribers to LTE-A-TVWS service if only the traditional wireless wideband services are congested or non-existence. This will maximise the

wireless broadband service availability, quality and speed and minimise interferences in the traditional broadband spectrum such as (3G, 4G/LTE and Wi-Max) by utilising TV White Space (TVWS) channels. The algorithm could also be developed further to switch BSs on/off when demand increases/decreases by users. That means, when there are a very little number of users connected or requesting service (set up by SP), the system must turn on/off the BS.

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APPENDEXES

APPENDEX .1

Sample Radio Spectrum Traffic
Ruwi - All Time

		MHz								
Date	Time	40	45	50	55	60	65	70	75	80
		POWER IN dBm								
12/23/2013	7:26:57 PM	-74.276	-70.1	-72.084	-70.696	-70.648	-73.292	-71.66	-69.056	-38.5
12/23/2013	7:28:23 PM	-74.276	-71.368	-69.908	-69.648	-71.468	-71.704	-72.064	-70.084	-38.024
12/23/2013	7:29:49 PM	-74.276	-70.208	-70.492	-70	-69.8	-70.98	-67.808	-70.372	-38.04
12/23/2013	7:31:15 PM	-74.276	-73.092	-70.556	-72.564	-72.38	-71.708	-69.948	-71.788	-38.164
12/23/2013	7:32:41 PM	-74.276	-69.336	-70.56	-70.416	-70.092	-69.572	-71.088	-69.028	-38.084
12/23/2013	7:34:07 PM	-74.276	-75.388	-72.692	-73.268	-70.064	-69.916	-70.368	-70.976	-38.12
12/23/2013	7:35:33 PM	-74.276	-71.308	-72.1	-70.252	-71.156	-73.132	-72.348	-72.796	-38.048
12/23/2013	7:36:59 PM	-74.276	-66.92	-70.396	-71.744	-69.608	-71.716	-72.548	-68.496	-38.368
12/23/2013	7:38:25 PM	-74.276	-71.552	-70.732	-74.74	-71.384	-68.5	-69.152	-70.248	-38.188
12/23/2013	7:39:51 PM	-74.276	-69.288	-71.248	-70.816	-72.556	-72.74	-70.984	-69.96	-37.768
12/23/2013	7:41:17 PM	-74.276	-68.468	-68.216	-72.992	-69.16	-71.388	-71.532	-69.844	-38.036
12/23/2013	7:42:43 PM	-74.276	-70.924	-71.116	-71.084	-69.608	-69.808	-70.888	-70.048	-38.472
12/23/2013	7:44:09 PM	-74.276	-69.764	-70.972	-70.804	-69.436	-69.66	-70.448	-72.34	-38.336
12/23/2013	7:45:35 PM	-74.276	-69.74	-69.92	-71.62	-71.256	-71.424	-69.832	-72.856	-37.864
12/23/2013	7:47:01 PM	-74.276	-71.22	-70.464	-73.96	-71.492	-70.364	-70.384	-70.96	-38.512
12/23/2013	7:48:27 PM	-74.276	-67.476	-71.696	-72.316	-69.208	-71.056	-70.572	-71.24	-38.236
12/23/2013	7:49:53 PM	-74.276	-72.88	-68.488	-68.808	-69.824	-72.108	-71.408	-68.852	-38.004
12/23/2013	7:51:19 PM	-74.276	-70.776	-70.884	-70.884	-71.904	-70.608	-68.2	-71.98	-37.98
12/23/2013	7:52:45 PM	-74.276	-71.128	-69.424	-72.456	-73.428	-70.22	-71.312	-70.904	-37.96
12/23/2013	7:54:11 PM	-74.276	-72.276	-71.612	-68.784	-72.332	-70.924	-72.184	-68.824	-38.344
12/23/2013	7:55:37 PM	-74.276	-69.484	-69.644	-69.896	-71.016	-69.748	-72.168	-70.708	-38.252
12/23/2013	7:57:03 PM	-74.276	-73.812	-72.272	-70.208	-72.292	-69.36	-68.932	-70.468	-38.124
12/23/2013	7:58:29 PM	-74.276	-69.656	-69.748	-70.084	-69.588	-70.94	-72.684	-70.644	-38.024
12/23/2013	7:59:55 PM	-74.276	-70.212	-71.36	-71.736	-73.716	-68.772	-71.44	-71.04	-38.516
12/23/2013	8:01:21 PM	-74.276	-68.132	-73.468	-67.992	-68.732	-70.56	-71.072	-69.352	-38.192
12/23/2013	8:02:47 PM	-74.276	-72.752	-70.836	-71.068	-70.436	-70.748	-68.992	-69.304	-38.104
12/23/2013	8:04:13 PM	-74.276	-71.544	-72.104	-72.356	-73.904	-70.456	-67.016	-69.788	-38.112
12/23/2013	8:05:39 PM	-74.276	-71.292	-71.796	-72.024	-69.128	-70.824	-70.804	-69.248	-38.752
12/23/2013	8:07:05 PM	-74.276	-71.804	-71.776	-70	-69.152	-71.412	-71.768	-71.088	-38.28
12/23/2013	8:08:31 PM	-74.276	-71.32	-71.208	-71.304	-70.584	-71.68	-72.192	-69.912	-38.12
12/23/2013	8:09:57 PM	-74.276	-71.704	-71.084	-68.468	-72.048	-70.108	-70.34	-69.244	-38.496
12/23/2013	8:11:23 PM	-74.276	-71.96	-74.508	-71.336	-71.884	-69.86	-70.924	-71.564	-38.044
12/23/2013	8:12:49 PM	-74.276	-70.292	-71.2	-72.568	-71.688	-72.164	-72.732	-69.944	-38.296
12/23/2013	8:14:15 PM	-74.276	-71.176	-71.24	-70.256	-70.052	-70.3	-68.732	-69.18	-38.108
12/23/2013	8:15:41 PM	-74.276	-73.524	-71.404	-72.46	-69.144	-70.892	-70.588	-68.22	-38.192
12/23/2013	8:17:07 PM	-74.276	-72.868	-71.236	-72.952	-69.696	-71.808	-69.268	-69.324	-37.996
12/23/2013	8:18:33 PM	-74.276	-68.984	-69.016	-70.976	-71.036	-72.128	-70.748	-70.252	-37.844
12/23/2013	8:19:59 PM	-74.276	-72.308	-71.756	-71.968	-72.76	-71.212	-69.34	-69.964	-38.032
12/23/2013	8:21:25 PM	-74.276	-71.676	-69.372	-71.8	-71.748	-74.288	-72.508	-69.672	-38.044
12/23/2013	8:22:51 PM	-74.276	-72.28	-70.296	-71.536	-71.932	-72.408	-70.204	-68.724	-38.076
12/23/2013	8:24:17 PM	-74.276	-68.748	-70.976	-72.5	-69.532	-71.84	-73.612	-69.42	-38.308
12/23/2013	8:25:43 PM	-72.868	-70.372	-71.568	-70.688	-70.02	-72.868	-73.784	-71.808	-38.244
12/23/2013	8:27:09 PM	-72.868	-72.168	-72.944	-70.612	-69.372	-72.424	-71.468	-69.544	-37.928
12/23/2013	8:28:35 PM	-72.868	-71.464	-72.5	-71.212	-73.136	-68.564	-71.052	-70.536	-38.76
12/23/2013	8:30:01 PM	-72.868	-72.12	-71.808	-71.468	-68.928	-70.696	-71.896	-71.124	-38.932
12/23/2013	8:31:27 PM	-72.868	-69.752	-71.14	-70.804	-71.496	-70.488	-70.12	-69.452	-38.028
12/23/2013	8:32:53 PM	-72.868	-70.34	-70.96	-70.204	-72.056	-69.28	-71.152	-73.36	-38.332
12/23/2013	8:34:19 PM	-72.868	-71.44	-71.508	-70.54	-70.708	-71.496	-71.388	-71.436	-37.932
12/23/2013	8:35:45 PM	-72.868	-68.376	-69.264	-69.744	-69.352	-70.196	-72.744	-71.208	-38.708
12/23/2013	8:37:11 PM	-72.868	-71.192	-70.268	-68.38	-70.556	-69.812	-71.888	-70.636	-38.068
12/23/2013	8:38:37 PM	-72.868	-70.588	-70.94	-70.908	-71.524	-71.96	-74.584	-69.76	-38.476
12/23/2013	8:40:03 PM	-72.868	-72.02	-72.152	-70.968	-72.856	-72.304	-70.664	-69.272	-38.008
12/23/2013	8:41:29 PM	-72.868	-73.3	-71.616	-71.284	-71.776	-68.928	-70.656	-70.212	-37.592
12/23/2013	8:42:55 PM	-72.868	-71.988	-72.2	-70.012	-72.996	-71.06	-68.524	-70.772	-38.028
12/23/2013	8:44:21 PM	-72.868	-70.596	-71.976	-69.308	-69.388	-71.108	-71.704	-71.108	-38.476
12/23/2013	8:45:47 PM	-72.868	-69.376	-70.772	-70.672	-69.036	-70.968	-71.352	-68.28	-38.052
12/23/2013	8:47:13 PM	-72.868	-71.708	-72.328	-72.204	-70.52	-72.2	-72.264	-71.548	-38.78
12/23/2013	8:48:39 PM	-72.868	-70.752	-70.772	-70.892	-70.16	-69.78	-71.188	-70.78	-38.38
12/23/2013	8:50:05 PM	-72.868	-72.62	-71.208	-70.672	-71.304	-71.948	-70.908	-68.636	-38.164
12/23/2013	8:51:31 PM	-72.868	-67	-70.016	-69.884	-69.576	-71.292	-72.604	-71.944	-37.972
12/23/2013	8:52:57 PM	-72.868	-72.276	-72.556	-73.652	-73.196	-72.824	-72.468	-71.936	-38.356
12/23/2013	8:55:49 PM	-72.868	-73.084	-71.316	-72.756	-71.992	-74.664	-67.436	-70.292	-38.312

APPENDEX .2

All Time Sample Radio Spectrum Traffic

		MHz								
Date	Time	85	90	95	100	105	110	115	120	125
		POWER IN dBm								
09/12/2013	6:41:09 PM	-46.184	-54.268	-63.256	-58.156	-59.204	-73.42	-74.132	-74.256	-74.048
09/12/2013	6:42:35 PM	-46.576	-54.24	-63.624	-57.656	-58.78	-73.396	-73.452	-73.42	-72.412
09/12/2013	6:44:01 PM	-46.096	-53.852	-63.232	-57.912	-59.764	-73.748	-73.776	-73.804	-73.048
09/12/2013	6:45:27 PM	-46.424	-53.204	-63.504	-58.152	-59.256	-73.832	-73.292	-73.22	-73.272
09/12/2013	6:46:53 PM	-46.148	-53.664	-63.26	-58.056	-59.912	-73.432	-71.62	-72.576	-74.072
09/12/2013	6:48:19 PM	-46.564	-53.832	-63.116	-57.516	-57.86	-73.472	-74.544	-73.18	-73.508
09/12/2013	6:49:45 PM	-46.408	-53.532	-63.44	-58.288	-60.188	-73.356	-74.464	-72.696	-74.048
09/12/2013	6:51:11 PM	-46.108	-54.18	-63.336	-57.9	-59.972	-72.976	-74.748	-73.996	-73.996
09/12/2013	6:52:37 PM	-46.596	-54.404	-63.892	-58.744	-59.824	-74.332	-73.128	-73.704	-75.052
09/12/2013	6:54:03 PM	-46.44	-53.772	-63.036	-57.976	-59.916	-73.664	-71.872	-75.148	-75.332
09/12/2013	6:55:29 PM	-46.08	-54.092	-63.296	-58.052	-60.24	-74.908	-72.748	-76.248	-75.328
09/12/2013	6:56:55 PM	-46.336	-54.312	-62.228	-58.444	-59.5	-73.172	-73.316	-72.936	-75.68
09/12/2013	6:58:21 PM	-46.348	-53.844	-62.956	-57.76	-59.288	-71.9	-75.328	-74.7	-74.336
09/12/2013	6:59:47 PM	-46.492	-53.916	-63.88	-58.22	-59.616	-74.004	-74.24	-73	-73.592
09/12/2013	7:01:13 PM	-46.52	-53.58	-62.828	-57.928	-59.376	-74.276	-73.5	-73.944	-73.74
09/12/2013	7:02:39 PM	-46.348	-54.296	-63.916	-57.86	-59.592	-75.432	-73.424	-74.156	-73.44
09/12/2013	7:04:05 PM	-46.136	-54.62	-63.6	-57.324	-59.42	-73.588	-72.18	-74.048	-73.604
09/12/2013	7:05:31 PM	-46.212	-53.892	-63.548	-58.052	-59.32	-74.776	-74.076	-73.94	-73.852
09/12/2013	7:06:57 PM	-46.192	-53.904	-62.288	-57.876	-59.116	-73.48	-73.624	-72.892	-73.192
09/12/2013	7:08:23 PM	-46.292	-53.48	-63.472	-57.512	-59.024	-73.604	-73.264	-75.256	-73.98
09/12/2013	7:09:49 PM	-46.42	-53.56	-63.476	-57.828	-59.888	-73.624	-73.1	-74.428	-75.256
09/12/2013	7:11:15 PM	-46.22	-53.82	-62.856	-58.016	-59.324	-73.388	-71.48	-74.308	-73.196
09/12/2013	7:12:41 PM	-46.336	-53.884	-62.856	-57.972	-59.064	-74.052	-72.576	-74.232	-74.096
09/12/2013	7:14:07 PM	-46.584	-53.584	-62.672	-57.824	-59.044	-73.644	-74.4	-73.876	-73.8
09/12/2013	7:15:33 PM	-46.412	-53.436	-62.24	-57.936	-59.152	-73.572	-73.692	-73.488	-74.432
09/12/2013	7:16:59 PM	-46.296	-53.844	-62.516	-58.284	-59.632	-74.524	-73.32	-72.4	-72.436
09/12/2013	7:18:25 PM	-46.152	-53.42	-63.784	-58.172	-59.308	-73.76	-73.352	-75.78	-74.64
09/12/2013	7:19:51 PM	-46.232	-54.172	-63.82	-57.936	-60.5	-73.872	-73.224	-74.608	-73.78
09/12/2013	7:21:17 PM	-46.532	-54.12	-62.2	-58.176	-58.46	-73.988	-73.1	-74.108	-75.12
09/12/2013	7:22:43 PM	-46.608	-54.036	-63.032	-57.64	-59.372	-74.616	-72.996	-73.768	-75.104
09/12/2013	7:24:09 PM	-46.512	-54.048	-63.028	-58.144	-59.056	-73.448	-74.84	-74.608	-73.308
09/12/2013	7:25:35 PM	-46.16	-53.82	-62.644	-57.356	-59.244	-73.224	-72.936	-74.004	-72.956
09/12/2013	7:27:01 PM	-46.532	-53.852	-63.496	-58.012	-59.564	-74.248	-73.696	-72.692	-73.944
09/12/2013	7:28:27 PM	-46.4	-54.392	-62.336	-58.108	-59.892	-74.376	-74.2	-73.8	-71.048
09/12/2013	7:29:53 PM	-46.16	-53.692	-63.744	-57.512	-59.056	-73.668	-73.596	-74.504	-74.108
09/12/2013	7:31:19 PM	-46.116	-53.384	-62.388	-57.62	-59.512	-74.028	-73.22	-74.532	-75.332
09/12/2013	7:32:45 PM	-46.356	-54.14	-63.208	-57.488	-59.072	-73.288	-74.272	-74.18	-73.88
09/12/2013	7:34:11 PM	-46.388	-53.956	-63.408	-57.644	-58.76	-74.268	-72.56	-74.364	-74.004
09/12/2013	7:35:37 PM	-46.36	-54.204	-63.26	-57.444	-59.18	-74.944	-72.94	-73.144	-75.344
09/12/2013	7:37:03 PM	-46.688	-54.28	-63.404	-57.136	-59.288	-73.708	-73.224	-72.312	-74.312
09/12/2013	7:38:29 PM	-46.128	-53.36	-63.62	-57.96	-59.888	-74.316	-73.98	-73.188	-72.112
09/12/2013	7:39:55 PM	-46.708	-54.308	-63.972	-58.448	-60.128	-72.96	-73.256	-74.712	-75.128
09/12/2013	7:41:21 PM	-46.416	-53.752	-62.792	-57.804	-59.124	-74.688	-75.084	-74.852	-74.676
09/12/2013	7:42:47 PM	-46.352	-54.112	-64.16	-57.632	-59.152	-73.116	-73.352	-74.048	-73.056
09/12/2013	7:44:13 PM	-46.124	-53.264	-63.152	-57.928	-59.796	-74.328	-73.928	-74.8	-74.54
09/12/2013	7:45:39 PM	-46.52	-54.38	-63.004	-57.892	-59.016	-74.22	-72.016	-73.072	-72.24
09/12/2013	7:47:05 PM	-46.076	-53.3	-63.416	-58.076	-59.152	-73.876	-74.16	-74.064	-73.376
09/12/2013	7:48:31 PM	-46.3	-53.932	-62.264	-58.152	-59.112	-71.412	-74.744	-73.416	-74.44
09/12/2013	7:49:57 PM	-46.092	-53.964	-63.496	-57.9	-59.432	-74.684	-73.948	-74.02	-73.324
09/12/2013	7:51:23 PM	-46.108	-53.748	-63.772	-58.176	-59.424	-74.108	-73.596	-73.844	-75.772
09/12/2013	7:52:49 PM	-46.356	-53.88	-62.352	-57.8	-59.716	-73.836	-73.22	-72.828	-75.028
09/12/2013	7:54:15 PM	-46.44	-53.368	-63.52	-58.468	-59.24	-72.856	-74.96	-74.904	-73.76
09/12/2013	7:55:41 PM	-46.2	-53.472	-63.968	-57.84	-59.196	-73.68	-72.684	-73.196	-73.82
09/12/2013	7:57:07 PM	-46.46	-54.344	-62.744	-57.58	-59.02	-74.288	-73.944	-74.2	-73.164
09/12/2013	7:58:33 PM	-46.2	-54.228	-63.168	-58.48	-60.212	-75.944	-72.644	-74.772	-72.452
09/12/2013	7:59:59 PM	-46.488	-54.08	-62.472	-57.44	-59.324	-72.38	-73.752	-74.2	-72.932
09/12/2013	8:01:25 PM	-46.264	-54.128	-64.552	-57.388	-58.76	-73.748	-71.868	-72.58	-73.744
09/12/2013	8:02:51 PM	-46.204	-53.928	-63.56	-57.496	-58.96	-72.548	-72.592	-72.276	-74.048
09/12/2013	8:04:17 PM	-46.156	-53.736	-62.936	-57.588	-59.4	-72.704	-74.308	-74.724	-73.928
09/12/2013	8:05:43 PM	-46.396	-54.02	-63.424	-57.904	-59.888	-73.076	-72.704	-73.436	-72.604
09/12/2013	8:07:09 PM	-46.22	-53.984	-63.38	-58.044	-58.256	-72.6	-74.54	-74.476	-75.052
09/12/2013	8:10:01 PM	-46.44	-53.564	-63.032	-57.68	-59.32	-73.636	-74.004	-73.804	-74.216

APPENDEX .3

Alkhodh
All Time Sample Radio Spectrum Traffic

		MHz								
Date	Time	130	135	140	145	150	155	160	165	170
		POWER IN dBm								
2/3/2014	09:22:43 PM	-103.344	-104.132	-104.752	-97.804	-104.448	-103.572	-102.832	-103.96	-100.204
2/3/2014	09:24:09 PM	-103.22	-103.22	-101.716	-95.896	-103.88	-100.236	-102.34	-104.592	-99.852
2/3/2014	09:25:35 PM	-105.172	-102.676	-103.06	-96.136	-104.792	-103.284	-103.344	-103.584	-100.244
2/3/2014	09:27:01 PM	-103.02	-103.672	-103.716	-104.352	-104.332	-103.316	-101.608	-103.54	-98.072
2/3/2014	09:28:27 PM	-103.164	-102.348	-103.268	-104.04	-102.564	-103.892	-104.444	-103.572	-101.824
2/3/2014	09:29:53 PM	-103.948	-102.516	-104.5	-94.864	-103.432	-103.672	-102.048	-102.408	-100.344
2/3/2014	09:31:19 PM	-103.444	-103.488	-103.968	-102.676	-103.86	-103.556	-103.456	-104.052	-103.232
2/3/2014	09:32:45 PM	-104.092	-104.428	-104.168	-104.268	-104.26	-103.284	-103.976	-102.12	-96.868
2/3/2014	09:34:11 PM	-102.568	-103.764	-103.664	-97.272	-104.808	-103.256	-104	-102.544	-102.552
2/3/2014	09:35:37 PM	-103.684	-102.456	-102.388	-103.656	-103.948	-104.58	-102.016	-104.7	-96.944
2/3/2014	09:37:03 PM	-103.172	-103.296	-103.14	-93.168	-103.88	-104.324	-103.656	-103.2	-100.16
2/3/2014	09:38:29 PM	-103.936	-103.104	-103.4	-95.828	-103.288	-103.056	-100.744	-103.36	-99.976
2/3/2014	09:39:55 PM	-103.228	-103.344	-103.828	-95.616	-101.96	-101.12	-104.712	-102.724	-102.704
2/3/2014	09:41:21 PM	-104.06	-103.156	-103.304	-95.604	-102.94	-102.632	-103.936	-102.056	-98.356
2/3/2014	09:42:47 PM	-104.004	-102.808	-103.416	-96.836	-103.28	-101.952	-103.604	-102.844	-100.56
2/3/2014	09:44:13 PM	-104.892	-104.044	-103.204	-103.756	-104.52	-104.108	-101.928	-104.352	-95.56
2/3/2014	09:45:39 PM	-104.492	-103.684	-102.904	-103.116	-103.648	-103.692	-103.488	-103.332	-102.66
2/3/2014	09:47:05 PM	-103.664	-103.848	-103.968	-98.356	-104.52	-102.984	-100.992	-103.092	-99.028
2/3/2014	09:48:31 PM	-103.26	-103.436	-102.824	-94.152	-103.548	-101.752	-103.164	-103.004	-99.3
2/3/2014	09:49:57 PM	-103.684	-103.944	-102.94	-94.2	-103.528	-102.7	-103.412	-102.084	-101.848
2/3/2014	09:51:23 PM	-101.412	-103.768	-104.184	-94.664	-102.172	-102.536	-103.916	-103.812	-102.004
2/3/2014	09:52:49 PM	-101.336	-104.548	-103.988	-93.884	-101.792	-103.272	-103.044	-103.46	-94.956
2/3/2014	09:54:15 PM	-102.32	-102.952	-103.82	-94.864	-104.076	-103.984	-103.56	-102.348	-102.668
2/3/2014	09:55:41 PM	-103.416	-103.652	-103.204	-103.1	-102.344	-102.596	-103.412	-103.8	-98.992
2/3/2014	09:57:07 PM	-102.972	-103.516	-102.068	-103.468	-103.54	-102.372	-101.992	-102.944	-97.168
2/3/2014	09:58:33 PM	-103.156	-103.724	-104.404	-98.68	-101.48	-103.292	-102.524	-103.092	-98.72
2/3/2014	09:59:59 PM	-103.26	-103.716	-103.616	-94.94	-102.08	-103.048	-103.236	-101.424	-98.02
2/3/2014	10:01:25 PM	-103.936	-104.248	-103.616	-95.164	-102.68	-102.804	-104.112	-102.488	-98.56
2/3/2014	10:02:51 PM	-104.54	-104.536	-103.036	-95.224	-102.592	-102.936	-103.056	-102.312	-100.964
2/3/2014	10:04:17 PM	-102.048	-102.684	-104.008	-93.012	-104.172	-103.356	-103.476	-101.408	-99.12
2/3/2014	10:05:43 PM	-102.92	-104.664	-104.244	-93.768	-103.348	-103.156	-103.496	-104.168	-98.336
2/3/2014	10:07:09 PM	-103.612	-103.672	-100.268	-95.164	-102.556	-103.912	-102.276	-102.02	-101.168
2/3/2014	10:08:35 PM	-102.076	-104.036	-104.256	-94.708	-103.812	-103.88	-103.236	-103.636	-98.388
2/3/2014	10:10:01 PM	-103.86	-103.172	-103.608	-95.524	-104.076	-103.396	-103.832	-103.236	-100.864
2/3/2014	10:11:27 PM	-104.052	-103.748	-104.504	-96.324	-103.14	-103.676	-104.612	-103.176	-95.676
2/3/2014	10:12:53 PM	-103.684	-103.9	-104.66	-95.116	-103.832	-102.308	-104.392	-101.884	-102.696
2/3/2014	10:14:19 PM	-104.108	-104.248	-103.028	-94.84	-103.02	-101.612	-104.408	-104.044	-97.24
2/3/2014	10:15:45 PM	-101.976	-103.28	-104.464	-95.964	-103.488	-102.56	-103.356	-102.4	-99.344
2/3/2014	10:17:11 PM	-103.468	-103.464	-103.484	-94.676	-103.356	-103.056	-102.708	-103.46	-102.004
2/3/2014	10:18:37 PM	-101.78	-103.024	-103.184	-103.408	-104.004	-103.684	-102.056	-102.54	-97.98
2/3/2014	10:20:03 PM	-103.128	-104.56	-102.172	-104.516	-103.924	-103.832	-103.276	-103.752	-98.36
2/3/2014	10:21:29 PM	-103.568	-103.352	-103.708	-104.612	-103.896	-103.712	-101.456	-103.68	-100.624
2/3/2014	10:22:55 PM	-104.032	-104.032	-102.088	-95.252	-103.372	-102.336	-102.868	-103.824	-102.292
2/3/2014	10:24:21 PM	-103.936	-102.752	-103.512	-95.164	-103.78	-102.76	-103.128	-102.704	-95.828
2/3/2014	10:25:47 PM	-103.044	-104.176	-102.648	-96.196	-102.82	-103.4	-103.372	-103.876	-97.636
2/3/2014	10:27:13 PM	-103.904	-103.744	-102.76	-99.82	-103.02	-103.96	-102.928	-103.092	-103.42
2/3/2014	10:28:39 PM	-103.148	-104.632	-103.12	-95.552	-103.332	-102.724	-102.516	-102.156	-100.564
2/3/2014	10:30:05 PM	-102.988	-104.116	-104.64	-93.664	-104.316	-103.356	-103.712	-102.58	-102.896
2/3/2014	10:31:31 PM	-102.18	-103.16	-103.428	-104.144	-103.128	-104.304	-103.644	-103.62	-98.256
2/3/2014	10:32:57 PM	-104.164	-102.14	-103.016	-93.172	-103.168	-102.184	-103.396	-103	-95.688
2/3/2014	10:34:23 PM	-104.576	-104.796	-103.664	-103.872	-103.288	-103.852	-101.884	-101.548	-101.912
2/3/2014	10:35:49 PM	-102.932	-102.796	-101.388	-94.404	-103.588	-103.54	-102.464	-103.112	-98.516
2/3/2014	10:37:15 PM	-101.596	-103.42	-104.196	-93.588	-102.972	-104.124	-103.516	-102.664	-95.168
2/3/2014	10:38:41 PM	-103.96	-102.216	-103.236	-93.712	-102.28	-102.136	-101.916	-103.008	-99.1
2/3/2014	10:40:07 PM	-104.9	-104.632	-102.196	-95.04	-102.784	-103.596	-103.772	-102.392	-98.052
2/3/2014	10:41:33 PM	-104.08	-103.3	-102.368	-103.1	-103.676	-102.932	-103.296	-103.048	-100.564
2/3/2014	10:42:59 PM	-104.176	-102.7	-103.16	-94.712	-103.216	-102.5	-103.08	-102.452	-99.032
2/3/2014	10:44:25 PM	-103.568	-101.496	-103.052	-91.616	-103.544	-102.852	-102.772	-103.836	-101.496
2/3/2014	10:45:51 PM	-103.612	-104.604	-103.428	-96.8	-102.86	-103.768	-103.288	-103.964	-98.528
2/3/2014	10:47:17 PM	-102.652	-104.008	-103.932	-103.904	-103.664	-101.428	-103.596	-102.176	-101.66
2/3/2014	10:48:43 PM	-103.388	-103.028	-103.18	-95.472	-103.812	-103.688	-100.736	-103.164	-100.576
2/3/2014	10:50:09 PM	-103.556	-104.264	-104.372	-95.064	-103.308	-102.844	-102.008	-104.132	-101.324

APPENDEX .4

Salalah

All Time Sample Radio Spectrum Traffic

		MHz								
Date	Time	175	180	185	190	195	200	205	210	215
		POWER IN dBm								
8/11/2014	11:31:15 AM	-102.868	-103.168	-102.408	-104.164	-75.296	-74.052	-84.092	-104.904	-103.68
8/11/2014	11:32:41 AM	-102.22	-104.084	-103.968	-103.78	-75.82	-71.196	-83.988	-103.38	-103.904
8/11/2014	11:34:07 AM	-105.016	-104.34	-101.624	-104.26	-75.64	-75.128	-102.184	-104.16	-102.72
8/11/2014	11:35:33 AM	-103.812	-104.34	-102.936	-103.936	-75.364	-73.26	-83.056	-104.328	-103.62
8/11/2014	11:36:59 AM	-102.648	-102.996	-104.152	-103.308	-74.76	-75.952	-83.392	-101.216	-103.688
8/11/2014	11:38:25 AM	-103.644	-103.824	-104.236	-104.876	-74.484	-72.7	-82.956	-102.88	-103.78
8/11/2014	11:39:51 AM	-102.292	-103.684	-103.336	-102.484	-75.396	-74.472	-89.452	-103.796	-103.912
8/11/2014	11:41:17 AM	-102.664	-102.692	-104.024	-102.672	-74.348	-75.98	-83.104	-103.692	-103.744
8/11/2014	11:42:43 AM	-103.432	-102.944	-101.576	-102.816	-74.328	-75.72	-82.744	-103.428	-103.868
8/11/2014	11:44:09 AM	-103.332	-103.768	-102.6	-102.332	-75.328	-74.824	-83.004	-103.212	-103.616
8/11/2014	11:45:35 AM	-104.428	-103	-102.96	-103.624	-75.232	-71.756	-83.988	-102.82	-103.28
8/11/2014	11:47:01 AM	-104.124	-102.556	-103.376	-103.736	-75.116	-75.06	-83.488	-102.3	-102.628
8/11/2014	11:48:27 AM	-103.624	-103.892	-103.428	-102.932	-73.544	-71.004	-83.044	-103.372	-103.4
8/11/2014	11:49:53 AM	-104.836	-103.316	-103.656	-102.844	-72.788	-70.916	-82.744	-102.36	-103.412
8/11/2014	11:51:19 AM	-104.568	-103.996	-102.768	-102.716	-75.004	-72.92	-83.132	-101.976	-102.984
8/11/2014	11:52:45 AM	-102.82	-102.016	-103.748	-104.276	-75.328	-70.692	-82.696	-102.128	-102.088
8/11/2014	11:54:11 AM	-103.888	-103.704	-103.2	-103.544	-75.54	-72.62	-83.752	-103.152	-102.64
8/11/2014	11:55:37 AM	-103.652	-102.796	-103.336	-102.588	-75.808	-71.716	-83.42	-103.24	-102.972
8/11/2014	11:57:03 AM	-103.088	-103.396	-103.5	-103.72	-76.72	-72.756	-83.736	-103.74	-103.1
8/11/2014	11:58:29 AM	-102.276	-103.112	-103.952	-102.98	-76.832	-70.692	-83.164	-102.4	-103.728
8/11/2014	11:59:55 AM	-103.664	-103.032	-101.852	-101.888	-77.1	-71.272	-83.8	-103.316	-102.444
8/11/2014	12:01:21 PM	-102.088	-104.244	-101.988	-102.46	-77.476	-71.092	-82.952	-102.456	-102.84
8/11/2014	12:02:47 PM	-103.556	-102.688	-102.392	-100.708	-76.928	-71.504	-84.304	-101.984	-102.76
8/11/2014	12:04:13 PM	-103.356	-103.292	-102.472	-103.332	-77.008	-71.108	-84.148	-101.352	-101.416
8/11/2014	12:05:39 PM	-102.608	-103.852	-102.524	-102.472	-77.536	-72.44	-83.404	-101.484	-103.3
8/11/2014	12:07:05 PM	-103.628	-103.312	-102.42	-102.524	-78.336	-71.316	-83.736	-102.512	-102.224
8/11/2014	12:08:31 PM	-103.52	-101.516	-102.572	-102.52	-78.044	-71.72	-83.304	-103.064	-102.776
8/11/2014	12:09:57 PM	-101.32	-102.628	-103.828	-102.944	-77.976	-71.172	-82.884	-102.772	-101.56
8/11/2014	12:11:23 PM	-104.44	-102.608	-102.656	-102.16	-77.236	-71.484	-83.792	-102.34	-103.136
8/11/2014	12:12:49 PM	-103.356	-104.2	-103.876	-102.84	-77.336	-72.26	-83.928	-103.276	-103.044
8/11/2014	12:14:15 PM	-102.892	-102.352	-103.632	-102.84	-77.38	-78.152	-82.12	-103.704	-101.996
8/11/2014	12:15:41 PM	-103.324	-103.404	-103.716	-103.144	-77.176	-74.168	-82.02	-102.752	-102.108
8/11/2014	12:17:07 PM	-101.692	-101.46	-103.244	-102.78	-77.204	-74.372	-82.46	-102.672	-101.84
8/11/2014	12:18:33 PM	-104.048	-103.504	-103.608	-102.924	-77.12	-74.636	-83.176	-101.616	-102.472
8/11/2014	12:19:59 PM	-102.404	-102.856	-101.788	-102.02	-76.916	-71.36	-82.712	-101.356	-102.632
8/11/2014	12:21:25 PM	-104.108	-103.676	-103.064	-101.156	-77.472	-72.012	-82.352	-102.492	-102.744
8/11/2014	12:22:51 PM	-102.508	-102.844	-103.84	-102.124	-77.336	-73.324	-81.976	-101.812	-103.488
8/11/2014	12:24:17 PM	-103.804	-103.436	-103.148	-101.076	-77.456	-73.756	-82.816	-102.024	-103.144
8/11/2014	12:25:43 PM	-103.828	-103.584	-102.952	-102.82	-77.716	-72.384	-82.316	-102.24	-101.212
8/11/2014	12:27:09 PM	-102.92	-104.856	-103.608	-103.416	-77.308	-71.608	-82.484	-102.388	-102.924
8/11/2014	12:28:35 PM	-102.44	-103.372	-103.376	-102.984	-77.292	-73.152	-84.128	-103.244	-101.468
8/11/2014	12:30:01 PM	-103.596	-101.376	-103.412	-102.82	-77.236	-70.76	-92.304	-102.996	-101.528
8/11/2014	12:31:27 PM	-103.272	-103.584	-102.588	-103.7	-77.604	-73.836	-82.12	-103.528	-100.916
8/11/2014	12:32:53 PM	-102.912	-103.872	-102.404	-101.716	-77.356	-70.928	-83.236	-101.508	-103.036
8/11/2014	12:34:19 PM	-103.568	-102.248	-102.204	-102.188	-76.932	-70.684	-82.36	-103.436	-103.852
8/11/2014	12:35:45 PM	-103.064	-104.256	-102.016	-103.208	-77.64	-72.116	-82.264	-102.984	-102.748
8/11/2014	12:37:11 PM	-104.768	-102.98	-102.444	-102.288	-77.512	-72.828	-83.144	-102.556	-101.42
8/11/2014	12:38:37 PM	-101.808	-102.388	-102.624	-103.144	-77.836	-73.448	-92.764	-102.796	-103.32
8/11/2014	12:40:03 PM	-102.584	-102.056	-101.316	-102.448	-77.204	-73.804	-81.516	-102.82	-103.128
8/11/2014	12:41:29 PM	-102.404	-101.764	-102.784	-102.028	-77.42	-74.712	-82.748	-101.816	-102.812
8/11/2014	12:42:55 PM	-102.504	-100.952	-102.332	-103.516	-78.372	-71.072	-83.296	-103.18	-101.468
8/11/2014	12:44:21 PM	-102.88	-102.928	-102.128	-102.48	-78.728	-76.704	-82.204	-102.828	-101.452
8/11/2014	12:45:47 PM	-103.148	-102.144	-103.544	-101.464	-78.864	-71.264	-82.336	-103.892	-101.916
8/11/2014	12:47:13 PM	-102.68	-101.748	-103.424	-101.256	-78.308	-72.94	-81.628	-101.724	-103.544
8/11/2014	12:48:39 PM	-102.952	-104.272	-104.208	-102.116	-78.136	-71.468	-82.436	-102.456	-104.124
8/11/2014	12:50:05 PM	-102.512	-100.7	-102.196	-102.42	-77.64	-73.576	-82.064	-101.74	-102.968
8/11/2014	12:51:31 PM	-102.64	-101.908	-101.228	-103.184	-77.82	-72.948	-82.488	-102.964	-102.308
8/11/2014	12:52:57 PM	-103.052	-102.328	-102.36	-102.328	-78.112	-74.216	-82.588	-103.372	-102.164
8/11/2014	12:54:23 PM	-102.812	-102.848	-102.744	-102.536	-78.212	-72.764	-83.28	-101.768	-102.988
8/11/2014	12:55:49 PM	-101.9	-102.74	-103.184	-101.7	-78.268	-72.372	-82.204	-102.64	-102.64
8/11/2014	12:57:15 PM	-103.244	-103.96	-103.508	-103.652	-78.02	-73.512	-83.716	-103.716	-102.556
8/11/2014	12:58:41 PM	-102.096	-102.364	-102.576	-103.888	-77.356	-72.256	-82.628	-103.312	-102.108

APPENDEX .5

Ibri

All Time Sample Radio Spectrum Traffic

		MHz								
Date	Time	220	225	230	235	240	245	250	255	260
		POWER IN dBm								
01/04/2014	12:05:39 PM	-81.612	-82.624	-80.988	-80.932	-81.352	-81.128	-81.544	-82.828	-83.1
01/04/2014	12:07:05 PM	-83.296	-81.628	-83.236	-83.528	-81.624	-82.548	-81.716	-83.68	-81.716
01/04/2014	12:08:31 PM	-81.78	-81.36	-81.908	-83.328	-83.46	-82.164	-83.056	-81.524	-83.856
01/04/2014	12:09:57 PM	-81.696	-80.84	-81.012	-82.576	-82.232	-81.564	-83.008	-83.06	-83.94
01/04/2014	12:11:23 PM	-82.164	-81.512	-83.02	-80.968	-82.476	-81.908	-83.076	-82.452	-82.832
01/04/2014	12:12:49 PM	-82.008	-82.528	-82.356	-82.632	-82.2	-81.412	-83.216	-82.912	-82.772
01/04/2014	12:14:15 PM	-82.036	-82.748	-81.984	-80.852	-83.652	-82.656	-82.008	-83.148	-84.32
01/04/2014	12:15:41 PM	-81.28	-79.936	-82.328	-84.328	-80.3	-81.204	-82.508	-84.08	-82.452
01/04/2014	12:17:07 PM	-83.04	-81.732	-82.676	-83.032	-82.024	-81.592	-81.86	-83.576	-80.424
01/04/2014	12:18:33 PM	-83.6	-81.848	-83.58	-81.892	-81.46	-84.112	-81.948	-81.34	-80.952
01/04/2014	12:19:59 PM	-82.84	-81.468	-82.128	-82.648	-81.46	-83.412	-82.136	-84.072	-82.24
01/04/2014	12:21:25 PM	-81.696	-82.484	-81.776	-81.38	-82.156	-83.864	-82.308	-82.728	-81.364
01/04/2014	12:22:51 PM	-83.108	-83.52	-83.04	-82.108	-82.644	-82.42	-81.608	-83.636	-82.632
01/04/2014	12:24:17 PM	-83.692	-82.844	-81.164	-81.568	-81.784	-81.976	-83.22	-81.612	-82.532
01/04/2014	12:25:43 PM	-82.356	-82.56	-82.912	-84.22	-81.3	-81.68	-83.044	-83.192	-82.408
01/04/2014	12:27:09 PM	-83.684	-81.596	-81.82	-83.352	-81.868	-82.704	-83.76	-82.308	-80.868
01/04/2014	12:28:35 PM	-83.352	-81.944	-81.996	-81.016	-81.66	-82.016	-83.104	-81.788	-81.384
01/04/2014	12:30:01 PM	-81.204	-81.892	-81.648	-80.896	-81.64	-81.744	-81.468	-83.58	-82.852
01/04/2014	12:31:27 PM	-82.968	-81.948	-82.456	-82.876	-83	-81.232	-81.992	-82.704	-82.268
01/04/2014	12:32:53 PM	-81.56	-81.9	-81.44	-82.292	-82.072	-82.792	-80.636	-83.044	-82.976
01/04/2014	12:34:19 PM	-80.484	-81.916	-82.644	-82.148	-82.404	-82.608	-82.088	-82.884	-80.552
01/04/2014	12:35:45 PM	-81.46	-83.272	-81.74	-80.672	-82.1	-82.732	-83.248	-82.584	-82.86
01/04/2014	12:37:11 PM	-81.732	-83.028	-82.5	-83.356	-81.988	-82.404	-82.872	-82.556	-82.156
01/04/2014	12:38:37 PM	-80.928	-82.072	-81.524	-82.928	-81.972	-82.256	-82	-82.888	-82
01/04/2014	12:40:03 PM	-83.384	-81.972	-83.384	-81.828	-82.076	-82.796	-82.808	-82.788	-81.4
01/04/2014	12:41:29 PM	-83.084	-81.828	-81.412	-82.512	-82.9	-83.128	-81.844	-82.724	-82.972
01/04/2014	12:42:55 PM	-82.804	-83.908	-83.02	-83.096	-82.02	-81.288	-82.348	-82.296	-83.596
01/04/2014	12:44:21 PM	-82.36	-81.812	-83.028	-84.32	-81.46	-81.272	-80.592	-82.536	-81.4
01/04/2014	12:45:47 PM	-82.604	-81.948	-82.364	-83.316	-80.592	-83.636	-82.132	-83.28	-82.052
01/04/2014	12:47:13 PM	-82.996	-82.128	-79.376	-82.98	-81.808	-83.352	-82.292	-83.328	-80.684
01/04/2014	12:48:39 PM	-82.168	-80.3	-83.232	-82.78	-82.652	-83.348	-79.928	-81.84	-82.908
01/04/2014	12:50:05 PM	-83.068	-83.484	-83.052	-82.496	-82.74	-81.988	-82.62	-82.048	-81.22
01/04/2014	12:51:31 PM	-80.96	-81.568	-81.968	-81.456	-82.028	-81.964	-82.152	-81.368	-81.964
01/04/2014	12:52:57 PM	-82.916	-82.836	-80.432	-81.588	-80.852	-82.66	-82.196	-82.756	-84.58
01/04/2014	12:54:23 PM	-83.196	-80.88	-81.6	-81.924	-82.676	-82.064	-82.456	-81.664	-81.62
01/04/2014	12:55:49 PM	-83.496	-82.38	-82.392	-82.524	-82.096	-82.292	-82.34	-83.552	-82.668
01/04/2014	12:57:15 PM	-81.832	-84.312	-83.408	-80.94	-82.992	-83.732	-84.688	-82.792	-83.42
01/04/2014	12:58:41 PM	-82.004	-83.992	-80.632	-81.62	-82.056	-82.12	-82.084	-83.404	-83.536
01/04/2014	01:00:07 PM	-82.148	-81.932	-82.584	-82.32	-83.104	-82.74	-81.852	-83.324	-82.592
01/04/2014	01:01:33 PM	-81.856	-80.284	-83.228	-82.148	-82.972	-81.668	-81.268	-81.476	-82.628
01/04/2014	01:02:59 PM	-82.004	-83.852	-83.48	-83.348	-82.852	-82.204	-80.56	-83.644	-82.976
01/04/2014	01:04:25 PM	-82.376	-82.436	-82.748	-83.62	-82.172	-83.992	-83.264	-83.7	-84.308
01/04/2014	01:05:51 PM	-84.152	-82.344	-82.496	-81.352	-83.308	-82.308	-82.948	-81.204	-80.632
01/04/2014	01:07:17 PM	-80.256	-81.26	-82.132	-81.172	-82.324	-82.524	-81.924	-83.46	-83.156
01/04/2014	01:08:43 PM	-82.644	-81.616	-80.8	-82.656	-82.976	-82.224	-82.412	-82.872	-83.572
01/04/2014	01:10:09 PM	-82.388	-82.1	-82.424	-82.748	-83.492	-81.208	-83.032	-81.824	-80.968
01/04/2014	01:11:35 PM	-81.28	-82.34	-83.58	-83.428	-82.704	-81.648	-83.248	-82.012	-82.536
01/04/2014	01:13:01 PM	-79.928	-83.132	-83.176	-80.508	-81.324	-83.204	-81.26	-81.992	-83.328
01/04/2014	01:14:27 PM	-82.72	-82.864	-83.184	-81.9	-80.972	-82.28	-82.06	-82.86	-81.248
01/04/2014	01:15:53 PM	-83.504	-82.464	-81.832	-81.168	-81.644	-82.028	-82.488	-82.984	-82.952
01/04/2014	01:17:19 PM	-83.068	-83.212	-81.32	-81.824	-83.124	-82.672	-83.552	-83.064	-83.032
01/04/2014	01:18:45 PM	-82.736	-80.88	-80.432	-82.776	-82.784	-82.64	-81.076	-82.028	-84.064
01/04/2014	01:20:11 PM	-83.372	-81.72	-81.148	-82.18	-83.692	-81.484	-82.028	-83.04	-81.824
01/04/2014	01:21:37 PM	-81.44	-81.152	-81.84	-83.66	-81.94	-81.06	-82.036	-84.196	-83.956
01/04/2014	01:23:03 PM	-82.216	-81.592	-84.184	-81.072	-81.744	-82.536	-83.712	-83.428	-82.732
01/04/2014	01:24:29 PM	-84.004	-82.876	-82.028	-82.952	-81.276	-81.82	-81.556	-82.804	-82.988
01/04/2014	01:25:55 PM	-82.948	-81.768	-82.54	-82.508	-82.356	-81.94	-83.256	-82.272	-82.816
01/04/2014	01:27:21 PM	-83.216	-83.764	-82.504	-83.252	-83.228	-82.74	-83.116	-83.744	-82.932
01/04/2014	01:28:47 PM	-81.348	-83.752	-81.9	-82.108	-82.844	-82.26	-83.304	-82.788	-82.596
01/04/2014	01:30:13 PM	-82.236	-81.708	-82.532	-80.436	-82.524	-82.948	-79.812	-82.672	-82.86
01/04/2014	01:31:39 PM	-82.096	-82.956	-83.816	-81.172	-82.32	-82.464	-81.052	-82.584	-83.708
01/04/2014	01:33:05 PM	-83.852	-82.048	-82.748	-82.796	-82.208	-82.244	-82.272	-81.076	-82.528

APPENDEX .6

Ruwi - 12AM-6AM
Sample Radio Spectrum Traffic

		MHz								
Date	Time	40	45	50	55	60	65	70	75	80
		POWER IN dBm								
12/24/2013	12:00:43 AM	-72.868	-70.676	-70.124	-72.92	-68.052	-70.208	-69.292	-71.676	-37.844
12/24/2013	12:02:09 AM	-72.868	-66.816	-74.712	-71.504	-71.104	-72.12	-71.12	-67.668	-37.948
12/24/2013	12:03:35 AM	-72.868	-72.792	-70.352	-69.38	-72.608	-71.372	-72.08	-70.9	-38.344
12/24/2013	12:05:01 AM	-72.868	-71.128	-71.216	-71.488	-72.808	-70.136	-71.964	-71.3	-37.96
12/24/2013	12:06:27 AM	-72.868	-67.76	-70.788	-69.704	-70.524	-69.42	-68.896	-67.104	-37.988
12/24/2013	12:07:53 AM	-72.868	-69.916	-70.992	-70.884	-71.82	-71.84	-72.156	-71.612	-38.008
12/24/2013	12:09:19 AM	-72.868	-73.516	-72.232	-70.692	-70.244	-70.792	-72.028	-70.884	-38.068
12/24/2013	12:10:45 AM	-72.868	-69.68	-70.924	-71.952	-69.356	-69.316	-70.58	-69.864	-37.996
12/24/2013	12:12:11 AM	-72.868	-74.148	-71.536	-71.424	-69.1	-71.96	-71.088	-71.112	-38.18
12/24/2013	12:13:37 AM	-72.868	-73.852	-72.28	-69.416	-70.352	-71.752	-72.972	-71.124	-38.004
12/24/2013	12:15:03 AM	-72.868	-72.26	-71.608	-69.656	-70.64	-70.476	-71.932	-71.2	-37.94
12/24/2013	12:16:29 AM	-72.868	-72.8	-71.504	-72.868	-71.028	-71.616	-70.428	-71.492	-37.984
12/24/2013	12:17:55 AM	-72.868	-71.624	-70.404	-69.536	-70.668	-70.296	-70.376	-70.748	-38.636
12/24/2013	12:19:21 AM	-72.868	-69.408	-71.42	-70.6	-69.896	-70.916	-69.592	-70.784	-38.312
12/24/2013	12:20:47 AM	-72.868	-71.272	-72.752	-71.648	-74.492	-72.272	-69.668	-71.388	-38.244
12/24/2013	12:22:13 AM	-72.868	-72.156	-71.464	-71.048	-70.568	-70.416	-71.504	-71.168	-38.244
12/24/2013	12:23:39 AM	-72.868	-70.944	-69.816	-70.096	-71.664	-70.3	-71.412	-70.252	-38.04
12/24/2013	12:25:05 AM	-72.868	-70.18	-70.872	-69.2	-71.256	-73.74	-73.592	-70.168	-37.772
12/24/2013	12:26:31 AM	-72.868	-69.66	-72.464	-68.892	-70.556	-72.584	-69.316	-68.32	-38.272
12/24/2013	12:27:57 AM	-72.868	-72.836	-71.932	-72.54	-70.876	-69.372	-70.632	-69.976	-38.176
12/24/2013	12:29:23 AM	-72.868	-69.532	-68.28	-70.244	-69.296	-71.208	-70.744	-68.744	-37.736
12/24/2013	12:30:49 AM	-72.868	-71.62	-70.82	-72.024	-68.952	-71.384	-69.8	-69.928	-37.732
12/24/2013	12:32:15 AM	-72.868	-70.152	-69.268	-71.724	-73.3	-71.28	-70.112	-71.036	-37.908
12/24/2013	12:33:41 AM	-72.868	-70.152	-69.444	-70.944	-72.316	-72.952	-71.224	-69.928	-37.66
12/24/2013	12:35:07 AM	-72.868	-72.1	-68.824	-72.756	-72.228	-68.88	-70.388	-70.532	-38.296
12/24/2013	12:36:33 AM	-72.868	-71.368	-69.924	-69.312	-71.116	-70.948	-70.572	-71.088	-37.988
12/24/2013	12:37:59 AM	-72.868	-70.556	-69.796	-69.756	-71.236	-71.164	-69.04	-67.364	-38.04
12/24/2013	12:39:25 AM	-72.868	-69.38	-69.012	-70.764	-72.788	-73.472	-67.588	-70.272	-38.124
12/24/2013	12:40:51 AM	-72.868	-70.72	-69.9	-72.368	-68.4	-69.868	-72.816	-69.656	-37.836
12/24/2013	12:42:17 AM	-72.868	-73.476	-70.032	-72.044	-69.364	-71.116	-70.504	-73.008	-37.956
12/24/2013	12:43:43 AM	-72.868	-69.088	-71.72	-70.692	-66.7	-71.616	-71.636	-68.456	-37.976
12/24/2013	12:45:09 AM	-72.868	-72.94	-73.296	-71.992	-69.928	-69.648	-71.704	-68.296	-38.14
12/24/2013	12:46:35 AM	-72.868	-71.268	-70.888	-69.856	-72.184	-70.816	-68.344	-70.448	-38.392
12/24/2013	12:48:01 AM	-72.868	-70.184	-71.404	-72.016	-68.884	-71.596	-72.288	-68.76	-37.848
12/24/2013	12:49:27 AM	-72.868	-71.804	-70.112	-71.496	-70.304	-69.708	-70.936	-70.572	-37.98
12/24/2013	12:50:53 AM	-72.868	-69.524	-71.02	-69.144	-71.564	-72.9	-71.464	-72.144	-37.744
12/24/2013	12:52:19 AM	-72.868	-72.68	-71.628	-72.4	-71.06	-70.62	-70.084	-70.524	-37.916
12/24/2013	12:53:45 AM	-72.868	-69.464	-70.96	-70.828	-70.432	-70.912	-69.584	-68.26	-38.252
12/24/2013	12:55:11 AM	-72.868	-72.064	-69.496	-74.612	-70.784	-70.616	-71.908	-69.936	-37.792
12/24/2013	12:56:37 AM	-72.868	-68.328	-72.548	-71.728	-69.732	-73.016	-73.108	-68.424	-37.864
12/24/2013	12:58:03 AM	-72.868	-72.088	-70.748	-70.616	-70.584	-70.296	-71.392	-67.512	-38.472
12/24/2013	12:59:29 AM	-72.868	-69.9	-72.348	-68.988	-72.432	-71.42	-69.408	-68.876	-38.092
12/24/2013	1:00:55 AM	-72.868	-72.652	-69.904	-71.856	-71.412	-70.352	-70.66	-71.952	-38.276
12/24/2013	1:02:21 AM	-72.868	-69.788	-70.452	-70.768	-70.896	-71.316	-71.476	-68.952	-37.956
12/24/2013	1:03:47 AM	-72.868	-71.412	-70.828	-71.004	-71.168	-68.94	-69.396	-68.792	-37.864
12/24/2013	1:05:13 AM	-72.868	-72.548	-74.56	-71.1	-71.888	-68.824	-70.496	-71.736	-37.804
12/24/2013	1:06:39 AM	-72.868	-70.74	-68.124	-68.824	-70.54	-71.08	-71.588	-71.208	-37.944
12/24/2013	1:08:05 AM	-72.868	-71.128	-71.38	-71.776	-68.848	-72.388	-73.008	-72.924	-38.612
12/24/2013	1:09:31 AM	-72.868	-71.372	-71.548	-68.424	-70.464	-72.756	-68.584	-69.124	-38.216
12/24/2013	1:10:57 AM	-72.868	-69.772	-71.428	-72.064	-70.396	-70.496	-72.208	-70.836	-37.748
12/24/2013	1:12:23 AM	-72.868	-69.58	-69.26	-71.412	-72.184	-69.864	-69.456	-71.936	-37.792
12/24/2013	1:13:49 AM	-72.868	-70.964	-73.568	-72.008	-71.492	-70.436	-71.024	-70.376	-37.796
12/24/2013	1:15:15 AM	-72.868	-69.328	-70.5	-73.028	-72.428	-72.312	-71.728	-69.304	-38.416
12/24/2013	1:16:41 AM	-72.868	-71.172	-70.08	-69.416	-69.692	-72.532	-69.4	-72.176	-38.488
12/24/2013	1:18:07 AM	-72.868	-72.564	-70.144	-69.928	-70.748	-71.624	-69.864	-70.708	-38.416
12/24/2013	1:19:33 AM	-72.868	-69.096	-72.452	-70.708	-71.012	-73.648	-72.46	-70.14	-38.232
12/24/2013	1:20:59 AM	-72.868	-69.688	-69.788	-70.488	-71.604	-71.364	-72.288	-69.076	-38.028
12/24/2013	1:22:25 AM	-72.868	-70.468	-72.256	-72.304	-73.784	-70.34	-69.668	-69.708	-37.888
12/24/2013	1:23:51 AM	-72.868	-70.228	-71.356	-72.528	-72.26	-72.116	-71.372	-72.048	-38.14
12/24/2013	1:25:17 AM	-72.868	-68.416	-68.9	-73.068	-70.74	-70.176	-71.172	-71.576	-38.392
12/24/2013	1:26:43 AM	-72.868	-71.548	-70.428	-70.468	-72.692	-68.324	-70.884	-69.036	-38.072
12/24/2013	1:28:09 AM	-72.868	-70.356	-68.416	-69.944	-71.588	-72.148	-69.78	-70.596	-37.936
12/24/2013	1:29:35 AM	-72.868	-70.1	-71.396	-68.212	-71.908	-69.58	-70.74	-71.36	-37.872

APPENDEX .7

Ruwi 6AM-12PM
Sample Radio Spectrum Traffic

		MHz								
Date	Time	85	90	95	100	105	110	115	120	125
		POWER IN dBm								
12/24/2013	6:01:55 AM	-16.468	-8.696	-9.876	-10.588	-11.892	-59.056	-69.224	-72.012	-72.54
12/24/2013	6:03:21 AM	-14.772	-12.44	-10.748	-10.596	-12.348	-59.128	-70.668	-70.888	-70.92
12/24/2013	6:04:47 AM	-15.692	-10.332	-10.104	-11.424	-12.876	-58.356	-69.652	-70.532	-71.544
12/24/2013	6:06:13 AM	-16.508	-11.136	-9.724	-11.028	-13.196	-58.888	-68.556	-69.712	-72.932
12/24/2013	6:07:39 AM	-13.412	-13.208	-12.232	-11.848	-13.092	-59.288	-69.624	-69.264	-68.92
12/24/2013	6:09:05 AM	-16.044	-13.928	-10.856	-11.848	-13.64	-59.496	-69.26	-73.404	-72.008
12/24/2013	6:10:31 AM	-15.736	-10.092	-9.96	-10.968	-14.02	-59.516	-64.768	-69.384	-71.544
12/24/2013	6:11:57 AM	-14.28	-12.372	-11.596	-10.616	-12.316	-58.608	-66.456	-70.676	-70.572
12/24/2013	6:13:23 AM	-14.172	-12.484	-9.692	-11.252	-11.144	-58.624	-67.028	-71.292	-73.124
12/24/2013	6:14:49 AM	-14.844	-10.732	-11.344	-11.412	-12.212	-58.94	-67.008	-70.56	-71.876
12/24/2013	6:16:15 AM	-15.604	-9.22	-9.092	-10.772	-13.544	-59.572	-66.02	-69.904	-72.564
12/24/2013	6:17:41 AM	-15.976	-10.644	-10.532	-11.316	-12.464	-58.76	-68.992	-70.14	-72.432
12/24/2013	6:19:07 AM	-15.904	-10.076	-12.68	-11.192	-10.46	-58.136	-68.176	-70.86	-71.056
12/24/2013	6:20:33 AM	-15.844	-10.136	-8.784	-12	-13.752	-57.732	-68.748	-72.704	-68.92
12/24/2013	6:21:59 AM	-16.724	-9.116	-10.476	-10.52	-11.832	-58.748	-69.664	-73.616	-71.464
12/24/2013	6:23:25 AM	-17.108	-12.544	-11.74	-10.924	-12.728	-59.544	-72.064	-69.768	-71.212
12/24/2013	6:24:51 AM	-16.324	-10.064	-10.284	-12.4	-11.984	-58.912	-69.216	-69.524	-70.58
12/24/2013	6:26:17 AM	-14.332	-11.596	-10.636	-10.912	-11.444	-57.596	-68.28	-69.276	-71.788
12/24/2013	6:27:43 AM	-16.956	-10.596	-11.252	-10.808	-12.104	-59.228	-67.908	-71.036	-70.952
12/24/2013	6:29:09 AM	-16.268	-9.768	-10.732	-11.948	-13.388	-57.616	-67.66	-69.94	-71.732
12/24/2013	6:30:35 AM	-14.08	-13.04	-10.84	-10.256	-11.12	-59.2	-69.548	-69.412	-69
12/24/2013	6:32:01 AM	-15.32	-12.16	-12.46	-10.644	-11.66	-60.896	-67.828	-72.916	-70.04
12/24/2013	6:33:27 AM	-16.244	-12.304	-11.428	-10.152	-13.364	-57.556	-68.204	-69.984	-70.448
12/24/2013	6:34:53 AM	-15.296	-8.736	-10.436	-11.216	-11.228	-60.084	-67.324	-69.48	-70.52
12/24/2013	6:36:19 AM	-15	-9.244	-9.548	-11.104	-10.92	-59.636	-72	-68.12	-70.172
12/24/2013	6:37:45 AM	-16.6	-8.368	-9.46	-10.784	-11.316	-57.176	-69.192	-71.548	-70.2
12/24/2013	6:39:11 AM	-14.376	-9.84	-11.656	-10.876	-12.624	-58.356	-69.88	-72.232	-72.548
12/24/2013	6:40:37 AM	-14.24	-12.38	-12.016	-12.304	-11.524	-58.356	-69.856	-70.492	-73.612
12/24/2013	6:42:03 AM	-16.276	-12.8	-8.828	-11.656	-12.792	-59.68	-70.408	-70.52	-72.652
12/24/2013	6:43:29 AM	-15.82	-11.928	-12.516	-10.516	-10.188	-58.592	-68.348	-72.292	-73.392
12/24/2013	6:44:55 AM	-15.164	-14.644	-12.172	-10.28	-10.724	-58.808	-70.952	-71.516	-71.98
12/24/2013	6:46:21 AM	-15.788	-13.34	-11.58	-10.448	-13.864	-60.168	-68.884	-69.96	-69.216
12/24/2013	6:47:47 AM	-16.664	-10.516	-9.844	-12.464	-12.32	-59.388	-69.592	-73.908	-69.452
12/24/2013	6:49:13 AM	-16.052	-13.432	-8.5	-10.58	-10.84	-59.532	-67.952	-71.344	-71.992
12/24/2013	6:50:39 AM	-15.428	-11.548	-10.592	-11.848	-12.504	-58.62	-68.532	-70.044	-71.736
12/24/2013	6:52:05 AM	-16.564	-10.204	-11.112	-10.476	-10.724	-58.816	-69.064	-70.72	-70.896
12/24/2013	6:53:31 AM	-15.292	-12.024	-11.696	-10.276	-10.892	-59.396	-67.968	-69.48	-69.62
12/24/2013	6:54:57 AM	-17.62	-12.98	-8.696	-9.916	-10.536	-59.392	-68.02	-71.408	-72.356
12/24/2013	6:56:23 AM	-15.932	-11.152	-9.404	-10.508	-11.896	-58.828	-68.044	-70.54	-74.172
12/24/2013	6:57:49 AM	-16.488	-10.14	-11.692	-9.62	-11.36	-58.572	-67.572	-69.884	-68.092
12/24/2013	6:59:15 AM	-16.94	-13.48	-8.972	-11.012	-13.58	-58.156	-67.6	-70.72	-73.064
12/24/2013	7:00:41 AM	-14.316	-10.844	-10.508	-9.98	-12.74	-58.752	-70.224	-70.56	-71.244
12/24/2013	7:02:07 AM	-14.152	-11.5	-11.424	-12.336	-12.5	-59.22	-67.964	-70.916	-72.736
12/24/2013	7:03:33 AM	-17.128	-12.996	-11.388	-10.924	-10.784	-59.424	-66.144	-71.788	-71.632
12/24/2013	7:04:59 AM	-16.492	-12.868	-9.876	-10.732	-11.22	-58.624	-74.084	-71.844	-73.62
12/24/2013	7:06:25 AM	-15.66	-12.736	-11.76	-12.036	-14.152	-59.108	-67.76	-70.02	-69.132
12/24/2013	7:07:51 AM	-17.084	-11.616	-9.796	-12.84	-12.708	-59.904	-68.508	-71.708	-72.9
12/24/2013	7:09:17 AM	-16.912	-11.156	-9.896	-10.012	-12.984	-58.408	-70.672	-69.824	-73.396
12/24/2013	7:10:43 AM	-16.488	-13.436	-11.344	-12.056	-11.668	-57.46	-67.9	-69.96	-71.892
12/24/2013	7:12:09 AM	-16.288	-11.476	-9.056	-11.332	-11.116	-60.296	-68.912	-71.216	-70.132
12/24/2013	7:13:35 AM	-16.096	-12.996	-9.528	-11.632	-13.588	-58.184	-67.872	-70.784	-70.316
12/24/2013	7:15:01 AM	-16.652	-9.168	-9.248	-11.38	-11.496	-58.804	-69.444	-71.816	-72.004
12/24/2013	7:16:27 AM	-14.024	-11.148	-10.576	-10.56	-13.228	-60.252	-68.3	-71.7	-70.908
12/24/2013	7:17:53 AM	-15.812	-10.832	-11.712	-10.748	-11.08	-59.152	-70.164	-74.16	-70.98
12/24/2013	7:19:19 AM	-16.156	-9.484	-10.064	-11.092	-12.196	-58.368	-69.892	-72.548	-73.496
12/24/2013	7:20:45 AM	-16.372	-11.676	-11.952	-10.652	-13.596	-60.188	-67.54	-69.608	-72.764
12/24/2013	7:22:11 AM	-16.56	-10.036	-11.86	-11.836	-11.968	-57.488	-67.92	-69.924	-73.636
12/24/2013	7:23:37 AM	-15.172	-12.204	-9.376	-11.568	-10.372	-58.36	-66.088	-71.36	-71.388
12/24/2013	7:25:03 AM	-17.22	-10.248	-9.204	-11.216	-12.396	-57.94	-68.908	-71.064	-70.768
12/24/2013	7:26:29 AM	-15.972	-9.408	-11.176	-10.788	-14.02	-58.084	-69.972	-69	-71.944
12/24/2013	7:27:55 AM	-16.692	-13.32	-7.528	-11.976	-11.232	-59.296	-69.472	-69.776	-72.264
12/24/2013	7:29:21 AM	-16.676	-9.908	-8.904	-10.608	-12.236	-59.76	-67.956	-69.448	-69.208
12/24/2013	7:30:47 AM	-15.496	-15.8	-8.824	-12.532	-13.408	-60.396	-70.172	-68.476	-68.944

APPENDEX .8

Ruwi - 12PM-6PM
Sample Radio Spectrum Traffic

		MHz								
Date	Time	130	135	140	145	150	155	160	165	170
		POWER IN dBm								
12/24/2013	12:00:15 PM	-71.676	-72.864	-71.28	-70.672	-72.96	-68.84	-71.676	-70.46	-40.24
12/24/2013	12:01:41 PM	-71.108	-70.52	-72.144	-71.808	-72.86	-72.664	-71.22	-70.852	-35.14
12/24/2013	12:03:07 PM	-69.4	-70.764	-72.104	-70.676	-67.76	-69.62	-70.628	-71.772	-39.108
12/24/2013	12:04:33 PM	-69.34	-71.624	-70.572	-69.204	-68.744	-70.324	-70.68	-71.776	-40.32
12/24/2013	12:05:59 PM	-73.136	-74.504	-73.84	-70.924	-69.6	-71.128	-71.004	-68.044	-34.316
12/24/2013	12:07:25 PM	-72.22	-71.644	-73.48	-70.584	-68.588	-70.164	-69.72	-70.972	-36.232
12/24/2013	12:08:51 PM	-73.48	-71.82	-70.636	-70.372	-70.424	-69.964	-70.364	-69.828	-39.444
12/24/2013	12:10:17 PM	-70.56	-69.916	-71.964	-72.028	-71.032	-70.644	-70.524	-71.052	-41.808
12/24/2013	12:11:43 PM	-69.952	-70.04	-67.94	-70.744	-67.876	-71.272	-70.484	-69.304	-37.056
12/24/2013	12:13:09 PM	-72.02	-68.988	-69.632	-72.648	-70.432	-70.116	-73.452	-70.42	-38.64
12/24/2013	12:14:35 PM	-72.112	-70.02	-69.432	-72.824	-70.472	-71.596	-73.636	-69.148	-35.412
12/24/2013	12:16:01 PM	-69.716	-71.472	-73.676	-71.064	-72.68	-72.356	-69.912	-68.948	-36.716
12/24/2013	12:17:27 PM	-73.212	-70.084	-69.208	-69.064	-70.8	-71.32	-70.724	-71.8	-42.264
12/24/2013	12:18:53 PM	-69.18	-72.992	-71.04	-71.092	-72.8	-69.408	-70.12	-70.284	-39.312
12/24/2013	12:20:19 PM	-72.312	-74.004	-70.648	-67.488	-71.18	-70.236	-71.316	-72.188	-44.608
12/24/2013	12:21:45 PM	-70.66	-70.768	-71	-70.58	-70.404	-71.324	-71.208	-70.712	-44.004
12/24/2013	12:23:11 PM	-71.944	-71.356	-70.888	-72.808	-71.82	-71.444	-71.68	-68.564	-34.736
12/24/2013	12:24:37 PM	-71.148	-69.528	-69.176	-71.976	-69.48	-71.348	-73.444	-70.7	-35.432
12/24/2013	12:26:03 PM	-69.996	-72.512	-71.612	-73.704	-72.98	-71.352	-71.264	-71.748	-35.172
12/24/2013	12:27:29 PM	-72.524	-72.308	-69.392	-71.556	-71.62	-71.084	-70.628	-74.02	-38.616
12/24/2013	12:28:55 PM	-72.388	-72.236	-70.96	-69.612	-70.068	-72.4	-71.816	-72.38	-35.736
12/24/2013	12:30:21 PM	-70.252	-70.136	-72.716	-68.736	-71.3	-67.984	-69.364	-67.984	-36.108
12/24/2013	12:31:47 PM	-71.068	-72.308	-71.352	-74.128	-68.556	-72.184	-71.548	-68.992	-37.012
12/24/2013	12:33:13 PM	-70.204	-69.96	-69.104	-73.64	-72.376	-72.128	-73.216	-71.132	-36.824
12/24/2013	12:34:39 PM	-72.508	-71.228	-69.412	-70.56	-71.904	-71.092	-68.392	-69.972	-35.24
12/24/2013	12:36:05 PM	-70.932	-70.488	-72.112	-72.764	-71.652	-69.612	-71.388	-74.196	-39.4
12/24/2013	12:37:31 PM	-70.668	-69.9	-70.14	-64.664	-69.112	-72.576	-69.4	-69.796	-37.112
12/24/2013	12:38:57 PM	-72.012	-73.304	-69.984	-63.672	-70.124	-69.7	-70.556	-72.128	-38.936
12/24/2013	12:40:23 PM	-71.124	-71.776	-68.488	-73.796	-72.18	-73.824	-70.364	-71.432	-40.376
12/24/2013	12:41:49 PM	-71.216	-71.388	-70.864	-71.228	-70.052	-71.112	-71.528	-68.88	-36.88
12/24/2013	12:43:15 PM	-69.516	-73.972	-70.836	-70.808	-73.048	-70.896	-66.656	-71.016	-39.156
12/24/2013	12:44:41 PM	-70.184	-73.676	-72.18	-69.148	-69.404	-73.788	-74.072	-70.408	-36.964
12/24/2013	12:46:07 PM	-72.176	-72.856	-72.036	-68.144	-71.516	-70.5	-69.896	-67.776	-39.308
12/24/2013	12:47:33 PM	-73.132	-69.136	-70.724	-72.016	-70.124	-71.952	-74.708	-69.924	-40.2
12/24/2013	12:48:59 PM	-71.468	-71.252	-71.408	-71.636	-69.48	-69.472	-70.028	-70.808	-36.78
12/24/2013	12:50:25 PM	-71.036	-73.024	-71.952	-72.28	-71.524	-70.704	-72.092	-69.868	-37.188
12/24/2013	12:51:51 PM	-71.504	-71.82	-70.996	-69.348	-72.996	-72.544	-70.832	-71.896	-38.808
12/24/2013	12:53:17 PM	-73.752	-70.228	-70.768	-70.1	-72.22	-71.028	-70.908	-72.348	-39.776
12/24/2013	12:54:43 PM	-71.376	-71.584	-71.756	-72.42	-70.348	-70.708	-73.088	-67.628	-36.948
12/24/2013	12:56:09 PM	-73.54	-72.948	-68.552	-72.6	-70.42	-70.82	-69.624	-69.664	-45.22
12/24/2013	12:57:35 PM	-69.54	-73.272	-69.96	-73.208	-71.408	-69.768	-69.14	-69.324	-37.368
12/24/2013	12:59:01 PM	-70.308	-71.256	-72.304	-69.14	-68.668	-73.684	-72.32	-68.844	-39.192
12/24/2013	1:00:27 PM	-71.548	-71.28	-70.168	-71.284	-70.388	-70.54	-70.336	-70.456	-36.72
12/24/2013	1:01:53 PM	-68.396	-68.06	-71.368	-72.748	-73.676	-71.072	-72.408	-70.376	-38.924
12/24/2013	1:03:19 PM	-72.132	-72.2	-72.48	-70.372	-70.008	-71.324	-71.044	-72.18	-41.708
12/24/2013	1:04:45 PM	-69.984	-73.824	-73.068	-69.656	-73.724	-72.352	-72.104	-70.132	-35.08
12/24/2013	1:06:11 PM	-72.228	-72.396	-71.756	-73.584	-70.952	-70.508	-70.4	-69.844	-35.464
12/24/2013	1:07:37 PM	-70.476	-72.08	-71.828	-72.888	-71.176	-74.192	-70.608	-71.776	-36.884
12/24/2013	1:09:03 PM	-74.8	-72.848	-71.964	-70.816	-71.716	-69.612	-71.916	-70.856	-36.616
12/24/2013	1:10:29 PM	-70.076	-69.112	-72.944	-69.368	-69.3	-71.804	-70.6	-71.792	-38.952
12/24/2013	1:11:55 PM	-69.248	-71.092	-71.368	-72.964	-68.092	-72.404	-73.272	-71.728	-41.016
12/24/2013	1:13:21 PM	-70.336	-72.392	-70.872	-70.652	-70.152	-70.94	-69.632	-70.424	-36.98
12/24/2013	1:14:47 PM	-69.592	-71.424	-70.784	-72.228	-69.08	-72.776	-68.784	-70.168	-40.228
12/24/2013	1:16:13 PM	-72.292	-72.192	-72.432	-70.02	-69.264	-71.608	-70.328	-69.968	-45.276
12/24/2013	1:17:39 PM	-71.432	-73.552	-73.092	-73.556	-72.48	-70.416	-71.04	-69.6	-36.868
12/24/2013	1:19:05 PM	-72.94	-72.548	-72.828	-70.232	-72.488	-71.552	-72.108	-69.464	-36.824
12/24/2013	1:20:31 PM	-72.56	-69.444	-69.152	-71.836	-73.604	-72.416	-71.072	-72.572	-40.148
12/24/2013	1:21:57 PM	-72.936	-70.152	-70.44	-70.792	-71.468	-70.212	-68.14	-72.612	-42
12/24/2013	1:23:23 PM	-69.804	-70.372	-68.98	-72.1	-72.66	-71.928	-74.092	-72.164	-35.04
12/24/2013	1:24:49 PM	-71.168	-71.284	-70.472	-72.364	-72.888	-72.256	-72.844	-71.96	-35.144
12/24/2013	1:26:15 PM	-71.984	-71.02	-71.536	-69.94	-72	-75.06	-69.68	-73.212	-35.576
12/24/2013	1:27:41 PM	-70.312	-70.8	-71.384	-71.208	-72.32	-70.604	-69.572	-73.832	-36.424
12/24/2013	1:29:07 PM	-71.08	-69.352	-74.3	-70.652	-69.772	-70.868	-72.164	-71.552	-39.328

APPENDEX .9

Ruwi - 6PM-12AM
Sample Radio Spectrum Traffic

		MHz								
Date	Time	175	180	185	190	195	200	205	210	215
		POWER IN dBm								
12/23/2013	7:26:57 PM	-33.04	-33.368	-65.016	-62.472	-64.92	-70.168	-68.352	-70.612	-70.716
12/23/2013	7:28:23 PM	-32.484	-33.216	-65.66	-61.964	-64.988	-69.544	-69.708	-71.924	-71.428
12/23/2013	7:29:49 PM	-33.008	-33.128	-63.576	-64.06	-65.944	-65.236	-70.86	-71.732	-71.852
12/23/2013	7:31:15 PM	-34.22	-34.452	-63.344	-63.568	-63.636	-69.768	-72.332	-73.312	-69.196
12/23/2013	7:32:41 PM	-33.984	-34.228	-64.284	-63.216	-66.876	-68.288	-68.608	-67.96	-68.252
12/23/2013	7:34:07 PM	-33.5	-34.824	-66.836	-63.62	-65.228	-67.408	-70.836	-71.34	-72.572
12/23/2013	7:35:33 PM	-33.856	-33.976	-63.124	-64.432	-60.884	-68.968	-69.984	-71.06	-72.86
12/23/2013	7:36:59 PM	-34.34	-34.772	-63.476	-62.492	-63.072	-70.112	-67.732	-70.424	-71.024
12/23/2013	7:38:25 PM	-33.852	-34.032	-64.656	-63.664	-62.564	-69.8	-71.308	-70.812	-72.08
12/23/2013	7:39:51 PM	-34.048	-33.968	-61.044	-64.712	-63.224	-67.888	-71.132	-68.676	-70.72
12/23/2013	7:41:17 PM	-34.068	-34.208	-68.052	-64.632	-64.188	-68.632	-71.404	-70.208	-71.044
12/23/2013	7:42:43 PM	-33.8	-33.964	-64.892	-65.436	-64.176	-69.756	-71.576	-70.52	-71.492
12/23/2013	7:44:09 PM	-35.148	-35.64	-64.712	-63.164	-63.424	-70.528	-69.7	-71.44	-69.064
12/23/2013	7:45:35 PM	-33.94	-34.152	-65.412	-63.276	-64.132	-65.844	-70.78	-68.9	-69.264
12/23/2013	7:47:01 PM	-34.34	-34.588	-63.008	-66.54	-66.944	-69.412	-70.068	-71.88	-69.628
12/23/2013	7:48:27 PM	-34.14	-34.096	-64.372	-63.352	-61.444	-69.292	-70.132	-72.1	-70.744
12/23/2013	7:49:53 PM	-35.136	-35.792	-60.408	-65.472	-65.224	-69.412	-68.772	-68.112	-70.528
12/23/2013	7:51:19 PM	-35.1	-36.312	-63.364	-60.836	-62.188	-67.76	-70.236	-70.532	-69.8
12/23/2013	7:52:45 PM	-35.204	-35.636	-60.636	-64.32	-63.368	-68.304	-71.9	-73.556	-72.392
12/23/2013	7:54:11 PM	-33.804	-33.884	-64.392	-61.16	-64.66	-67.2	-70.596	-70.628	-68.944
12/23/2013	7:55:37 PM	-34.42	-34.44	-61.608	-65.728	-62.34	-67.668	-69.968	-70.328	-70.208
12/23/2013	7:57:03 PM	-34.94	-35.32	-62.668	-65.592	-61.82	-67.772	-69.544	-70.228	-69.444
12/23/2013	7:58:29 PM	-34.82	-34.976	-63.58	-64.752	-62.092	-67.236	-69.324	-71.196	-71.264
12/23/2013	7:59:55 PM	-35.784	-35.888	-64.236	-63.632	-62.316	-68.736	-69.06	-73.46	-70.536
12/23/2013	8:01:21 PM	-35.108	-35.984	-66.404	-65.716	-64.288	-68.876	-69.856	-71.684	-72.412
12/23/2013	8:02:47 PM	-34.46	-34.676	-63.136	-65.28	-63.58	-67.816	-67.876	-69.556	-71.496
12/23/2013	8:04:13 PM	-32.676	-33.26	-64.96	-64.364	-63.312	-65.476	-71.036	-69.332	-70.92
12/23/2013	8:05:39 PM	-33.576	-34.096	-62.596	-63.46	-62.968	-65.92	-69.228	-70.948	-71.24
12/23/2013	8:07:05 PM	-33.172	-32.96	-63.468	-63.76	-62.24	-65.904	-69.856	-70.368	-70.852
12/23/2013	8:08:31 PM	-34.192	-34.116	-62.964	-63.096	-64.396	-69.852	-71.032	-69.72	-72.992
12/23/2013	8:09:57 PM	-32.804	-33.084	-66.72	-63.42	-63.772	-69.044	-68.644	-68.86	-70.34
12/23/2013	8:11:23 PM	-33.328	-33.536	-65.828	-61.372	-63.436	-67.96	-67.932	-70.712	-71.488
12/23/2013	8:12:49 PM	-34.128	-35.004	-63.744	-60.412	-62.356	-68.368	-71.212	-70.028	-70.172
12/23/2013	8:14:15 PM	-35.152	-35.332	-64.452	-61.7	-62.692	-70.488	-67.116	-71.968	-68.972
12/23/2013	8:15:41 PM	-33.944	-34.096	-62.544	-62.096	-61.8	-68.264	-72.12	-70.448	-70.848
12/23/2013	8:17:07 PM	-34.308	-34.368	-61.392	-65.508	-62.972	-65.744	-72.232	-71.012	-72.168
12/23/2013	8:18:33 PM	-35.168	-34.292	-61.012	-62.156	-64.308	-68.472	-71.268	-73.572	-71.556
12/23/2013	8:19:59 PM	-34.02	-34.296	-67.22	-65.16	-60.62	-67.708	-69.008	-71.548	-72.516
12/23/2013	8:21:25 PM	-33.816	-34.032	-62.072	-62.544	-63.992	-67.808	-71.316	-69.46	-68.748
12/23/2013	8:22:51 PM	-34.16	-34.512	-62.04	-65.26	-63.52	-71.168	-70.68	-72.868	-71.816
12/23/2013	8:24:17 PM	-33.876	-33.968	-67.2	-63.132	-64.644	-68.656	-69.804	-72.92	-72.696
12/23/2013	8:25:43 PM	-34.116	-34.32	-62.756	-63.452	-61.292	-68.612	-69.828	-73.38	-68.652
12/23/2013	8:27:09 PM	-34.136	-34.36	-62.92	-65.756	-61.776	-65.66	-71.252	-71.596	-70.34
12/23/2013	8:28:35 PM	-33.516	-33.544	-61.652	-66.616	-64.576	-67.792	-68.488	-72.436	-70.664
12/23/2013	8:30:01 PM	-33.812	-34.016	-64.188	-63.328	-61.872	-66.888	-68.872	-71.192	-71.768
12/23/2013	8:31:27 PM	-33.88	-34.256	-64.8	-62.544	-67.344	-68.156	-71.312	-70.7	-72.908
12/23/2013	8:32:53 PM	-33.948	-34.836	-63.512	-61.896	-63.216	-66.632	-69.772	-69.252	-71.792
12/23/2013	8:34:19 PM	-34.876	-35.196	-63.684	-63.832	-62.876	-68.172	-70.484	-71.904	-68.392
12/23/2013	8:35:45 PM	-34.984	-35.204	-64.536	-63.368	-63.08	-67.072	-70.576	-70.94	-72.588
12/23/2013	8:37:11 PM	-35.132	-34.816	-64.956	-62.332	-63.964	-68.012	-68.552	-68.548	-71.292
12/23/2013	8:38:37 PM	-35.684	-35.516	-62.324	-65.736	-63.516	-65.712	-67.984	-69.72	-70.56
12/23/2013	8:40:03 PM	-33.084	-33.836	-62.128	-63.82	-66.996	-69.256	-69.308	-71.944	-71.044
12/23/2013	8:41:29 PM	-33.62	-34.204	-62.868	-61.088	-61.484	-68.088	-72.1	-73.96	-69.796
12/23/2013	8:42:55 PM	-33.076	-33.2	-64.864	-66.144	-63.404	-67.104	-70.54	-71.764	-70.996
12/23/2013	8:44:21 PM	-34.168	-34.364	-66.436	-61.228	-62.748	-67.36	-71.412	-69.356	-69.972
12/23/2013	8:45:47 PM	-33.432	-33.008	-63.724	-62.456	-63.452	-65.828	-68.248	-71.276	-71.616
12/23/2013	8:47:13 PM	-33.148	-33.424	-62.92	-64.34	-62.272	-66.436	-70.512	-72.304	-71.532
12/23/2013	8:48:39 PM	-33.972	-34.112	-61.836	-61	-64.528	-67.188	-69.308	-70.252	-71.86
12/23/2013	8:50:05 PM	-33.224	-33.496	-62.912	-62.692	-61.18	-69.7	-71.804	-70.048	-70.592
12/23/2013	8:51:31 PM	-33.128	-33.772	-62.204	-64.92	-62.476	-70.012	-71.244	-70.892	-71.56
12/23/2013	8:52:57 PM	-34.256	-34.252	-64.42	-61.548	-61.644	-66.388	-69.14	-71.024	-71.716
12/23/2013	8:54:23 PM	-33.024	-33.328	-61.672	-65.532	-64.86	-67.096	-69.584	-68.108	-70.988
12/23/2013	8:55:49 PM	-34	-35.256	-62.852	-63.984	-63.56	-65.064	-67.46	-71.544	-71.208

APPENDEX .10

AlGhobrah - 12AM-6AM
Sample Radio Spectrum Traffic

		MHz								
Date	Time	220	225	230	235	240	245	250	255	260
		POWER IN dBm								
18/12/2013	12:00:03 AM	-71.164	-71.784	-71.928	-72.616	-73.028	-71.808	-74.06	-73.164	-72.14
20/12/2013	12:00:07 AM	-72.304	-72.412	-71.632	-72.516	-72.992	-71.724	-72.636	-73.952	-71.832
11/12/2013	12:00:21 AM	-71.552	-73.16	-72.976	-72.22	-71.368	-70.256	-72.3	-71.928	-73.12
13/12/2013	12:00:25 AM	-70.888	-73.588	-71.8	-71.752	-72.836	-73.468	-72.288	-73.968	-72.924
16/12/2013	12:00:29 AM	-70.528	-71.604	-72.712	-71.764	-71.044	-71.916	-72.672	-71.832	-72.884
18/12/2013	12:00:33 AM	-72.38	-73.708	-71.348	-70.772	-71.416	-72.56	-71.108	-71.72	-72.436
21/12/2013	12:00:37 AM	-73.536	-73.62	-74.028	-73.22	-73.364	-72.32	-73.092	-71.896	-72.168
10/12/2013	12:00:47 AM	-72.96	-72.256	-72.448	-73.244	-73.496	-73.084	-72.784	-72.82	-73.888
11/12/2013	12:00:51 AM	-71.216	-72.644	-73.852	-72.44	-72.48	-71.948	-74.38	-72.656	-73.12
14/12/2013	12:00:55 AM	-72.464	-73.18	-71.328	-72.104	-71.976	-71.376	-72.984	-70.644	-73.868
17/12/2013	12:00:59 AM	-71.532	-72.3	-72.544	-72.356	-72.728	-74.032	-73.584	-71.36	-72.216
19/12/2013	12:01:03 AM	-73.276	-73.592	-72.748	-72.004	-72.688	-73.292	-73.076	-72.032	-73.592
10/12/2013	12:01:17 AM	-73.016	-72.608	-73.368	-73.468	-72.496	-73.492	-73.264	-71.648	-73.756
12/12/2013	12:01:21 AM	-71.924	-72.216	-72.564	-71.616	-70.744	-73.328	-73.772	-73.256	-72.988
15/12/2013	12:01:25 AM	-72.052	-72.18	-72.612	-73.444	-73.812	-71.512	-72.204	-74.284	-72.96
18/12/2013	12:01:29 AM	-72.892	-72.504	-72.676	-73.288	-71.156	-72.872	-73.428	-73.152	-72.364
20/12/2013	12:01:33 AM	-74.3	-72.648	-73.048	-72.084	-73.168	-72.78	-72.156	-71.768	-71.276
11/12/2013	12:01:47 AM	-72.112	-72.144	-73.552	-73.232	-73.156	-73.052	-72.416	-71.104	-73.36
13/12/2013	12:01:51 AM	-72.668	-71.512	-72.42	-72.072	-71.792	-71.9	-72.148	-72.744	-72.808
16/12/2013	12:01:55 AM	-71.616	-71.344	-72.408	-71.784	-72.604	-71.432	-70.76	-72.124	-72.512
18/12/2013	12:01:59 AM	-71.556	-73.296	-71.156	-71.32	-72.312	-72.396	-73.676	-72.012	-72.272
21/12/2013	12:02:03 AM	-72.296	-72.476	-73.288	-71.876	-72.12	-71.828	-71.592	-73.512	-71.844
10/12/2013	12:02:13 AM	-73.888	-73.592	-73.424	-71.976	-71.02	-72.06	-72.656	-73.616	-73.932
11/12/2013	12:02:17 AM	-72.808	-71.06	-71.652	-72.924	-73.56	-72.024	-73.328	-73.244	-71.5
14/12/2013	12:02:21 AM	-73.184	-72.136	-71.456	-73.54	-71.38	-72.072	-72.408	-71.68	-72.58
17/12/2013	12:02:25 AM	-71.8	-72.56	-72.856	-71.444	-71.78	-72.852	-72.388	-73.476	-74.624
19/12/2013	12:02:29 AM	-73.396	-72.312	-72.284	-71.576	-71.048	-72.408	-72.648	-72.664	-73.472
10/12/2013	12:02:43 AM	-72.516	-74.18	-72.3	-71.348	-71.728	-74.244	-72.148	-73.496	-75.5
12/12/2013	12:02:47 AM	-72.924	-72.54	-73.056	-73.708	-73.276	-75.024	-72.98	-72.708	-74.664
15/12/2013	12:02:51 AM	-73.548	-73.296	-71.468	-71.208	-70.788	-71.98	-73.024	-72.816	-74.144
18/12/2013	12:02:55 AM	-72.032	-73.832	-71.52	-73.82	-72.104	-72.612	-72.86	-72.688	-73.332
20/12/2013	12:02:59 AM	-73.212	-71.068	-72.564	-71.924	-72.648	-73.716	-70.812	-72.228	-72.324
11/12/2013	12:03:13 AM	-73.044	-72.208	-73.712	-72.452	-73.316	-70.356	-72.84	-73.772	-73.412
13/12/2013	12:03:17 AM	-72.336	-72.972	-71.96	-70.268	-72.888	-72.764	-71.612	-73.324	-71.232
16/12/2013	12:03:21 AM	-72.516	-73.404	-72.396	-72.616	-72.372	-71.248	-72.92	-71.952	-71.832
18/12/2013	12:03:25 AM	-72.564	-73.252	-73.86	-70.468	-70.868	-72.804	-72.892	-72.68	-73
21/12/2013	12:03:29 AM	-71.644	-71.072	-72.108	-71.608	-71.892	-71.344	-71.26	-71.264	-71.872
10/12/2013	12:03:39 AM	-72.456	-73.748	-71.928	-73.38	-72.844	-71.572	-72.548	-74.552	-71.32
11/12/2013	12:03:43 AM	-73.416	-73.408	-73.624	-73.44	-72.332	-71.692	-72.608	-74.344	-73.3
14/12/2013	12:03:47 AM	-72.876	-71.868	-72.188	-72.132	-72.788	-72.236	-71.804	-72.388	-73.34
17/12/2013	12:03:51 AM	-73.18	-72.188	-71.524	-72.748	-72.144	-72.364	-70.928	-70.98	-72.372
19/12/2013	12:03:55 AM	-72.536	-72.964	-72.608	-72.252	-72.46	-71.336	-72.432	-73.5	-73.708
10/12/2013	12:04:09 AM	-73.084	-74.276	-71.864	-72.248	-72.216	-72.844	-72.024	-72.244	-73.684
12/12/2013	12:04:13 AM	-72.06	-72.36	-73.432	-73.84	-74.036	-73.072	-73.944	-72.212	-72.644
15/12/2013	12:04:17 AM	-70.812	-71.72	-71.98	-72.752	-72.928	-70.412	-73.16	-72.62	-72.716
18/12/2013	12:04:21 AM	-72.052	-71.644	-73.908	-72.784	-71.824	-71.896	-71.928	-71.732	-72.612
20/12/2013	12:04:25 AM	-71.328	-72.496	-73.3	-70.856	-73.196	-72.748	-74.776	-72.396	-71.232
11/12/2013	12:04:39 AM	-73.816	-72.728	-74.26	-71.332	-72.528	-72.5	-72.4	-72.5	-71.82
13/12/2013	12:04:43 AM	-72.384	-72.64	-72.992	-71.4	-72.264	-72.376	-72.632	-71.676	-72.296
16/12/2013	12:04:47 AM	-72.316	-72.956	-72.344	-72.884	-71.256	-71.912	-72.828	-73.24	-74.524
18/12/2013	12:04:51 AM	-72.872	-72.288	-72.488	-72.672	-72.552	-73.632	-72.54	-74.024	-75.708
21/12/2013	12:04:55 AM	-72.512	-70.952	-71.904	-72.724	-71.996	-71.536	-73.48	-71.728	-72.42
10/12/2013	12:05:05 AM	-72.208	-73.116	-72.9	-72.836	-72.404	-73.548	-72.576	-73.512	-73.112
11/12/2013	12:05:09 AM	-72.396	-72.148	-72.556	-71.376	-72.512	-71.652	-72.856	-72.432	-73.176
14/12/2013	12:05:13 AM	-71.156	-73.508	-72.556	-72.764	-71.036	-73.356	-72.56	-73.504	-71.248
17/12/2013	12:05:17 AM	-72.136	-73.152	-73.048	-72.38	-72.724	-72.768	-70.936	-72.392	-72.032
19/12/2013	12:05:21 AM	-72.484	-73.128	-73.152	-71.764	-72.94	-71.136	-73.108	-72.892	-71.924
10/12/2013	12:05:35 AM	-72.9	-72.296	-72.784	-71.928	-73.68	-72.692	-72.964	-74.976	-73.172
12/12/2013	12:05:39 AM	-72.7	-72.972	-73.524	-72.536	-71.992	-70.24	-72.9	-73.068	-72.016
15/12/2013	12:05:43 AM	-72.208	-71.784	-72.136	-71.832	-71.456	-71.184	-71.044	-72.792	-71.92
18/12/2013	12:05:47 AM	-72.636	-72.716	-72.696	-71.972	-74.176	-71.692	-72.432	-73.632	-73.124
20/12/2013	12:05:51 AM	-72.528	-72.292	-71.9	-72.04	-73.616	-70.492	-74.496	-71	-73.012
11/12/2013	12:06:05 AM	-73.272	-70.004	-73.856	-71.74	-72.492	-73.116	-72.428	-72.652	-73.156

APPENDEX .11

ALGobrah - 6AM-12PM
Sample Radio Spectrum Traffic

		MHz								
Date	Time	265	270	275	280	285	290	295	300	305
		POWER IN dBm								
11/12/2013	6:00:07 AM	-73.032	-71.38	-72.272	-72.788	-72.604	-74.36	-73.2	-72.64	-74.04
14/12/2013	6:00:11 AM	-73.176	-73.98	-73.476	-74.328	-74.424	-72.928	-74.288	-72.68	-74.06
17/12/2013	6:00:15 AM	-71.932	-73.78	-72.936	-74.484	-72.84	-75.192	-72.324	-73.5	-73.608
19/12/2013	6:00:19 AM	-70.572	-71.92	-72.824	-72.728	-73.676	-70.856	-71.904	-72.988	-71.568
22/12/2013	6:00:23 AM	-71.212	-72.496	-73.02	-71.408	-73.572	-71.636	-73.48	-73.288	-73.804
10/12/2013	6:00:33 AM	-72.432	-73.888	-71.604	-73.604	-73.868	-72.008	-73.648	-73.304	-76.224
11/12/2013	6:00:37 AM	-73.336	-72.556	-74.072	-73.708	-70.976	-73.684	-72.468	-73.404	-74.468
15/12/2013	6:00:41 AM	-73.388	-73.992	-72.536	-71.652	-72.3	-72.704	-73.72	-74.912	-72.62
18/12/2013	6:00:45 AM	-72.804	-72.536	-74.06	-73.172	-71.864	-73.964	-73.828	-72.132	-72.404
20/12/2013	6:00:49 AM	-73.38	-71.172	-73.684	-72.692	-71.728	-72.096	-71.928	-73.624	-74.468
10/12/2013	6:01:03 AM	-73.856	-73.58	-74.476	-73.108	-72.184	-74.296	-73.612	-73.988	-73.328
12/12/2013	6:01:07 AM	-72.384	-73.264	-73.452	-72.4	-73.592	-72.92	-73.492	-73.388	-73.076
16/12/2013	6:01:11 AM	-74.192	-71.788	-73.032	-73.124	-73.556	-73.572	-71.532	-73.8	-74.016
18/12/2013	6:01:15 AM	-72.62	-71.524	-72.928	-73.224	-72.672	-72.448	-72.524	-73.592	-72.244
21/12/2013	6:01:19 AM	-72.308	-72.692	-73.46	-72.028	-73.46	-73.356	-72.772	-73.952	-72.348
11/12/2013	6:01:33 AM	-72.9	-72	-72.352	-72.276	-71.892	-72.472	-72.88	-73.088	-74.404
14/12/2013	6:01:37 AM	-71.788	-72.816	-73.892	-72.192	-72.168	-69.992	-72.744	-74.468	-73.404
17/12/2013	6:01:41 AM	-72.884	-72.9	-73.744	-73.208	-73.208	-72.512	-74.024	-72.408	-71.672
19/12/2013	6:01:45 AM	-71.936	-73.452	-71.724	-73.124	-73.392	-70.524	-73.104	-72.804	-72.776
22/12/2013	6:01:49 AM	-73.272	-73.208	-72.068	-73.532	-73.608	-71.296	-73.908	-70.864	-71.68
10/12/2013	6:01:59 AM	-73.816	-71.2	-73.632	-73.596	-72.44	-73.052	-72.416	-73.476	-74.216
11/12/2013	6:02:03 AM	-72.624	-73.832	-73.024	-73.344	-71.772	-73.948	-73.248	-72.348	-73.748
15/12/2013	6:02:07 AM	-71.06	-72.712	-73.28	-73.372	-71.38	-71.684	-72.628	-72.976	-71.4
18/12/2013	6:02:11 AM	-72.696	-73.908	-72.956	-72.652	-73.488	-72.948	-72.916	-72.82	-73.156
20/12/2013	6:02:15 AM	-72.884	-72.008	-73.26	-71.684	-73.704	-72.516	-73.856	-74.576	-72.804
10/12/2013	6:02:29 AM	-73.012	-74.004	-74.86	-72.88	-73.208	-72.98	-71.232	-72.184	-73.112
12/12/2013	6:02:33 AM	-72.448	-71.456	-72.232	-73.26	-72.652	-74.168	-73.18	-71.848	-72.82
16/12/2013	6:02:37 AM	-73.348	-71.704	-71.276	-72.872	-73.624	-71.472	-73.856	-73.952	-72.82
18/12/2013	6:02:41 AM	-72.908	-73.212	-71.576	-73.612	-71.512	-72.648	-74.536	-72.744	-71.528
21/12/2013	6:02:45 AM	-72.204	-72.26	-72.772	-72.012	-72.616	-73.044	-72.548	-72.672	-73.088
11/12/2013	6:02:59 AM	-71.66	-73.252	-72.932	-72.964	-72.936	-73.968	-71.66	-73.44	-71.256
14/12/2013	6:03:03 AM	-72.764	-74.124	-72.536	-73.988	-73.412	-73.168	-73.5	-74.396	-73.18
17/12/2013	6:03:07 AM	-73.248	-71.996	-73.648	-71.62	-72.616	-72.532	-72.688	-73.376	-72.888
19/12/2013	6:03:11 AM	-72.748	-73.62	-73.136	-73.928	-73.976	-72.668	-71.996	-72.188	-71.544
22/12/2013	6:03:15 AM	-73.096	-73.424	-72.196	-73.088	-72.032	-71.172	-72.868	-73.24	-73.524
10/12/2013	6:03:25 AM	-73.532	-73.116	-74.096	-75.112	-73.416	-73.2	-72.496	-73.692	-73.164
11/12/2013	6:03:29 AM	-72.668	-73.296	-71.568	-71.668	-71.752	-72.216	-72.848	-73.556	-71.776
15/12/2013	6:03:33 AM	-72.688	-72.44	-73.436	-73.064	-72.496	-71.108	-71.136	-74.936	-72.036
18/12/2013	6:03:37 AM	-74.02	-72.408	-72.2	-73.94	-72.548	-73.34	-72.56	-73.628	-73.02
20/12/2013	6:03:41 AM	-73.256	-73.104	-75.224	-73.232	-72.54	-72.632	-73.368	-74.476	-72.484
10/12/2013	6:03:55 AM	-72.288	-73.264	-73.768	-73.132	-72.656	-72.812	-73.036	-74.936	-72.244
12/12/2013	6:03:59 AM	-72.248	-72.296	-72.104	-72.336	-73.888	-73.356	-72.436	-73.6	-71.212
16/12/2013	6:04:03 AM	-71.42	-71.916	-72.464	-71.78	-74.128	-73.58	-73.284	-73.032	-73.608
18/12/2013	6:04:07 AM	-73.28	-73.62	-71.82	-72.256	-71.568	-72.376	-70.524	-73.696	-73.04
21/12/2013	6:04:11 AM	-71.136	-72.964	-72.752	-70.952	-72.692	-72.344	-73.66	-73.176	-72.848
11/12/2013	6:04:25 AM	-72.464	-73.568	-75.428	-72.42	-71.648	-71.928	-72.32	-73.78	-73.9
14/12/2013	6:04:29 AM	-72.98	-73.024	-72.908	-72.384	-72.8	-71.44	-73.008	-73.756	-73.004
17/12/2013	6:04:33 AM	-72.508	-73.12	-73.16	-73.988	-73.46	-72.628	-73.188	-71.944	-72.748
19/12/2013	6:04:37 AM	-72.172	-73.28	-72.992	-70.184	-73.572	-72.084	-74.056	-73.528	-72.188
22/12/2013	6:04:41 AM	-71.136	-74.264	-72.388	-70.028	-70.684	-71.996	-73.596	-72.288	-74.328
10/12/2013	6:04:51 AM	-73.672	-73.128	-73.808	-71.988	-71.208	-73.852	-73.064	-73.576	-73.584
11/12/2013	6:04:55 AM	-73.076	-74.12	-72.752	-72.864	-71.404	-73.604	-73.644	-71.88	-73.444
15/12/2013	6:04:59 AM	-73.04	-72.14	-72.936	-72.232	-71.508	-73.188	-74.24	-73.22	-71.944
18/12/2013	6:05:03 AM	-72.656	-73.624	-72.468	-72.572	-73.5	-72.792	-72.584	-71.584	-73.328
20/12/2013	6:05:07 AM	-73.28	-72.184	-73.216	-73.712	-71.612	-71.1	-71.228	-71.32	-71.908
10/12/2013	6:05:21 AM	-71.976	-73.808	-73.504	-73.88	-72.432	-73.232	-74.184	-74.224	-72.784
12/12/2013	6:05:25 AM	-72.932	-74.316	-73.008	-73.552	-74.312	-72.62	-70.868	-72.884	-71.624
16/12/2013	6:05:29 AM	-72.44	-72.676	-72.304	-73.412	-72.572	-74.328	-73.284	-72.2	-73.54
18/12/2013	6:05:33 AM	-72.2	-72.984	-72.32	-73.592	-74.5	-72.884	-73.916	-72.676	-72.272
21/12/2013	6:05:37 AM	-73.404	-72.944	-71.98	-72.468	-72.992	-71.156	-71.708	-73.04	-73.852
11/12/2013	6:05:51 AM	-72.136	-73.368	-72.184	-71.244	-72.956	-72.624	-74.62	-74.02	-72.116
14/12/2013	6:05:55 AM	-74.524	-73.16	-73.24	-73.544	-72.092	-72.528	-72.54	-72.788	-73.84
17/12/2013	6:05:59 AM	-71.372	-73.104	-73.284	-72.156	-71.936	-73.256	-73.04	-72.456	-73.296

APPENDEX .12

ALGobrah - 12PM-6PM
Sample Radio Spectrum Traffic

		MHz								
Date	Time	310	315	320	325	330	335	340	345	350
		POWER IN dBm								
17/12/2013	12:00:01 PM	-72.68	-72.844	-71.964	-71.868	-74.268	-72.644	-71.436	-72.504	-72.976
19/12/2013	12:00:05 PM	-72.46	-73.384	-70.672	-73.872	-74.604	-71.424	-73.344	-72.532	-72.82
22/12/2013	12:00:09 PM	-71.604	-72.012	-72.892	-71.796	-73.332	-72.312	-71.796	-73.02	-73.072
10/12/2013	12:00:19 PM	-73.428	-72.444	-73.232	-73.264	-74.44	-74	-74.1	-74.44	-72.664
11/12/2013	12:00:23 PM	-71.548	-72.916	-72.632	-72.84	-73.256	-73.336	-73.008	-72.452	-73.844
15/12/2013	12:00:27 PM	-72.6	-71.464	-72.908	-73.116	-73.448	-74.312	-73.712	-71.872	-72.456
18/12/2013	12:00:31 PM	-72.208	-72.676	-74.364	-73.38	-72.14	-70.528	-71.508	-72.12	-74.396
20/12/2013	12:00:35 PM	-73.74	-73.056	-72.996	-73.6	-72.008	-74.16	-71.136	-72.96	-72.78
11/12/2013	12:00:49 PM	-74.48	-73.764	-72.208	-74.096	-74.348	-72.556	-73.316	-73.704	-73.072
12/12/2013	12:00:53 PM	-72.232	-74.372	-74.604	-73.688	-73.248	-72.516	-72.56	-72.604	-72.656
16/12/2013	12:00:57 PM	-73.42	-72.976	-73.096	-73.524	-72.968	-73.536	-72.188	-74.668	-72.112
18/12/2013	12:01:01 PM	-72.28	-73.348	-72.196	-72.12	-73.18	-72.284	-72.644	-72.58	-73.824
21/12/2013	12:01:05 PM	-72.408	-71.208	-72.912	-72.492	-71.38	-73.112	-73.108	-71.956	-72.996
11/12/2013	12:01:19 PM	-72.064	-72.424	-71.504	-72.5	-74.296	-75.376	-72.1	-73.74	-74.38
14/12/2013	12:01:23 PM	-71.668	-73.304	-73.86	-73.996	-72.552	-70.388	-72.432	-72.716	-74.184
17/12/2013	12:01:27 PM	-72.428	-72.104	-72.388	-72.824	-72.652	-73.508	-73.036	-72.316	-72.984
19/12/2013	12:01:31 PM	-73.832	-73.616	-72.936	-73.932	-73.132	-73.724	-72.212	-73.236	-72.54
22/12/2013	12:01:35 PM	-73.828	-72.196	-74.416	-72.68	-73.004	-73.988	-73.276	-71.116	-74.348
10/12/2013	12:01:45 PM	-73.276	-72.64	-73.436	-73.576	-73.22	-72.852	-73.016	-73.688	-72.584
11/12/2013	12:01:49 PM	-72.844	-73.904	-72.564	-72.98	-74.004	-72.344	-72.388	-71.336	-71.908
15/12/2013	12:01:53 PM	-73.588	-73.36	-73.704	-73.188	-74.768	-71.776	-73.328	-72.792	-72.688
18/12/2013	12:01:57 PM	-69.576	-72.228	-73.308	-72.632	-73.964	-73.352	-73.264	-73.528	-72.78
20/12/2013	12:02:01 PM	-72.148	-71.924	-72.572	-73.604	-73.604	-71.268	-71.82	-73.068	-73.804
11/12/2013	12:02:15 PM	-73.704	-74.172	-73.912	-72.276	-74.348	-73.412	-72.296	-72.672	-73.1
12/12/2013	12:02:19 PM	-72.176	-72.368	-72.532	-72.412	-74.86	-72.644	-71.604	-72.696	-72.82
16/12/2013	12:02:23 PM	-72.332	-74.8	-71.756	-72.368	-73.28	-72.964	-71.54	-73.728	-72.744
18/12/2013	12:02:27 PM	-72.5	-73.252	-70.364	-73.852	-72.472	-73.824	-71.82	-72.208	-73.468
21/12/2013	12:02:31 PM	-71.872	-71.308	-73.636	-71.732	-73.864	-72.972	-72.516	-72.148	-72.18
11/12/2013	12:02:45 PM	-73.148	-73.268	-72.536	-71.936	-73.052	-73.284	-73.82	-73.2	-72.196
14/12/2013	12:02:49 PM	-73.924	-71.984	-73.38	-72.784	-73.76	-73.392	-73.456	-73.588	-72.788
17/12/2013	12:02:53 PM	-73.392	-72.928	-71.944	-72.328	-73.024	-72.332	-74.66	-71.66	-72.204
19/12/2013	12:02:57 PM	-72.204	-72.88	-73.644	-72.224	-74	-74.932	-74.116	-72.476	-71.476
22/12/2013	12:03:01 PM	-72.632	-72.112	-72.76	-72.216	-72.568	-72.4	-71.796	-72.948	-70.996
10/12/2013	12:03:11 PM	-72.104	-74.576	-73.34	-73.444	-73.212	-72.968	-74.288	-71.852	-74.444
11/12/2013	12:03:15 PM	-71.336	-71.872	-71.06	-71.188	-71.448	-72.964	-72.712	-73.304	-72.776
15/12/2013	12:03:19 PM	-72.292	-72.684	-73.296	-73.772	-74.34	-73.196	-73.136	-72.62	-71.7
18/12/2013	12:03:23 PM	-73.784	-72.932	-71.848	-73.004	-73.052	-73.968	-72.756	-73.308	-72.316
20/12/2013	12:03:27 PM	-73.028	-73.464	-71.8	-72.184	-71.504	-73.664	-70.676	-73.144	-72.74
11/12/2013	12:03:41 PM	-72.868	-72.584	-73.244	-71.576	-73.48	-73.568	-73.972	-72.608	-73.936
12/12/2013	12:03:45 PM	-74.228	-72.46	-73.28	-73	-72.44	-72.856	-71.808	-74.128	-72.02
16/12/2013	12:03:49 PM	-73.052	-71.804	-71.784	-73.14	-72.972	-74.688	-72.184	-71.94	-73.62
18/12/2013	12:03:53 PM	-71.116	-72.696	-71.708	-72.124	-71.62	-73.136	-72.076	-72.576	-73.504
21/12/2013	12:03:57 PM	-71.732	-73.156	-72.352	-71.772	-73.036	-73.108	-73.292	-71.952	-72.896
11/12/2013	12:04:11 PM	-72.952	-73.212	-73.292	-72.148	-73.408	-72.512	-73.86	-71.912	-73.208
14/12/2013	12:04:15 PM	-72.68	-71.932	-73.072	-73.152	-74.216	-72.712	-73.076	-73.416	-72.228
17/12/2013	12:04:19 PM	-73.632	-72.548	-72.324	-71.556	-72.012	-73.34	-71.648	-72.5	-73.88
19/12/2013	12:04:23 PM	-70.996	-72.044	-73.048	-74.02	-73.288	-73.184	-72.044	-73.132	-71.216
22/12/2013	12:04:27 PM	-73	-72.064	-73.912	-73	-70.908	-72.992	-72.792	-73.004	-73.824
10/12/2013	12:04:37 PM	-73.528	-73.924	-72.524	-73.984	-73.968	-72.548	-73.008	-72.72	-73.452
11/12/2013	12:04:41 PM	-72.056	-73.4	-72.672	-71.876	-72.6	-73.128	-73.072	-71.532	-74.992
15/12/2013	12:04:45 PM	-73.208	-73.856	-73.58	-72.068	-72.432	-73.068	-73.596	-71.816	-72.976
18/12/2013	12:04:49 PM	-71.928	-72.472	-73.256	-74.22	-72.592	-72.72	-71.56	-73.292	-73.328
20/12/2013	12:04:53 PM	-74.956	-72.616	-71.796	-72.544	-73.336	-73.544	-72.072	-71.356	-73.356
11/12/2013	12:05:07 PM	-73.228	-73.472	-72.984	-71.436	-73.592	-74.196	-73.552	-72.3	-73.972
12/12/2013	12:05:11 PM	-74.468	-73.844	-72.988	-71.312	-73.208	-73.504	-73.764	-71.4	-72.924
16/12/2013	12:05:15 PM	-73.96	-73.456	-73.272	-73.38	-73.94	-74.216	-74.376	-73.216	-72.376
18/12/2013	12:05:19 PM	-71.86	-74.604	-72.844	-72.964	-72.316	-71.488	-71.512	-71.996	-73.28
21/12/2013	12:05:23 PM	-72.02	-72.26	-72.312	-71.92	-71.18	-72.832	-75.3	-71.376	-72.684
11/12/2013	12:05:37 PM	-71.072	-74.12	-71.528	-73.292	-73.352	-72.74	-73.096	-73.544	-73.812
14/12/2013	12:05:41 PM	-73.252	-73.204	-73.284	-72.516	-72.22	-71.772	-73.12	-74.172	-72.512
17/12/2013	12:05:45 PM	-73.94	-72.204	-72.632	-73.46	-72.448	-72.836	-72.708	-73.46	-73.896
19/12/2013	12:05:49 PM	-74.068	-73.708	-73.236	-74.244	-73.392	-71.472	-72.588	-71.964	-73.528
22/12/2013	12:05:53 PM	-75.56	-72.548	-72.208	-72.308	-72.032	-72.316	-71.952	-72.52	-72.516

APPENDEX .13

AlGhobrah - 6PM-12AM
Sample Radio Spectrum Traffic

		MHz								
Date	Time	355	360	365	370	375	380	385	390	395
		POWER IN dBm								
10/12/2013	6:00:05 PM	-71.024	-73.208	-73.656	-72.704	-73.964	-73.672	-73.476	-73.612	-73.056
11/12/2013	6:00:09 PM	-74.092	-73.944	-72.804	-72.236	-72.008	-72.26	-72.924	-72.168	-72.792
15/12/2013	6:00:13 PM	-74.072	-73.628	-74.86	-71.416	-72.872	-73.192	-73.584	-71.156	-71.9
18/12/2013	6:00:17 PM	-73.032	-70.804	-71.684	-71.044	-73.124	-74.028	-71.52	-71.328	-72.58
20/12/2013	6:00:21 PM	-73.004	-74.032	-73.252	-72.704	-72.54	-73.488	-72.688	-72.768	-73
11/12/2013	6:00:35 PM	-75.332	-73.4	-73.276	-72.748	-75.696	-73.128	-73.032	-73.124	-73.836
12/12/2013	6:00:39 PM	-73.892	-73.824	-73.236	-71.276	-72.872	-73.464	-72.808	-72.188	-71.816
16/12/2013	6:00:43 PM	-73.348	-73.516	-71.992	-72.536	-72.376	-73.896	-72.612	-71.528	-74.316
18/12/2013	6:00:47 PM	-72.48	-71.58	-72.24	-71.66	-73.576	-74.152	-73.092	-73.028	-71.776
21/12/2013	6:00:51 PM	-72.144	-72.38	-71.164	-72.376	-74.192	-72.368	-71.572	-73.892	-72.328
11/12/2013	6:01:05 PM	-73.412	-72.912	-72.776	-71.116	-71.284	-74.58	-73.196	-74.052	-74.152
14/12/2013	6:01:09 PM	-72.884	-72.652	-72.388	-70.396	-71.988	-73.116	-72.44	-73.904	-73.836
17/12/2013	6:01:13 PM	-72.068	-72.176	-73.248	-69.728	-73.948	-72.276	-70.892	-72.804	-73.816
19/12/2013	6:01:17 PM	-72.86	-73.148	-74.036	-71.444	-73.28	-72.604	-72.944	-72.844	-71.24
10/12/2013	6:01:31 PM	-73.612	-74.42	-73.692	-72.32	-73.66	-73.74	-73.944	-72.976	-72.812
11/12/2013	6:01:35 PM	-72.384	-72.904	-73.476	-71.888	-72.616	-74.792	-73.26	-72.98	-74.116
15/12/2013	6:01:39 PM	-73.072	-74.628	-72.572	-73.308	-71.9	-72.488	-72.896	-72.028	-73.132
18/12/2013	6:01:43 PM	-72.008	-72.8	-72.184	-72.26	-74.088	-72.196	-73.652	-73.196	-72.448
20/12/2013	6:01:47 PM	-72.332	-72.012	-71.756	-71.928	-73.748	-71.544	-72.072	-72.36	-72.3
11/12/2013	6:02:01 PM	-71.388	-73.656	-73.952	-72.232	-73.504	-74.192	-71.4	-71.996	-74.74
12/12/2013	6:02:05 PM	-72.884	-74.404	-72.08	-73.64	-73.26	-72.844	-73.784	-72.836	-72.616
16/12/2013	6:02:09 PM	-71.944	-72.22	-73.06	-73.344	-72.836	-74.5	-71.452	-71.096	-72.964
18/12/2013	6:02:13 PM	-72.56	-72.428	-70.328	-67.172	-74.076	-73.276	-71.348	-74.104	-72.2
21/12/2013	6:02:17 PM	-73.556	-72.896	-72.156	-72.072	-70.4	-71.136	-73.196	-73.852	-74.004
11/12/2013	6:02:31 PM	-73.14	-72.612	-71.928	-70.912	-72.956	-72.548	-73.236	-74.028	-72.46
14/12/2013	6:02:35 PM	-73.44	-72.404	-72.848	-71.828	-72.336	-72.356	-72.876	-73.528	-74.416
17/12/2013	6:02:39 PM	-72.944	-71.764	-72.324	-72.8	-73.22	-73.304	-73.008	-71.408	-73.324
19/12/2013	6:02:43 PM	-71.644	-71.492	-73.068	-72.748	-72.488	-71.54	-72.392	-72.276	-71.492
10/12/2013	6:02:57 PM	-72.008	-73.856	-73.336	-72.596	-72.92	-73.056	-74.088	-73.42	-73.104
11/12/2013	6:03:01 PM	-73.228	-73.62	-74.016	-71.676	-73.58	-74.584	-73.148	-73.02	-72.196
15/12/2013	6:03:05 PM	-71.116	-74.116	-69.252	-71.804	-72.836	-71.588	-72.468	-73.048	-72.7
18/12/2013	6:03:09 PM	-73.036	-72.884	-72.052	-73.528	-71.396	-72.616	-71.896	-73.288	-72.584
20/12/2013	6:03:13 PM	-71.808	-72.74	-73.252	-69.684	-74.056	-72.8	-71.604	-72.152	-72.572
11/12/2013	6:03:27 PM	-73.44	-72.66	-74.504	-71.504	-71.888	-72.028	-71.368	-74.1	-71.912
12/12/2013	6:03:31 PM	-72.24	-73.74	-73.756	-72.728	-71.496	-73.904	-71.792	-74.856	-72.992
16/12/2013	6:03:35 PM	-72.708	-71.872	-73.596	-69.472	-72.484	-71.8	-73.68	-72.696	-73.004
18/12/2013	6:03:39 PM	-72.72	-74.496	-72.204	-71.892	-73.176	-71.884	-71.524	-72.54	-73.964
21/12/2013	6:03:43 PM	-73.6	-73.332	-71.076	-70.148	-72.236	-73.732	-73.372	-71.804	-72.604
11/12/2013	6:03:57 PM	-71.676	-72.036	-71.856	-70.016	-73.444	-73.016	-71.248	-72.78	-74.252
14/12/2013	6:04:01 PM	-73.232	-73.632	-73.432	-71.408	-72.144	-72.712	-73.532	-73.612	-71.416
17/12/2013	6:04:05 PM	-73.6	-72.164	-73.216	-72.48	-71.98	-73.876	-72.228	-71.704	-73.456
19/12/2013	6:04:09 PM	-73.008	-72.94	-72.06	-72.604	-72.512	-72.076	-71.944	-72.664	-74.376
10/12/2013	6:04:23 PM	-74.824	-74.012	-72.68	-72.736	-72.748	-73.004	-75.3	-72.62	-73.736
11/12/2013	6:04:27 PM	-73.232	-73.688	-72.908	-71.868	-72.652	-72.38	-72.792	-73.048	-72.476
15/12/2013	6:04:31 PM	-71.972	-72.2	-71.932	-74.076	-72.96	-73.732	-72.3	-72.732	-71.82
18/12/2013	6:04:35 PM	-74.324	-73.116	-72.52	-71.664	-72.964	-72.02	-71.424	-72.212	-71.72
20/12/2013	6:04:39 PM	-71.572	-73.276	-73.776	-70.8	-71.92	-71.72	-71.032	-73.2	-74.012
11/12/2013	6:04:53 PM	-72.644	-74.048	-72.036	-72.936	-72.956	-73.484	-71.984	-72.484	-72.48
12/12/2013	6:04:57 PM	-73.628	-73	-73.508	-72.24	-72.004	-72.768	-72.456	-72.4	-73.136
16/12/2013	6:05:01 PM	-72.224	-71.776	-71.932	-71.468	-73.62	-72.248	-73.264	-72.732	-73.26
18/12/2013	6:05:05 PM	-73.64	-73.42	-72.784	-70.712	-72.848	-73.592	-72.78	-73.052	-71.472
21/12/2013	6:05:09 PM	-72.624	-72.544	-71.16	-71.636	-72.248	-72.796	-72.18	-73.228	-73.508
11/12/2013	6:05:23 PM	-72.488	-71.208	-72.18	-71.228	-73.188	-73.792	-73.348	-72.188	-73.388
14/12/2013	6:05:27 PM	-72.888	-72.94	-73.408	-70.38	-72.38	-72.804	-72.14	-71.808	-72.272
17/12/2013	6:05:31 PM	-73.504	-72.992	-74.412	-70.688	-73.14	-72.14	-71.884	-73.048	-72.104
19/12/2013	6:05:35 PM	-73.132	-72.228	-72.384	-72.808	-73.352	-74.044	-71.484	-72.58	-71.944
10/12/2013	6:05:49 PM	-72.5	-73.164	-73.944	-71.496	-73.244	-72.552	-71.896	-74.376	-74.176
11/12/2013	6:05:53 PM	-73.8	-73.904	-72.468	-73.212	-74.888	-72.924	-73.232	-71.764	-73.34
15/12/2013	6:05:57 PM	-71.82	-73.28	-72.032	-71.676	-72.584	-73.512	-73.2	-72.732	-73.224
18/12/2013	6:06:01 PM	-71.452	-73.944	-72.292	-73.676	-72.34	-74.02	-72.952	-71.036	-71.588
20/12/2013	6:06:05 PM	-74.016	-72.644	-72.164	-72.264	-71.66	-74.316	-73.872	-72.392	-72.064
11/12/2013	6:06:19 PM	-73.208	-74.3	-70.504	-72.636	-73.768	-71.996	-73.052	-73.1	-71.76
12/12/2013	6:06:23 PM	-71.176	-71.596	-73.312	-71.936	-73.708	-73.664	-75.272	-72.164	-73.084

APPENDEX .14

Alkhodh - 12AM-6AM
Sample Radio Spectrum Traffic

		MHz								
Date	Time	400	405	410	415	420	425	430	435	440
		POWER IN dBm								
8/3/2014	12:00:01 AM	-99.578	-103.737	-103.652	-99.069	-103.055	-102.917	-100.190	-106.298	-102.533
11/3/2014	12:00:05 AM	-97.654	-104.770	-104.675	-96.905	-103.719	-103.542	-98.903	-109.354	-102.962
03/14/2014	12:00:09 AM	-95.730	-105.804	-105.698	-94.740	-104.382	-104.168	-97.617	-112.410	-103.391
03/17/2014	12:00:13 AM	-93.806	-106.838	-106.721	-92.576	-105.046	-104.793	-96.330	-115.465	-103.820
3/3/2014	12:00:23 AM	-102.660	-101.908	-102.676	-102.360	-102.052	-102.156	-103.076	-101.896	-101.544
6/3/2014	12:00:27 AM	-100.861	-103.048	-102.970	-100.512	-102.613	-102.500	-101.048	-104.261	-102.247
9/3/2014	12:00:31 AM	-98.937	-104.081	-103.993	-98.347	-103.276	-103.125	-99.761	-107.317	-102.676
12/3/2014	12:00:35 AM	-97.013	-105.115	-105.016	-96.183	-103.940	-103.751	-98.474	-110.373	-103.105
03/15/2014	12:00:39 AM	-95.089	-106.149	-106.039	-94.018	-104.604	-104.376	-97.187	-113.429	-103.534
4/3/2014	12:00:53 AM	-103.460	-100.172	-101.260	-101.524	-100.740	-102.428	-102.672	-102.168	-101.964
7/3/2014	12:00:57 AM	-100.219	-103.392	-103.311	-99.790	-102.834	-102.708	-100.619	-105.280	-102.390
10/3/2014	12:01:01 AM	-98.295	-104.426	-104.334	-97.626	-103.498	-103.334	-99.332	-108.336	-102.819
03/13/2014	12:01:05 AM	-96.371	-105.460	-105.357	-95.461	-104.161	-103.959	-98.045	-111.392	-103.248
03/16/2014	12:01:09 AM	-94.447	-106.493	-106.380	-93.297	-104.825	-104.585	-96.758	-114.448	-103.677
5/3/2014	12:01:23 AM	-101.836	-102.172	-102.072	-102.440	-102.448	-102.320	-102.300	-102.004	-102.472
8/3/2014	12:01:27 AM	-99.578	-103.737	-103.652	-99.068	-103.055	-102.917	-100.190	-106.299	-102.533
11/3/2014	12:01:31 AM	-97.654	-104.771	-104.675	-96.904	-103.719	-103.542	-98.903	-109.355	-102.962
03/14/2014	12:01:35 AM	-95.730	-105.804	-105.698	-94.739	-104.383	-104.168	-97.616	-112.411	-103.391
03/17/2014	12:01:39 AM	-93.805	-106.838	-106.722	-92.575	-105.046	-104.793	-96.329	-115.466	-103.820
3/3/2014	12:01:49 AM	-101.928	-101.396	-102.496	-102.392	-102.832	-102.468	-101.888	-102.152	-101.112
6/3/2014	12:01:53 AM	-100.860	-103.048	-102.970	-100.511	-102.613	-102.500	-101.048	-104.262	-102.247
9/3/2014	12:01:57 AM	-98.936	-104.082	-103.993	-98.347	-103.277	-103.126	-99.761	-107.318	-102.676
12/3/2014	12:02:01 AM	-97.012	-105.115	-105.016	-96.182	-103.940	-103.751	-98.474	-110.374	-103.105
03/15/2014	12:02:05 AM	-95.088	-106.149	-106.040	-94.018	-104.604	-104.376	-97.187	-113.430	-103.534
4/3/2014	12:02:19 AM	-102.272	-101.348	-101.620	-102.816	-101.564	-102.044	-101.312	-101.972	-101.684
7/3/2014	12:02:23 AM	-100.218	-103.393	-103.311	-99.789	-102.834	-102.709	-100.618	-105.281	-102.390
10/3/2014	12:02:27 AM	-98.294	-104.426	-104.334	-97.625	-103.498	-103.334	-99.332	-108.337	-102.819
03/13/2014	12:02:31 AM	-96.370	-105.460	-105.358	-95.460	-104.162	-103.959	-98.045	-111.393	-103.248
03/16/2014	12:02:35 AM	-94.446	-106.494	-106.381	-93.296	-104.825	-104.585	-96.758	-114.449	-103.677
5/3/2014	12:02:49 AM	-102.436	-100.980	-102.804	-101.208	-101.428	-102.484	-100.708	-102.452	-101.396
8/3/2014	12:02:53 AM	-99.577	-103.737	-103.653	-99.068	-103.055	-102.917	-100.189	-106.300	-102.533
11/3/2014	12:02:57 AM	-97.653	-104.771	-104.676	-96.903	-103.719	-103.543	-98.903	-109.356	-102.962
03/14/2014	12:03:01 AM	-95.729	-105.805	-105.699	-94.739	-104.383	-104.168	-97.616	-112.412	-103.391
03/17/2014	12:03:05 AM	-93.805	-106.838	-106.722	-92.574	-105.047	-104.793	-96.329	-115.468	-103.820
3/3/2014	12:03:15 AM	-103.432	-101.936	-102.312	-100.808	-102.672	-101.876	-102.092	-102.584	-102.728
6/3/2014	12:03:19 AM	-100.859	-103.048	-102.971	-100.510	-102.613	-102.500	-101.047	-104.263	-102.247
9/3/2014	12:03:23 AM	-98.935	-104.082	-103.994	-98.346	-103.277	-103.126	-99.760	-107.319	-102.676
12/3/2014	12:03:27 AM	-97.011	-105.116	-105.017	-96.181	-103.940	-103.751	-98.473	-110.375	-103.105
03/15/2014	12:03:31 AM	-95.087	-106.149	-106.040	-94.017	-104.604	-104.376	-97.187	-113.431	-103.534
4/3/2014	12:03:45 AM	-101.764	-102.480	-102.168	-102.136	-102.516	-102.152	-102.612	-99.864	-101.208
7/3/2014	12:03:49 AM	-100.218	-103.393	-103.312	-99.789	-102.834	-102.709	-100.618	-105.282	-102.390
10/3/2014	12:03:53 AM	-98.294	-104.427	-104.335	-97.624	-103.498	-103.334	-99.331	-108.338	-102.819
03/13/2014	12:03:57 AM	-96.370	-105.460	-105.358	-95.460	-104.162	-103.960	-98.044	-111.394	-103.248
03/16/2014	12:04:01 AM	-94.446	-106.494	-106.381	-93.295	-104.825	-104.585	-96.758	-114.450	-103.677
5/3/2014	12:04:15 AM	-103.248	-102.812	-103.208	-101.020	-103.064	-102.912	-102.632	-102.848	-101.800
8/3/2014	12:04:19 AM	-99.576	-103.738	-103.653	-99.067	-103.056	-102.917	-100.189	-106.301	-102.533
11/3/2014	12:04:23 AM	-97.652	-104.771	-104.676	-96.902	-103.719	-103.543	-98.902	-109.357	-102.962
03/14/2014	12:04:27 AM	-95.728	-105.805	-105.699	-94.738	-104.383	-104.168	-97.615	-112.413	-103.391
03/17/2014	12:04:31 AM	-93.804	-106.839	-106.722	-92.573	-105.047	-104.794	-96.328	-115.469	-103.820
3/3/2014	12:04:41 AM	-104.116	-102.652	-101.976	-103.180	-102.188	-101.912	-99.784	-102.888	-102.872
6/3/2014	12:04:45 AM	-100.859	-103.049	-102.971	-100.510	-102.613	-102.501	-101.047	-104.264	-102.247
9/3/2014	12:04:49 AM	-98.935	-104.082	-103.994	-98.345	-103.277	-103.126	-99.760	-107.320	-102.676
12/3/2014	12:04:53 AM	-97.011	-105.116	-105.017	-96.181	-103.941	-103.751	-98.473	-110.376	-103.105
03/15/2014	12:04:57 AM	-95.087	-106.150	-106.040	-94.016	-104.604	-104.377	-97.186	-113.432	-103.534
4/3/2014	12:05:11 AM	-101.808	-102.568	-102.652	-101.596	-102.108	-102.056	-102.480	-101.756	-102.820
7/3/2014	12:05:15 AM	-100.217	-103.393	-103.312	-99.788	-102.835	-102.709	-100.618	-105.283	-102.390
10/3/2014	12:05:19 AM	-98.293	-104.427	-104.335	-97.623	-103.498	-103.334	-99.331	-108.339	-102.819
03/13/2014	12:05:23 AM	-96.369	-105.461	-105.358	-95.459	-104.162	-103.960	-98.044	-111.395	-103.248
03/16/2014	12:05:27 AM	-94.445	-106.494	-106.381	-93.294	-104.826	-104.585	-96.757	-114.451	-103.677
5/3/2014	12:05:41 AM	-102.116	-102.044	-102.020	-102.824	-103.180	-102.712	-102.704	-101.612	-102.732
8/3/2014	12:05:45 AM	-99.576	-103.738	-103.653	-99.066	-103.056	-102.918	-100.189	-106.302	-102.533
11/3/2014	12:05:49 AM	-97.652	-104.772	-104.676	-96.902	-103.720	-103.543	-98.902	-109.358	-102.962
03/14/2014	12:05:53 AM	-95.728	-105.805	-105.699	-94.737	-104.383	-104.168	-97.615	-112.414	-103.391

APPENDEX .15

AlKhodh - 6AM-12PM
Sample Radio Spectrum Traffic

		MHz								
Date	Time	445	450	455	460	465	470	475	480	485
		POWER IN dBm								
3/3/2014	06:00:09 AM	-102.768	-101.352	-101.412	-100.244	-101.636	-101.372	-102.480	-101.644	-99.628
6/3/2014	06:00:13 AM	-100.042	-102.297	-101.653	-100.866	-103.928	-100.242	-102.223	-105.197	-101.832
9/3/2014	06:00:17 AM	-97.850	-102.857	-101.448	-99.732	-106.544	-98.436	-102.783	-109.353	-101.999
12/3/2014	06:00:21 AM	-95.658	-103.416	-101.244	-98.598	-109.159	-96.630	-103.344	-113.509	-102.166
03/15/2014	06:00:25 AM	-93.466	-103.975	-101.039	-97.464	-111.775	-94.824	-103.904	-117.665	-102.332
4/3/2014	06:00:39 AM	-101.744	-101.888	-100.052	-102.236	-101.952	-102.064	-101.932	-102.452	-101.408
7/3/2014	06:00:43 AM	-99.311	-102.484	-101.585	-100.488	-104.800	-99.639	-102.410	-106.583	-101.888
10/3/2014	06:00:47 AM	-97.119	-103.043	-101.380	-99.354	-107.416	-97.833	-102.970	-110.739	-102.055
03/13/2014	06:00:51 AM	-94.927	-103.602	-101.176	-98.220	-110.032	-96.028	-103.531	-114.895	-102.221
03/16/2014	06:00:55 AM	-92.735	-104.161	-100.971	-97.086	-112.647	-94.222	-104.091	-119.050	-102.388
5/3/2014	06:01:09 AM	-101.876	-102.328	-100.540	-101.120	-102.056	-102.196	-100.724	-102.052	-100.780
8/3/2014	06:01:13 AM	-98.580	-102.670	-101.516	-100.110	-105.672	-99.037	-102.596	-107.969	-101.943
11/3/2014	06:01:17 AM	-96.388	-103.229	-101.312	-98.976	-108.288	-97.231	-103.157	-112.125	-102.110
03/14/2014	06:01:21 AM	-94.196	-103.789	-101.108	-97.842	-110.904	-95.425	-103.718	-116.280	-102.277
03/17/2014	06:01:25 AM	-92.004	-104.348	-100.903	-96.708	-113.519	-93.620	-104.278	-120.436	-102.443
3/3/2014	06:01:35 AM	-101.120	-101.556	-101.656	-101.968	-102.364	-101.772	-101.728	-102.200	-100.564
6/3/2014	06:01:39 AM	-100.041	-102.298	-101.653	-100.865	-103.929	-100.241	-102.223	-105.199	-101.832
9/3/2014	06:01:43 AM	-97.849	-102.857	-101.448	-99.731	-106.544	-98.435	-102.783	-109.355	-101.999
12/3/2014	06:01:47 AM	-95.657	-103.416	-101.244	-98.598	-109.160	-96.629	-103.344	-113.510	-102.166
03/15/2014	06:01:51 AM	-93.465	-103.975	-101.039	-97.464	-111.776	-94.823	-103.905	-117.666	-102.332
4/3/2014	06:02:05 AM	-102.848	-101.764	-101.296	-102.876	-102.004	-102.276	-102.152	-102.104	-100.916
7/3/2014	06:02:09 AM	-99.310	-102.484	-101.585	-100.487	-104.801	-99.639	-102.410	-106.585	-101.888
10/3/2014	06:02:13 AM	-97.118	-103.043	-101.380	-99.353	-107.417	-97.833	-102.970	-110.740	-102.055
03/13/2014	06:02:17 AM	-94.926	-103.602	-101.176	-98.220	-110.032	-96.027	-103.531	-114.896	-102.221
03/16/2014	06:02:21 AM	-92.734	-104.161	-100.971	-97.086	-112.648	-94.221	-104.092	-119.052	-102.388
5/3/2014	06:02:35 AM	-102.152	-101.512	-102.128	-100.408	-100.068	-101.380	-101.808	-101.440	-99.688
8/3/2014	06:02:39 AM	-98.579	-102.671	-101.516	-100.109	-105.673	-99.037	-102.597	-107.970	-101.944
11/3/2014	06:02:43 AM	-96.387	-103.230	-101.312	-98.975	-108.289	-97.231	-103.157	-112.126	-102.110
03/14/2014	06:02:47 AM	-94.195	-103.789	-101.108	-97.842	-110.905	-95.425	-103.718	-116.282	-102.277
03/17/2014	06:02:51 AM	-92.003	-104.348	-100.903	-96.708	-113.520	-93.619	-104.278	-120.437	-102.443
3/3/2014	06:03:01 AM	-102.420	-101.576	-101.152	-102.820	-102.472	-102.044	-102.348	-101.728	-101.468
6/3/2014	06:03:05 AM	-100.040	-102.298	-101.653	-100.865	-103.930	-100.240	-102.223	-105.200	-101.832
9/3/2014	06:03:09 AM	-97.848	-102.857	-101.448	-99.731	-106.545	-98.434	-102.784	-109.356	-101.999
12/3/2014	06:03:13 AM	-95.656	-103.416	-101.244	-98.597	-109.161	-96.629	-103.344	-113.512	-102.166
03/15/2014	06:03:17 AM	-93.464	-103.975	-101.039	-97.464	-111.777	-94.823	-103.905	-117.667	-102.332
4/3/2014	06:03:31 AM	-100.484	-101.340	-102.624	-102.124	-101.928	-102.636	-100.488	-102.548	-101.332
7/3/2014	06:03:35 AM	-99.309	-102.484	-101.585	-100.487	-104.802	-99.638	-102.410	-106.586	-101.888
10/3/2014	06:03:39 AM	-97.117	-103.043	-101.380	-99.353	-107.418	-97.832	-102.971	-110.742	-102.055
03/13/2014	06:03:43 AM	-94.925	-103.602	-101.176	-98.219	-110.033	-96.026	-103.531	-114.897	-102.221
03/16/2014	06:03:47 AM	-92.733	-104.162	-100.971	-97.085	-112.649	-94.221	-104.092	-119.053	-102.388
5/3/2014	06:04:01 AM	-101.016	-102.320	-101.812	-102.028	-100.736	-102.312	-101.284	-101.784	-102.380
8/3/2014	06:04:05 AM	-98.579	-102.671	-101.516	-100.109	-105.674	-99.036	-102.597	-107.972	-101.944
11/3/2014	06:04:09 AM	-96.387	-103.230	-101.312	-98.975	-108.290	-97.230	-103.157	-112.127	-102.110
03/14/2014	06:04:13 AM	-94.195	-103.789	-101.107	-97.841	-110.905	-95.424	-103.718	-116.283	-102.277
03/17/2014	06:04:17 AM	-92.003	-104.348	-100.903	-96.707	-113.521	-93.618	-104.279	-120.439	-102.444
3/3/2014	06:04:27 AM	-101.332	-101.332	-102.032	-101.052	-102.436	-101.936	-103.284	-102.444	-101.592
6/3/2014	06:04:31 AM	-100.040	-102.298	-101.653	-100.865	-103.930	-100.240	-102.223	-105.202	-101.832
9/3/2014	06:04:35 AM	-97.848	-102.857	-101.448	-99.731	-106.546	-98.434	-102.784	-109.357	-101.999
12/3/2014	06:04:39 AM	-95.656	-103.416	-101.244	-98.597	-109.162	-96.628	-103.344	-113.513	-102.166
03/15/2014	06:04:43 AM	-93.464	-103.975	-101.039	-97.463	-111.778	-94.822	-103.905	-117.669	-102.332
4/3/2014	06:04:57 AM	-102.444	-101.304	-100.304	-101.952	-101.276	-101.152	-101.624	-102.228	-100.832
7/3/2014	06:05:01 AM	-99.309	-102.484	-101.584	-100.486	-104.803	-99.638	-102.410	-106.587	-101.888
10/3/2014	06:05:05 AM	-97.117	-103.044	-101.380	-99.353	-107.418	-97.832	-102.971	-110.743	-102.055
03/13/2014	06:05:09 AM	-94.925	-103.603	-101.176	-98.219	-110.034	-96.026	-103.531	-114.899	-102.221
03/16/2014	06:05:13 AM	-92.733	-104.162	-100.971	-97.085	-112.650	-94.220	-104.092	-119.054	-102.388
5/3/2014	06:05:27 AM	-101.744	-102.760	-102.328	-102.008	-102.444	-102.572	-102.240	-101.440	-101.996
8/3/2014	06:05:31 AM	-98.578	-102.671	-101.516	-100.108	-105.675	-99.035	-102.597	-107.973	-101.944
11/3/2014	06:05:35 AM	-96.386	-103.230	-101.312	-98.975	-108.291	-97.230	-103.158	-112.129	-102.110
03/14/2014	06:05:39 AM	-94.194	-103.789	-101.107	-97.841	-110.906	-95.424	-103.718	-116.284	-102.277
03/17/2014	06:05:43 AM	-92.002	-104.348	-100.903	-96.707	-113.522	-93.618	-104.279	-120.440	-102.444
3/3/2014	06:05:53 AM	-101.844	-102.124	-100.844	-102.356	-102.520	-102.844	-102.360	-102.704	-100.612
6/3/2014	06:05:57 AM	-100.039	-102.298	-101.653	-100.864	-103.931	-100.239	-102.223	-105.203	-101.833
9/3/2014	06:06:01 AM	-97.847	-102.857	-101.448	-99.730	-106.547	-98.433	-102.784	-109.359	-101.999

APPENDEX .16

Ruwi - 12AM-6AM
Sample Radio Spectrum Traffic

		MHz								
Date	Time	40	45	50	55	60	65	70	75	80
		POWER IN dBm								
12/24/2013	12:00:43 AM	-72.868	-70.676	-70.124	-72.92	-68.052	-70.208	-69.292	-71.676	-37.844
12/24/2013	12:02:09 AM	-72.868	-66.816	-74.712	-71.504	-71.104	-72.12	-71.12	-67.668	-37.948
12/24/2013	12:03:35 AM	-72.868	-72.792	-70.352	-69.38	-72.608	-71.372	-72.08	-70.9	-38.344
12/24/2013	12:05:01 AM	-72.868	-71.128	-71.216	-71.488	-72.808	-70.136	-71.964	-71.3	-37.96
12/24/2013	12:06:27 AM	-72.868	-67.76	-70.788	-69.704	-70.524	-69.42	-68.896	-67.104	-37.988
12/24/2013	12:07:53 AM	-72.868	-69.916	-70.992	-70.884	-71.82	-71.84	-72.156	-71.612	-38.008
12/24/2013	12:09:19 AM	-72.868	-73.516	-72.232	-70.692	-70.244	-70.792	-72.028	-70.884	-38.068
12/24/2013	12:10:45 AM	-72.868	-69.68	-70.924	-71.952	-69.356	-69.316	-70.58	-69.864	-37.996
12/24/2013	12:12:11 AM	-72.868	-74.148	-71.536	-71.424	-69.1	-71.96	-71.088	-71.112	-38.18
12/24/2013	12:13:37 AM	-72.868	-73.852	-72.28	-69.416	-70.352	-71.752	-72.972	-71.124	-38.004
12/24/2013	12:15:03 AM	-72.868	-72.26	-71.608	-69.656	-70.64	-70.476	-71.932	-71.2	-37.94
12/24/2013	12:16:29 AM	-72.868	-72.8	-71.504	-72.868	-71.028	-71.616	-70.428	-71.492	-37.984
12/24/2013	12:17:55 AM	-72.868	-71.624	-70.404	-69.536	-70.668	-70.296	-70.376	-70.748	-38.636
12/24/2013	12:19:21 AM	-72.868	-69.408	-71.42	-70.6	-69.896	-70.916	-69.592	-70.784	-38.312
12/24/2013	12:20:47 AM	-72.868	-71.272	-72.752	-71.648	-74.492	-72.272	-69.668	-71.388	-38.244
12/24/2013	12:22:13 AM	-72.868	-72.156	-71.464	-71.048	-70.568	-70.416	-71.504	-71.168	-38.244
12/24/2013	12:23:39 AM	-72.868	-70.944	-69.816	-70.096	-71.664	-70.3	-71.412	-70.252	-38.04
12/24/2013	12:25:05 AM	-72.868	-70.18	-70.872	-69.2	-71.256	-73.74	-73.592	-70.168	-37.772
12/24/2013	12:26:31 AM	-72.868	-69.66	-72.464	-68.892	-70.556	-72.584	-69.316	-68.32	-38.272
12/24/2013	12:27:57 AM	-72.868	-72.836	-71.932	-72.54	-70.876	-69.372	-70.632	-69.976	-38.176
12/24/2013	12:29:23 AM	-72.868	-69.532	-68.28	-70.244	-69.296	-71.208	-70.744	-68.744	-37.736
12/24/2013	12:30:49 AM	-72.868	-71.62	-70.82	-72.024	-68.952	-71.384	-69.8	-69.928	-37.732
12/24/2013	12:32:15 AM	-72.868	-70.152	-69.268	-71.724	-73.3	-71.28	-70.112	-71.036	-37.908
12/24/2013	12:33:41 AM	-72.868	-70.152	-69.444	-70.944	-72.316	-72.952	-71.224	-69.928	-37.66
12/24/2013	12:35:07 AM	-72.868	-72.1	-68.824	-72.756	-72.228	-68.88	-70.388	-70.532	-38.296
12/24/2013	12:36:33 AM	-72.868	-71.368	-69.924	-69.312	-71.116	-70.948	-70.572	-71.088	-37.988
12/24/2013	12:37:59 AM	-72.868	-70.556	-69.796	-69.756	-71.236	-71.164	-69.04	-67.364	-38.04
12/24/2013	12:39:25 AM	-72.868	-69.38	-69.012	-70.764	-72.788	-73.472	-67.588	-70.272	-38.124
12/24/2013	12:40:51 AM	-72.868	-70.72	-69.9	-72.368	-68.4	-69.868	-72.816	-69.656	-37.836
12/24/2013	12:42:17 AM	-72.868	-73.476	-70.032	-72.044	-69.364	-71.116	-70.504	-73.008	-37.956
12/24/2013	12:43:43 AM	-72.868	-69.088	-71.72	-70.692	-66.7	-71.616	-71.636	-68.456	-37.976
12/24/2013	12:45:09 AM	-72.868	-72.94	-73.296	-71.992	-69.928	-69.648	-71.704	-68.296	-38.14
12/24/2013	12:46:35 AM	-72.868	-71.268	-70.888	-69.856	-72.184	-70.816	-68.344	-70.448	-38.392
12/24/2013	12:48:01 AM	-72.868	-70.184	-71.404	-72.016	-68.884	-71.596	-72.288	-68.76	-37.848
12/24/2013	12:49:27 AM	-72.868	-71.804	-70.112	-71.496	-70.304	-69.708	-70.936	-70.572	-37.98
12/24/2013	12:50:53 AM	-72.868	-69.524	-71.02	-69.144	-71.564	-72.9	-71.464	-72.144	-37.744
12/24/2013	12:52:19 AM	-72.868	-72.68	-71.628	-72.4	-71.06	-70.62	-70.084	-70.524	-37.916
12/24/2013	12:53:45 AM	-72.868	-69.464	-70.96	-70.828	-70.432	-70.912	-69.584	-68.26	-38.252
12/24/2013	12:55:11 AM	-72.868	-72.064	-69.496	-74.612	-70.784	-70.616	-71.908	-69.936	-37.792
12/24/2013	12:56:37 AM	-72.868	-68.328	-72.548	-71.728	-69.732	-73.016	-73.108	-68.424	-37.864
12/24/2013	12:58:03 AM	-72.868	-72.088	-70.748	-70.616	-70.584	-70.296	-71.392	-67.512	-38.472
12/24/2013	12:59:29 AM	-72.868	-69.9	-72.348	-68.988	-72.432	-71.42	-69.408	-68.876	-38.092
12/24/2013	1:00:55 AM	-72.868	-72.652	-69.904	-71.856	-71.412	-70.352	-70.66	-71.952	-38.276
12/24/2013	1:02:21 AM	-72.868	-69.788	-70.452	-70.768	-70.896	-71.316	-71.476	-68.952	-37.956
12/24/2013	1:03:47 AM	-72.868	-71.412	-70.828	-71.004	-71.168	-68.94	-69.396	-68.792	-37.864
12/24/2013	1:05:13 AM	-72.868	-72.548	-74.56	-71.1	-71.888	-68.824	-70.496	-71.736	-37.804
12/24/2013	1:06:39 AM	-72.868	-70.74	-68.124	-68.824	-70.54	-71.08	-71.588	-71.208	-37.944
12/24/2013	1:08:05 AM	-72.868	-71.128	-71.38	-71.776	-68.848	-72.388	-73.008	-72.924	-38.612
12/24/2013	1:09:31 AM	-72.868	-71.372	-71.548	-68.424	-70.464	-72.756	-68.584	-69.124	-38.216
12/24/2013	1:10:57 AM	-72.868	-69.772	-71.428	-72.064	-70.396	-70.496	-72.208	-70.836	-37.748
12/24/2013	1:12:23 AM	-72.868	-69.58	-69.26	-71.412	-72.184	-69.864	-69.456	-71.936	-37.792
12/24/2013	1:13:49 AM	-72.868	-70.964	-73.568	-72.008	-71.492	-70.436	-71.024	-70.376	-37.796
12/24/2013	1:15:15 AM	-72.868	-69.328	-70.5	-73.028	-72.428	-72.312	-71.728	-69.304	-38.416
12/24/2013	1:16:41 AM	-72.868	-71.172	-70.08	-69.416	-69.692	-72.532	-69.4	-72.176	-38.488
12/24/2013	1:18:07 AM	-72.868	-72.564	-70.144	-69.928	-70.748	-71.624	-69.864	-70.708	-38.416
12/24/2013	1:19:33 AM	-72.868	-69.096	-72.452	-70.708	-71.012	-73.648	-72.46	-70.14	-38.232
12/24/2013	1:20:59 AM	-72.868	-69.688	-69.788	-70.488	-71.604	-71.364	-72.288	-69.076	-38.028
12/24/2013	1:22:25 AM	-72.868	-70.468	-72.256	-72.304	-73.784	-70.34	-69.668	-69.708	-37.888
12/24/2013	1:23:51 AM	-72.868	-70.228	-71.356	-72.528	-72.26	-72.116	-71.372	-72.048	-38.14
12/24/2013	1:25:17 AM	-72.868	-68.416	-68.9	-73.068	-70.74	-70.176	-71.172	-71.576	-38.392
12/24/2013	1:26:43 AM	-72.868	-71.548	-70.428	-70.468	-72.692	-68.324	-70.884	-69.036	-38.072
12/24/2013	1:28:09 AM	-72.868	-70.356	-68.416	-69.944	-71.588	-72.148	-69.78	-70.596	-37.936
12/24/2013	1:29:35 AM	-72.868	-70.1	-71.396	-68.212	-71.908	-69.58	-70.74	-71.36	-37.872

APPENDEX .17

Ruwi - 6AM-12PM
Sample Radio Spectrum Traffic

Date	Time	85	90	95	100	105	110	115	120	125
		POWER IN dBm								
12/24/2013	6:01:55 AM	-16.468	-8.696	-9.876	-10.588	-11.892	-59.056	-69.224	-72.012	-72.54
12/24/2013	6:03:21 AM	-14.772	-12.44	-10.748	-10.596	-12.348	-59.128	-70.668	-70.888	-70.92
12/24/2013	6:04:47 AM	-15.692	-10.332	-10.104	-11.424	-12.876	-58.356	-69.652	-70.532	-71.544
12/24/2013	6:06:13 AM	-16.508	-11.136	-9.724	-11.028	-13.196	-58.888	-68.556	-69.712	-72.932
12/24/2013	6:07:39 AM	-13.412	-13.208	-12.232	-11.848	-13.092	-59.288	-69.624	-69.264	-68.92
12/24/2013	6:09:05 AM	-16.044	-13.928	-10.856	-11.848	-13.64	-59.496	-69.26	-73.404	-72.008
12/24/2013	6:10:31 AM	-15.736	-10.092	-9.96	-10.968	-14.02	-59.516	-64.768	-69.384	-71.544
12/24/2013	6:11:57 AM	-14.28	-12.372	-11.596	-10.616	-12.316	-58.608	-66.456	-70.676	-70.572
12/24/2013	6:13:23 AM	-14.172	-12.484	-9.692	-11.252	-11.144	-58.624	-67.028	-71.292	-73.124
12/24/2013	6:14:49 AM	-14.844	-10.732	-11.344	-11.412	-12.212	-58.94	-67.008	-70.56	-71.876
12/24/2013	6:16:15 AM	-15.604	-9.22	-9.092	-10.772	-13.544	-59.572	-66.02	-69.904	-72.564
12/24/2013	6:17:41 AM	-15.976	-10.644	-10.532	-11.316	-12.464	-58.76	-68.992	-70.14	-72.432
12/24/2013	6:19:07 AM	-15.904	-10.076	-12.68	-11.192	-10.46	-58.136	-68.176	-70.86	-71.056
12/24/2013	6:20:33 AM	-15.844	-10.136	-8.784	-12	-13.752	-57.732	-68.748	-72.704	-68.92
12/24/2013	6:21:59 AM	-16.724	-9.116	-10.476	-10.52	-11.832	-58.748	-69.664	-73.616	-71.464
12/24/2013	6:23:25 AM	-17.108	-12.544	-11.74	-10.924	-12.728	-59.544	-72.064	-69.768	-71.212
12/24/2013	6:24:51 AM	-16.324	-10.064	-10.284	-12.4	-11.984	-58.912	-69.216	-69.524	-70.58
12/24/2013	6:26:17 AM	-14.332	-11.596	-10.636	-10.912	-11.444	-57.596	-68.28	-69.276	-71.788
12/24/2013	6:27:43 AM	-16.956	-10.596	-11.252	-10.808	-12.104	-59.228	-67.908	-71.036	-70.952
12/24/2013	6:29:09 AM	-16.268	-9.768	-10.732	-11.948	-13.388	-57.616	-67.66	-69.94	-71.732
12/24/2013	6:30:35 AM	-14.08	-13.04	-10.84	-10.256	-11.12	-59.2	-69.548	-69.412	-69
12/24/2013	6:32:01 AM	-15.32	-12.16	-12.46	-10.644	-11.66	-60.896	-67.828	-72.916	-70.04
12/24/2013	6:33:27 AM	-16.244	-12.304	-11.428	-10.152	-13.364	-57.556	-68.204	-69.984	-70.448
12/24/2013	6:34:53 AM	-15.296	-8.736	-10.436	-11.216	-11.228	-60.084	-67.324	-69.48	-70.52
12/24/2013	6:36:19 AM	-15	-9.244	-9.548	-11.104	-10.92	-59.636	-72	-68.12	-70.172
12/24/2013	6:37:45 AM	-16.6	-8.368	-9.46	-10.784	-11.316	-57.176	-69.192	-71.548	-70.2
12/24/2013	6:39:11 AM	-14.376	-9.84	-11.656	-10.876	-12.624	-58.356	-69.88	-72.232	-72.548
12/24/2013	6:40:37 AM	-14.24	-12.38	-12.016	-12.304	-11.524	-58.356	-69.856	-70.492	-73.612
12/24/2013	6:42:03 AM	-16.276	-12.8	-8.828	-11.656	-12.792	-59.68	-70.408	-70.52	-72.652
12/24/2013	6:43:29 AM	-15.82	-11.928	-12.516	-10.516	-10.188	-58.592	-68.348	-72.292	-73.392
12/24/2013	6:44:55 AM	-15.164	-14.644	-12.172	-10.28	-10.724	-58.808	-70.952	-71.516	-71.98
12/24/2013	6:46:21 AM	-15.788	-13.34	-11.58	-10.448	-13.864	-60.168	-68.884	-69.96	-69.216
12/24/2013	6:47:47 AM	-16.664	-10.516	-9.844	-12.464	-12.32	-59.388	-69.592	-73.908	-69.452
12/24/2013	6:49:13 AM	-16.052	-13.432	-8.5	-10.58	-10.84	-59.532	-67.952	-71.344	-71.992
12/24/2013	6:50:39 AM	-15.428	-11.548	-10.592	-11.848	-12.504	-58.62	-68.532	-70.044	-71.736
12/24/2013	6:52:05 AM	-16.564	-10.204	-11.112	-10.476	-10.724	-58.816	-69.064	-70.72	-70.896
12/24/2013	6:53:31 AM	-15.292	-12.024	-11.696	-10.276	-10.892	-59.396	-67.968	-69.48	-69.62
12/24/2013	6:54:57 AM	-17.62	-12.98	-8.696	-9.916	-10.536	-59.392	-68.02	-71.408	-72.356
12/24/2013	6:56:23 AM	-15.932	-11.152	-9.404	-10.508	-11.896	-58.828	-68.044	-70.54	-74.172
12/24/2013	6:57:49 AM	-16.488	-10.14	-11.692	-9.62	-11.36	-58.572	-67.572	-69.884	-68.092
12/24/2013	6:59:15 AM	-16.94	-13.48	-8.972	-11.012	-13.58	-58.156	-67.6	-70.72	-73.064
12/24/2013	7:00:41 AM	-14.316	-10.844	-10.508	-9.98	-12.74	-58.752	-70.224	-70.56	-71.244
12/24/2013	7:02:07 AM	-14.152	-11.5	-11.424	-12.336	-12.5	-59.22	-67.964	-70.916	-72.736
12/24/2013	7:03:33 AM	-17.128	-12.996	-11.388	-10.924	-10.784	-59.424	-66.144	-71.788	-71.632
12/24/2013	7:04:59 AM	-16.492	-12.868	-9.876	-10.732	-11.22	-58.624	-74.084	-71.844	-73.62
12/24/2013	7:06:25 AM	-15.66	-12.736	-11.76	-12.036	-14.152	-59.108	-67.76	-70.02	-69.132
12/24/2013	7:07:51 AM	-17.084	-11.616	-9.796	-12.84	-12.708	-59.904	-68.508	-71.708	-72.9
12/24/2013	7:09:17 AM	-16.912	-11.156	-9.896	-10.012	-12.984	-58.408	-70.672	-69.824	-73.396
12/24/2013	7:10:43 AM	-16.488	-13.436	-11.344	-12.056	-11.668	-57.46	-67.9	-69.96	-71.892
12/24/2013	7:12:09 AM	-16.288	-11.476	-9.056	-11.332	-11.116	-60.296	-68.912	-71.216	-70.132
12/24/2013	7:13:35 AM	-16.096	-12.996	-9.528	-11.632	-13.588	-58.184	-67.872	-70.784	-70.316
12/24/2013	7:15:01 AM	-16.652	-9.168	-9.248	-11.38	-11.496	-58.804	-69.444	-71.816	-72.004
12/24/2013	7:16:27 AM	-14.024	-11.148	-10.576	-10.56	-13.228	-60.252	-68.3	-71.7	-70.908
12/24/2013	7:17:53 AM	-15.812	-10.832	-11.712	-10.748	-11.08	-59.152	-70.164	-74.16	-70.98
12/24/2013	7:19:19 AM	-16.156	-9.484	-10.064	-11.092	-12.196	-58.368	-69.892	-72.548	-73.496
12/24/2013	7:20:45 AM	-16.372	-11.676	-11.952	-10.652	-13.596	-60.188	-67.54	-69.608	-72.764
12/24/2013	7:22:11 AM	-16.56	-10.036	-11.86	-11.836	-11.968	-57.488	-67.92	-69.924	-73.636
12/24/2013	7:23:37 AM	-15.172	-12.204	-9.376	-11.568	-10.372	-58.36	-66.088	-71.36	-71.388
12/24/2013	7:25:03 AM	-17.22	-10.248	-9.204	-11.216	-12.396	-57.94	-68.908	-71.064	-70.768
12/24/2013	7:26:29 AM	-15.972	-9.408	-11.176	-10.788	-14.02	-58.084	-69.972	-69	-71.944
12/24/2013	7:27:55 AM	-16.692	-13.32	-7.528	-11.976	-11.232	-59.296	-69.472	-69.776	-72.264
12/24/2013	7:29:21 AM	-16.676	-9.908	-8.904	-10.608	-12.236	-59.76	-67.956	-69.448	-69.208
12/24/2013	7:30:47 AM	-15.496	-15.8	-8.824	-12.532	-13.408	-60.396	-70.172	-68.476	-68.944

APPENDEX .18

Ruwi - 12PM-6PM

Sample Radio Spectrum Traffic

		MHz								
Date	Time	130	135	140	145	150	155	160	165	170
		POWER IN dBm								
12/24/2013	12:00:15 PM	-71.676	-72.864	-71.28	-70.672	-72.96	-68.84	-71.676	-70.46	-40.24
12/24/2013	12:01:41 PM	-71.108	-70.52	-72.144	-71.808	-72.86	-72.664	-71.22	-70.852	-35.14
12/24/2013	12:03:07 PM	-69.4	-70.764	-72.104	-70.676	-67.76	-69.62	-70.628	-71.772	-39.108
12/24/2013	12:04:33 PM	-69.34	-71.624	-70.572	-69.204	-68.744	-70.324	-70.68	-71.776	-40.32
12/24/2013	12:05:59 PM	-73.136	-74.504	-73.84	-70.924	-69.6	-71.128	-71.004	-68.044	-34.316
12/24/2013	12:07:25 PM	-72.22	-71.644	-73.48	-70.584	-68.588	-70.164	-69.72	-70.972	-36.232
12/24/2013	12:08:51 PM	-73.48	-71.82	-70.636	-70.372	-70.424	-69.964	-70.364	-69.828	-39.444
12/24/2013	12:10:17 PM	-70.56	-69.916	-71.964	-72.028	-71.032	-70.644	-70.524	-71.052	-41.808
12/24/2013	12:11:43 PM	-69.952	-70.04	-67.94	-70.744	-67.876	-71.272	-70.484	-69.304	-37.056
12/24/2013	12:13:09 PM	-72.02	-68.988	-69.632	-72.648	-70.432	-70.116	-73.452	-70.42	-38.64
12/24/2013	12:14:35 PM	-72.112	-70.02	-69.432	-72.824	-70.472	-71.596	-73.636	-69.148	-35.412
12/24/2013	12:16:01 PM	-69.716	-71.472	-73.676	-71.064	-72.68	-72.356	-69.912	-68.948	-36.716
12/24/2013	12:17:27 PM	-73.212	-70.084	-69.208	-69.064	-70.8	-71.32	-70.724	-71.8	-42.264
12/24/2013	12:18:53 PM	-69.18	-72.992	-71.04	-71.092	-72.8	-69.408	-70.12	-70.284	-39.312
12/24/2013	12:20:19 PM	-72.312	-74.004	-70.648	-67.488	-71.18	-70.236	-71.316	-72.188	-44.608
12/24/2013	12:21:45 PM	-70.66	-70.768	-71	-70.58	-70.404	-71.324	-71.208	-70.712	-44.004
12/24/2013	12:23:11 PM	-71.944	-71.356	-70.888	-72.808	-71.82	-71.444	-71.68	-68.564	-34.736
12/24/2013	12:24:37 PM	-71.148	-69.528	-69.176	-71.976	-69.48	-71.348	-73.444	-70.7	-35.432
12/24/2013	12:26:03 PM	-69.996	-72.512	-71.612	-73.704	-72.98	-71.352	-71.264	-71.748	-35.172
12/24/2013	12:27:29 PM	-72.524	-72.308	-69.392	-71.556	-71.62	-71.084	-70.628	-74.02	-38.616
12/24/2013	12:28:55 PM	-72.388	-72.236	-70.96	-69.612	-70.068	-72.4	-71.816	-72.38	-35.736
12/24/2013	12:30:21 PM	-70.252	-70.136	-72.716	-68.736	-71.3	-67.984	-69.364	-67.984	-36.108
12/24/2013	12:31:47 PM	-71.068	-72.308	-71.352	-74.128	-68.556	-72.184	-71.548	-68.992	-37.012
12/24/2013	12:33:13 PM	-70.204	-69.96	-69.104	-73.64	-72.376	-72.128	-73.216	-71.132	-36.824
12/24/2013	12:34:39 PM	-72.508	-71.228	-69.412	-70.56	-71.904	-71.092	-68.392	-69.972	-35.24
12/24/2013	12:36:05 PM	-70.932	-70.488	-72.112	-72.764	-71.652	-69.612	-71.388	-74.196	-39.4
12/24/2013	12:37:31 PM	-70.668	-69.9	-70.14	-64.664	-69.112	-72.576	-69.4	-69.796	-37.112
12/24/2013	12:38:57 PM	-72.012	-73.304	-69.984	-63.672	-70.124	-69.7	-70.556	-72.128	-38.936
12/24/2013	12:40:23 PM	-71.124	-71.776	-68.488	-73.796	-72.18	-73.824	-70.364	-71.432	-40.376
12/24/2013	12:41:49 PM	-71.216	-71.388	-70.864	-71.228	-70.052	-71.112	-71.528	-68.88	-36.88
12/24/2013	12:43:15 PM	-69.516	-73.972	-70.836	-70.808	-73.048	-70.896	-66.656	-71.016	-39.156
12/24/2013	12:44:41 PM	-70.184	-73.676	-72.18	-69.148	-69.404	-73.788	-74.072	-70.408	-36.964
12/24/2013	12:46:07 PM	-72.176	-72.856	-72.036	-68.144	-71.516	-70.5	-69.896	-67.776	-39.308
12/24/2013	12:47:33 PM	-73.132	-69.136	-70.724	-72.016	-70.124	-71.952	-74.708	-69.924	-40.2
12/24/2013	12:48:59 PM	-71.468	-71.252	-71.408	-71.636	-69.48	-69.472	-70.028	-70.808	-36.78
12/24/2013	12:50:25 PM	-71.036	-73.024	-71.952	-72.28	-71.524	-70.704	-72.092	-69.868	-37.188
12/24/2013	12:51:51 PM	-71.504	-71.82	-70.996	-69.348	-72.996	-72.544	-70.832	-71.896	-38.808
12/24/2013	12:53:17 PM	-73.752	-70.228	-70.768	-70.1	-72.22	-71.028	-70.908	-72.348	-39.776
12/24/2013	12:54:43 PM	-71.376	-71.584	-71.756	-72.42	-70.348	-70.708	-73.088	-67.628	-36.948
12/24/2013	12:56:09 PM	-73.54	-72.948	-68.552	-72.6	-70.42	-70.82	-69.624	-69.664	-45.22
12/24/2013	12:57:35 PM	-69.54	-73.272	-69.96	-73.208	-71.408	-69.768	-69.14	-69.324	-37.368
12/24/2013	12:59:01 PM	-70.308	-71.256	-72.304	-69.14	-68.668	-73.684	-72.32	-68.844	-39.192
12/24/2013	1:00:27 PM	-71.548	-71.28	-70.168	-71.284	-70.388	-70.54	-70.336	-70.456	-36.72
12/24/2013	1:01:53 PM	-68.396	-68.06	-71.368	-72.748	-73.676	-71.072	-72.408	-70.376	-38.924
12/24/2013	1:03:19 PM	-72.132	-72.2	-72.48	-70.372	-70.008	-71.324	-71.044	-72.18	-41.708
12/24/2013	1:04:45 PM	-69.984	-73.824	-73.068	-69.656	-73.724	-72.352	-72.104	-70.132	-35.08
12/24/2013	1:06:11 PM	-72.228	-72.396	-71.756	-73.584	-70.952	-70.508	-70.4	-69.844	-35.464
12/24/2013	1:07:37 PM	-70.476	-72.08	-71.828	-72.888	-71.176	-74.192	-70.608	-71.776	-36.884
12/24/2013	1:09:03 PM	-74.8	-72.848	-71.964	-70.816	-71.716	-69.612	-71.916	-70.856	-36.616
12/24/2013	1:10:29 PM	-70.076	-69.112	-72.944	-69.368	-69.3	-71.804	-70.6	-71.792	-38.952
12/24/2013	1:11:55 PM	-69.248	-71.092	-71.368	-72.964	-68.092	-72.404	-73.272	-71.728	-41.016
12/24/2013	1:13:21 PM	-70.336	-72.392	-70.872	-70.652	-70.152	-70.94	-69.632	-70.424	-36.98
12/24/2013	1:14:47 PM	-69.592	-71.424	-70.784	-72.228	-69.08	-72.776	-68.784	-70.168	-40.228
12/24/2013	1:16:13 PM	-72.292	-72.192	-72.432	-70.02	-69.264	-71.608	-70.328	-69.968	-45.276
12/24/2013	1:17:39 PM	-71.432	-73.552	-73.092	-73.556	-72.48	-70.416	-71.04	-69.6	-36.868
12/24/2013	1:19:05 PM	-72.94	-72.548	-72.828	-70.232	-72.488	-71.552	-72.108	-69.464	-36.824
12/24/2013	1:20:31 PM	-72.56	-69.444	-69.152	-71.836	-73.604	-72.416	-71.072	-72.572	-40.148
12/24/2013	1:21:57 PM	-72.936	-70.152	-70.44	-70.792	-71.468	-70.212	-68.14	-72.612	-42
12/24/2013	1:23:23 PM	-69.804	-70.372	-68.98	-72.1	-72.66	-71.928	-74.092	-72.164	-35.04
12/24/2013	1:24:49 PM	-71.168	-71.284	-70.472	-72.364	-72.888	-72.256	-72.844	-71.96	-35.144
12/24/2013	1:26:15 PM	-71.984	-71.02	-71.536	-69.94	-72	-75.06	-69.68	-73.212	-35.576
12/24/2013	1:27:41 PM	-70.312	-70.8	-71.384	-71.208	-72.32	-70.604	-69.572	-73.832	-36.424
12/24/2013	1:29:07 PM	-71.08	-69.352	-74.3	-70.652	-69.772	-70.868	-72.164	-71.552	-39.328

APPENDEX .19

Ruwi - 6PM-12AM

Sample Radio Spectrum Traffic

		MHz								
Date	Time	175	180	185	190	195	200	205	210	215
		POWER IN dBm								
12/23/2013	7:26:57 PM	-33.04	-33.368	-65.016	-62.472	-64.92	-70.168	-68.352	-70.612	-70.716
12/23/2013	7:28:23 PM	-32.484	-33.216	-65.66	-61.964	-64.988	-69.544	-69.708	-71.924	-71.428
12/23/2013	7:29:49 PM	-33.008	-33.128	-63.576	-64.06	-65.944	-65.236	-70.86	-71.732	-71.852
12/23/2013	7:31:15 PM	-34.22	-34.452	-63.344	-63.568	-63.636	-69.768	-72.332	-73.312	-69.196
12/23/2013	7:32:41 PM	-33.984	-34.228	-64.284	-63.216	-66.876	-68.288	-68.608	-67.96	-68.252
12/23/2013	7:34:07 PM	-33.5	-34.824	-66.836	-63.62	-65.228	-67.408	-70.836	-71.34	-72.572
12/23/2013	7:35:33 PM	-33.856	-33.976	-63.124	-64.432	-60.884	-68.968	-69.984	-71.06	-72.86
12/23/2013	7:36:59 PM	-34.34	-34.772	-63.476	-62.492	-63.072	-70.112	-67.732	-70.424	-71.024
12/23/2013	7:38:25 PM	-33.852	-34.032	-64.656	-63.664	-62.564	-69.8	-71.308	-70.812	-72.08
12/23/2013	7:39:51 PM	-34.048	-33.968	-61.044	-64.712	-63.224	-67.888	-71.132	-68.676	-70.72
12/23/2013	7:41:17 PM	-34.068	-34.208	-68.052	-64.632	-64.188	-68.632	-71.404	-70.208	-71.044
12/23/2013	7:42:43 PM	-33.8	-33.964	-64.892	-65.436	-64.176	-69.756	-71.576	-70.52	-71.492
12/23/2013	7:44:09 PM	-35.148	-35.64	-64.712	-63.164	-63.424	-70.528	-69.7	-71.44	-69.064
12/23/2013	7:45:35 PM	-33.94	-34.152	-65.412	-63.276	-64.132	-65.844	-70.78	-68.9	-69.264
12/23/2013	7:47:01 PM	-34.34	-34.588	-63.008	-66.54	-66.944	-69.412	-70.068	-71.88	-69.628
12/23/2013	7:48:27 PM	-34.14	-34.096	-64.372	-63.352	-61.444	-69.292	-70.132	-72.1	-70.744
12/23/2013	7:49:53 PM	-35.136	-35.792	-60.408	-65.472	-65.224	-69.412	-68.772	-68.112	-70.528
12/23/2013	7:51:19 PM	-35.1	-36.312	-63.364	-60.836	-62.188	-67.76	-70.236	-70.532	-69.8
12/23/2013	7:52:45 PM	-35.204	-35.636	-60.636	-64.32	-63.368	-68.304	-71.9	-73.556	-72.392
12/23/2013	7:54:11 PM	-33.804	-33.884	-64.392	-61.16	-64.66	-67.2	-70.596	-70.628	-68.944
12/23/2013	7:55:37 PM	-34.42	-34.44	-61.608	-65.728	-62.34	-67.668	-69.968	-70.328	-70.208
12/23/2013	7:57:03 PM	-34.94	-35.32	-62.668	-65.592	-61.82	-67.772	-69.544	-70.228	-69.444
12/23/2013	7:58:29 PM	-34.82	-34.976	-63.58	-64.752	-62.092	-67.236	-69.324	-71.196	-71.264
12/23/2013	7:59:55 PM	-35.784	-35.888	-64.236	-63.632	-62.316	-68.736	-69.06	-73.46	-70.536
12/23/2013	8:01:21 PM	-35.108	-35.984	-66.404	-65.716	-64.288	-68.876	-69.856	-71.684	-72.412
12/23/2013	8:02:47 PM	-34.46	-34.676	-63.136	-65.28	-63.58	-67.816	-67.876	-69.556	-71.496
12/23/2013	8:04:13 PM	-32.676	-33.26	-64.96	-64.364	-63.312	-65.476	-71.036	-69.332	-70.92
12/23/2013	8:05:39 PM	-33.576	-34.096	-62.596	-63.46	-62.968	-65.92	-69.228	-70.948	-71.24
12/23/2013	8:07:05 PM	-33.172	-32.96	-63.468	-63.76	-62.24	-65.904	-69.856	-70.368	-70.852
12/23/2013	8:08:31 PM	-34.192	-34.116	-62.964	-63.096	-64.396	-69.852	-71.032	-69.72	-72.992
12/23/2013	8:09:57 PM	-32.804	-33.084	-66.72	-63.42	-63.772	-69.044	-68.644	-68.86	-70.34
12/23/2013	8:11:23 PM	-33.328	-33.536	-65.828	-61.372	-63.436	-67.96	-67.932	-70.712	-71.488
12/23/2013	8:12:49 PM	-34.128	-35.004	-63.744	-60.412	-62.356	-68.368	-71.212	-70.028	-70.172
12/23/2013	8:14:15 PM	-35.152	-35.332	-64.452	-61.7	-62.692	-70.488	-67.116	-71.968	-68.972
12/23/2013	8:15:41 PM	-33.944	-34.096	-62.544	-62.096	-61.8	-68.264	-72.12	-70.448	-70.848
12/23/2013	8:17:07 PM	-34.308	-34.368	-61.392	-65.508	-62.972	-65.744	-72.232	-71.012	-72.168
12/23/2013	8:18:33 PM	-35.168	-34.292	-61.012	-62.156	-64.308	-68.472	-71.268	-73.572	-71.556
12/23/2013	8:19:59 PM	-34.02	-34.296	-67.22	-65.16	-60.62	-67.708	-69.008	-71.548	-72.516
12/23/2013	8:21:25 PM	-33.816	-34.032	-62.072	-62.544	-63.992	-67.808	-71.316	-69.46	-68.748
12/23/2013	8:22:51 PM	-34.16	-34.512	-62.04	-65.26	-63.52	-71.168	-70.68	-72.868	-71.816
12/23/2013	8:24:17 PM	-33.876	-33.968	-67.2	-63.132	-64.644	-68.656	-69.804	-72.92	-72.696
12/23/2013	8:25:43 PM	-34.116	-34.32	-62.756	-63.452	-61.292	-68.612	-69.828	-73.38	-68.652
12/23/2013	8:27:09 PM	-34.136	-34.36	-62.92	-65.756	-61.776	-65.66	-71.252	-71.596	-70.34
12/23/2013	8:28:35 PM	-33.516	-33.544	-61.652	-66.616	-64.576	-67.792	-68.488	-72.436	-70.664
12/23/2013	8:30:01 PM	-33.812	-34.016	-64.188	-63.328	-61.872	-66.888	-68.872	-71.192	-71.768
12/23/2013	8:31:27 PM	-33.88	-34.256	-64.8	-62.544	-67.344	-68.156	-71.312	-70.7	-72.908
12/23/2013	8:32:53 PM	-33.948	-34.836	-63.512	-61.896	-63.216	-66.632	-69.772	-69.252	-71.792
12/23/2013	8:34:19 PM	-34.876	-35.196	-63.684	-63.832	-62.876	-68.172	-70.484	-71.904	-68.392
12/23/2013	8:35:45 PM	-34.984	-35.204	-64.536	-63.368	-63.08	-67.072	-70.576	-70.94	-72.588
12/23/2013	8:37:11 PM	-35.132	-34.816	-64.956	-62.332	-63.964	-68.012	-68.552	-68.548	-71.292
12/23/2013	8:38:37 PM	-35.684	-35.516	-62.324	-65.736	-63.516	-65.712	-67.984	-69.72	-70.56
12/23/2013	8:40:03 PM	-33.084	-33.836	-62.128	-63.82	-66.996	-69.256	-69.308	-71.944	-71.044
12/23/2013	8:41:29 PM	-33.62	-34.204	-62.868	-61.088	-61.484	-68.088	-72.1	-73.96	-69.796
12/23/2013	8:42:55 PM	-33.076	-33.2	-64.864	-66.144	-63.404	-67.104	-70.54	-71.764	-70.996
12/23/2013	8:44:21 PM	-34.168	-34.364	-66.436	-61.228	-62.748	-67.36	-71.412	-69.356	-69.972
12/23/2013	8:45:47 PM	-33.432	-33.008	-63.724	-62.456	-63.452	-65.828	-68.248	-71.276	-71.616
12/23/2013	8:47:13 PM	-33.148	-33.424	-62.92	-64.34	-62.272	-66.436	-70.512	-72.304	-71.532
12/23/2013	8:48:39 PM	-33.972	-34.112	-61.836	-61	-64.528	-67.188	-69.308	-70.252	-71.86
12/23/2013	8:50:05 PM	-33.224	-33.496	-62.912	-62.692	-61.18	-69.7	-71.804	-70.048	-70.592
12/23/2013	8:51:31 PM	-33.128	-33.772	-62.204	-64.92	-62.476	-70.012	-71.244	-70.892	-71.56
12/23/2013	8:52:57 PM	-34.256	-34.252	-64.42	-61.548	-61.644	-66.388	-69.14	-71.024	-71.716
12/23/2013	8:54:23 PM	-33.024	-33.328	-61.672	-65.532	-64.86	-67.096	-69.584	-68.108	-70.988
12/23/2013	8:55:49 PM	-34	-35.256	-62.852	-63.984	-63.56	-65.064	-67.46	-71.544	-71.208

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AlGhobrah - 12AM-6AM

Sample Radio Spectrum Traffic

		MHz								
Date	Time	220	225	230	235	240	245	250	255	260
		POWER IN dBm								
18/12/2013	12:00:03 AM	-71.164	-71.784	-71.928	-72.616	-73.028	-71.808	-74.06	-73.164	-72.14
20/12/2013	12:00:07 AM	-72.304	-72.412	-71.632	-72.516	-72.992	-71.724	-72.636	-73.952	-71.832
11/12/2013	12:00:21 AM	-71.552	-73.16	-72.976	-72.22	-71.368	-70.256	-72.3	-71.928	-73.12
13/12/2013	12:00:25 AM	-70.888	-73.588	-71.8	-71.752	-72.836	-73.468	-72.288	-73.968	-72.924
16/12/2013	12:00:29 AM	-70.528	-71.604	-72.712	-71.764	-71.044	-71.916	-72.672	-71.832	-72.884
18/12/2013	12:00:33 AM	-72.38	-73.708	-71.348	-70.772	-71.416	-72.56	-71.108	-71.72	-72.436
21/12/2013	12:00:37 AM	-73.536	-73.62	-74.028	-73.22	-73.364	-72.32	-73.092	-71.896	-72.168
10/12/2013	12:00:47 AM	-72.96	-72.256	-72.448	-73.244	-73.496	-73.084	-72.784	-72.82	-73.888
11/12/2013	12:00:51 AM	-71.216	-72.644	-73.852	-72.44	-72.48	-71.948	-74.38	-72.656	-73.12
14/12/2013	12:00:55 AM	-72.464	-73.18	-71.328	-72.104	-71.976	-71.376	-72.984	-70.644	-73.868
17/12/2013	12:00:59 AM	-71.532	-72.3	-72.544	-72.356	-72.728	-74.032	-73.584	-71.36	-72.216
19/12/2013	12:01:03 AM	-73.276	-73.592	-72.748	-72.004	-72.688	-73.292	-73.076	-72.032	-73.592
10/12/2013	12:01:17 AM	-73.016	-72.608	-73.368	-73.468	-72.496	-73.492	-73.264	-71.648	-73.756
12/12/2013	12:01:21 AM	-71.924	-72.216	-72.564	-71.616	-70.744	-73.328	-73.772	-73.256	-72.988
15/12/2013	12:01:25 AM	-72.052	-72.18	-72.612	-73.444	-73.812	-71.512	-72.204	-74.284	-72.96
18/12/2013	12:01:29 AM	-72.892	-72.504	-72.676	-73.288	-71.156	-72.872	-73.428	-73.152	-72.364
20/12/2013	12:01:33 AM	-74.3	-72.648	-73.048	-72.084	-73.168	-72.78	-72.156	-71.768	-71.276
11/12/2013	12:01:47 AM	-72.112	-72.144	-73.552	-73.232	-73.156	-73.052	-72.416	-71.104	-73.36
13/12/2013	12:01:51 AM	-72.668	-71.512	-72.42	-72.072	-71.792	-71.9	-72.148	-72.744	-72.808
16/12/2013	12:01:55 AM	-71.616	-71.344	-72.408	-71.784	-72.604	-71.432	-70.76	-72.124	-72.512
18/12/2013	12:01:59 AM	-71.556	-73.296	-71.156	-71.32	-72.312	-72.396	-73.676	-72.012	-72.272
21/12/2013	12:02:03 AM	-72.296	-72.476	-73.288	-71.876	-72.12	-71.828	-71.592	-73.512	-71.844
10/12/2013	12:02:13 AM	-73.888	-73.592	-73.424	-71.976	-71.02	-72.06	-72.656	-73.616	-73.932
11/12/2013	12:02:17 AM	-72.808	-71.06	-71.652	-72.924	-73.56	-72.024	-73.328	-73.244	-71.5
14/12/2013	12:02:21 AM	-73.184	-72.136	-71.456	-73.54	-71.38	-72.072	-72.408	-71.68	-72.58
17/12/2013	12:02:25 AM	-71.8	-72.56	-72.856	-71.444	-71.78	-72.852	-72.388	-73.476	-74.624
19/12/2013	12:02:29 AM	-73.396	-72.312	-72.284	-71.576	-71.048	-72.408	-72.648	-72.664	-73.472
10/12/2013	12:02:43 AM	-72.516	-74.18	-72.3	-71.348	-71.728	-74.244	-72.148	-73.496	-75.5
12/12/2013	12:02:47 AM	-72.924	-72.54	-73.056	-73.708	-73.276	-75.024	-72.98	-72.708	-74.664
15/12/2013	12:02:51 AM	-73.548	-73.296	-71.468	-71.208	-70.788	-71.98	-73.024	-72.816	-74.144
18/12/2013	12:02:55 AM	-72.032	-73.832	-71.52	-73.82	-72.104	-72.612	-72.86	-72.688	-73.332
20/12/2013	12:02:59 AM	-73.212	-71.068	-72.564	-71.924	-72.648	-73.716	-70.812	-72.228	-72.324
11/12/2013	12:03:13 AM	-73.044	-72.208	-73.712	-72.452	-73.316	-70.356	-72.84	-73.772	-73.412
13/12/2013	12:03:17 AM	-72.336	-72.972	-71.96	-70.268	-72.888	-72.764	-71.612	-73.324	-71.232
16/12/2013	12:03:21 AM	-72.516	-73.404	-72.396	-72.616	-72.372	-71.248	-72.92	-71.952	-71.832
18/12/2013	12:03:25 AM	-72.564	-73.252	-73.86	-70.468	-70.868	-72.804	-72.892	-72.68	-73
21/12/2013	12:03:29 AM	-71.644	-71.072	-72.108	-71.608	-71.892	-71.344	-71.26	-71.264	-71.872
10/12/2013	12:03:39 AM	-72.456	-73.748	-71.928	-73.38	-72.844	-71.572	-72.548	-74.552	-71.32
11/12/2013	12:03:43 AM	-73.416	-73.408	-73.624	-73.44	-72.332	-71.692	-72.608	-74.344	-73.3
14/12/2013	12:03:47 AM	-72.876	-71.868	-72.188	-72.132	-72.788	-72.236	-71.804	-72.388	-73.34
17/12/2013	12:03:51 AM	-73.18	-72.188	-71.524	-72.748	-72.144	-72.364	-70.928	-70.98	-72.372
19/12/2013	12:03:55 AM	-72.536	-72.964	-72.608	-72.252	-72.46	-71.336	-72.432	-73.5	-73.708
10/12/2013	12:04:09 AM	-73.084	-74.276	-71.864	-72.248	-72.216	-72.844	-72.024	-72.244	-73.684
12/12/2013	12:04:13 AM	-72.06	-72.36	-73.432	-73.84	-74.036	-73.072	-73.944	-72.212	-72.644
15/12/2013	12:04:17 AM	-70.812	-71.72	-71.98	-72.752	-72.928	-70.412	-73.16	-72.62	-72.716
18/12/2013	12:04:21 AM	-72.052	-71.644	-73.908	-72.784	-71.824	-71.896	-71.928	-71.732	-72.612
20/12/2013	12:04:25 AM	-71.328	-72.496	-73.3	-70.856	-73.196	-72.748	-74.776	-72.396	-71.232
11/12/2013	12:04:39 AM	-73.816	-72.728	-74.26	-71.332	-72.528	-72.5	-72.4	-72.5	-71.82
13/12/2013	12:04:43 AM	-72.384	-72.64	-72.992	-71.4	-72.264	-72.376	-72.632	-71.676	-72.296
16/12/2013	12:04:47 AM	-72.316	-72.956	-72.344	-72.884	-71.256	-71.912	-72.828	-73.24	-74.524
18/12/2013	12:04:51 AM	-72.872	-72.288	-72.488	-72.672	-72.552	-73.632	-72.54	-74.024	-75.708
21/12/2013	12:04:55 AM	-72.512	-70.952	-71.904	-72.724	-71.996	-71.536	-73.48	-71.728	-72.42
10/12/2013	12:05:05 AM	-72.208	-73.116	-72.9	-72.836	-72.404	-73.548	-72.576	-73.512	-73.112
11/12/2013	12:05:09 AM	-72.396	-72.148	-72.556	-71.376	-72.512	-71.652	-72.856	-72.432	-73.176
14/12/2013	12:05:13 AM	-71.156	-73.508	-72.556	-72.764	-71.036	-73.356	-72.56	-73.504	-71.248
17/12/2013	12:05:17 AM	-72.136	-73.152	-73.048	-72.38	-72.724	-72.768	-70.936	-72.392	-72.032
19/12/2013	12:05:21 AM	-72.484	-73.128	-73.152	-71.764	-72.94	-71.136	-73.108	-72.892	-71.924
10/12/2013	12:05:35 AM	-72.9	-72.296	-72.784	-71.928	-73.68	-72.692	-72.964	-74.976	-73.172
12/12/2013	12:05:39 AM	-72.7	-72.972	-73.524	-72.536	-71.992	-70.24	-72.9	-73.068	-72.016
15/12/2013	12:05:43 AM	-72.208	-71.784	-72.136	-71.832	-71.456	-71.184	-71.044	-72.792	-71.92
18/12/2013	12:05:47 AM	-72.636	-72.716	-72.696	-71.972	-74.176	-71.692	-72.432	-73.632	-73.124
20/12/2013	12:05:51 AM	-72.528	-72.292	-71.9	-72.04	-73.616	-70.492	-74.496	-71	-73.012
11/12/2013	12:06:05 AM	-73.272	-70.004	-73.856	-71.74	-72.492	-73.116	-72.428	-72.652	-73.156

APPENDEX .21

AlGhobrah - 6AM-12PM
Sample Radio Spectrum Traffic

Date	Time	265	270	275	280	285	290	295	300	305
		POWER IN dBm								
11/12/2013	6:00:07 AM	-73.032	-71.38	-72.272	-72.788	-72.604	-74.36	-73.2	-72.64	-74.04
14/12/2013	6:00:11 AM	-73.176	-73.98	-73.476	-74.328	-74.424	-72.928	-74.288	-72.68	-74.06
17/12/2013	6:00:15 AM	-71.932	-73.78	-72.936	-74.484	-72.84	-75.192	-72.324	-73.5	-73.608
19/12/2013	6:00:19 AM	-70.572	-71.92	-72.824	-72.728	-73.676	-70.856	-71.904	-72.988	-71.568
22/12/2013	6:00:23 AM	-71.212	-72.496	-73.02	-71.408	-73.572	-71.636	-73.48	-73.288	-73.804
10/12/2013	6:00:33 AM	-72.432	-73.888	-71.604	-73.604	-73.868	-72.008	-73.648	-73.304	-76.224
11/12/2013	6:00:37 AM	-73.336	-72.556	-74.072	-73.708	-70.976	-73.684	-72.468	-73.404	-74.468
15/12/2013	6:00:41 AM	-73.388	-73.992	-72.536	-71.652	-72.3	-72.704	-73.72	-74.912	-72.62
18/12/2013	6:00:45 AM	-72.804	-72.536	-74.06	-73.172	-71.864	-73.964	-73.828	-72.132	-72.404
20/12/2013	6:00:49 AM	-73.38	-71.172	-73.684	-72.692	-71.728	-72.096	-71.928	-73.624	-74.468
10/12/2013	6:01:03 AM	-73.856	-73.58	-74.476	-73.108	-72.184	-74.296	-73.612	-73.988	-73.328
12/12/2013	6:01:07 AM	-72.384	-73.264	-73.452	-72.4	-73.592	-72.92	-73.492	-73.388	-73.076
16/12/2013	6:01:11 AM	-74.192	-71.788	-73.032	-73.124	-73.556	-73.572	-71.532	-73.8	-74.016
18/12/2013	6:01:15 AM	-72.62	-71.524	-72.928	-73.224	-72.672	-72.448	-72.524	-73.592	-72.244
21/12/2013	6:01:19 AM	-72.308	-72.692	-73.46	-72.028	-73.46	-73.356	-72.772	-73.952	-72.348
11/12/2013	6:01:33 AM	-72.9	-72	-72.352	-72.276	-71.892	-72.472	-72.88	-73.088	-74.404
14/12/2013	6:01:37 AM	-71.788	-72.816	-73.892	-72.192	-72.168	-69.992	-72.744	-74.468	-73.404
17/12/2013	6:01:41 AM	-72.884	-72.9	-73.744	-73.208	-73.208	-72.512	-74.024	-72.408	-71.672
19/12/2013	6:01:45 AM	-71.936	-73.452	-71.724	-73.124	-73.392	-70.524	-73.104	-72.804	-72.776
22/12/2013	6:01:49 AM	-73.272	-73.208	-72.068	-73.532	-73.608	-71.296	-73.908	-70.864	-71.68
10/12/2013	6:01:59 AM	-73.816	-71.2	-73.632	-73.596	-72.44	-73.052	-72.416	-73.476	-74.216
11/12/2013	6:02:03 AM	-72.624	-73.832	-73.024	-73.344	-71.772	-73.948	-73.248	-72.348	-73.748
15/12/2013	6:02:07 AM	-71.06	-72.712	-73.28	-73.372	-71.38	-71.684	-72.628	-72.976	-71.4
18/12/2013	6:02:11 AM	-72.696	-73.908	-72.956	-72.652	-73.488	-72.948	-72.916	-72.82	-73.156
20/12/2013	6:02:15 AM	-72.884	-72.008	-73.26	-71.684	-73.704	-72.516	-73.856	-74.576	-72.804
10/12/2013	6:02:29 AM	-73.012	-74.004	-74.86	-72.88	-73.208	-72.98	-71.232	-72.184	-73.112
12/12/2013	6:02:33 AM	-72.448	-71.456	-72.232	-73.26	-72.652	-74.168	-73.18	-71.848	-72.82
16/12/2013	6:02:37 AM	-73.348	-71.704	-71.276	-72.872	-73.624	-71.472	-73.856	-73.952	-72.82
18/12/2013	6:02:41 AM	-72.908	-73.212	-71.576	-73.612	-71.512	-72.648	-74.536	-72.744	-71.528
21/12/2013	6:02:45 AM	-72.204	-72.26	-72.772	-72.012	-72.616	-73.044	-72.548	-72.672	-73.088
11/12/2013	6:02:59 AM	-71.66	-73.252	-72.932	-72.964	-72.936	-73.968	-71.66	-73.44	-71.256
14/12/2013	6:03:03 AM	-72.764	-74.124	-72.536	-73.988	-73.412	-73.168	-73.5	-74.396	-73.18
17/12/2013	6:03:07 AM	-73.248	-71.996	-73.648	-71.62	-72.616	-72.532	-72.688	-73.376	-72.888
19/12/2013	6:03:11 AM	-72.748	-73.62	-73.136	-73.928	-73.976	-72.668	-71.996	-72.188	-71.544
22/12/2013	6:03:15 AM	-73.096	-73.424	-72.196	-73.088	-72.032	-71.172	-72.868	-73.24	-73.524
10/12/2013	6:03:25 AM	-73.532	-73.116	-74.096	-75.112	-73.416	-73.2	-72.496	-73.692	-73.164
11/12/2013	6:03:29 AM	-72.668	-73.296	-71.568	-71.668	-71.752	-72.216	-72.848	-73.556	-71.776
15/12/2013	6:03:33 AM	-72.688	-72.44	-73.436	-73.064	-72.496	-71.108	-71.136	-74.936	-72.036
18/12/2013	6:03:37 AM	-74.02	-72.408	-72.2	-73.94	-72.548	-73.34	-72.56	-73.628	-73.02
20/12/2013	6:03:41 AM	-73.256	-73.104	-75.224	-73.232	-72.54	-72.632	-73.368	-74.476	-72.484
10/12/2013	6:03:55 AM	-72.288	-73.264	-73.768	-73.132	-72.656	-72.812	-73.036	-74.936	-72.244
12/12/2013	6:03:59 AM	-72.248	-72.296	-72.104	-72.336	-73.888	-73.356	-72.436	-73.6	-71.212
16/12/2013	6:04:03 AM	-71.42	-71.916	-72.464	-71.78	-74.128	-73.58	-73.284	-73.032	-73.608
18/12/2013	6:04:07 AM	-73.28	-73.62	-71.82	-72.256	-71.568	-72.376	-70.524	-73.696	-73.04
21/12/2013	6:04:11 AM	-71.136	-72.964	-72.752	-70.952	-72.692	-72.344	-73.66	-73.176	-72.848
11/12/2013	6:04:25 AM	-72.464	-73.568	-75.428	-72.42	-71.648	-71.928	-72.32	-73.78	-73.9
14/12/2013	6:04:29 AM	-72.98	-73.024	-72.908	-72.384	-72.8	-71.44	-73.008	-73.756	-73.004
17/12/2013	6:04:33 AM	-72.508	-73.12	-73.16	-73.988	-73.46	-72.628	-73.188	-71.944	-72.748
19/12/2013	6:04:37 AM	-72.172	-73.28	-72.992	-70.184	-73.572	-72.084	-74.056	-73.528	-72.188
22/12/2013	6:04:41 AM	-71.136	-74.264	-72.388	-70.028	-70.684	-71.996	-73.596	-72.288	-74.328
10/12/2013	6:04:51 AM	-73.672	-73.128	-73.808	-71.988	-71.208	-73.852	-73.064	-73.576	-73.584
11/12/2013	6:04:55 AM	-73.076	-74.12	-72.752	-72.864	-71.404	-73.604	-73.644	-71.88	-73.444
15/12/2013	6:04:59 AM	-73.04	-72.14	-72.936	-72.232	-71.508	-73.188	-74.24	-73.22	-71.944
18/12/2013	6:05:03 AM	-72.656	-73.624	-72.468	-72.572	-73.5	-72.792	-72.584	-71.584	-73.328
20/12/2013	6:05:07 AM	-73.28	-72.184	-73.216	-73.712	-71.612	-71.1	-71.228	-71.32	-71.908
10/12/2013	6:05:21 AM	-71.976	-73.808	-73.504	-73.88	-72.432	-73.232	-74.184	-74.224	-72.784
12/12/2013	6:05:25 AM	-72.932	-74.316	-73.008	-73.552	-74.312	-72.62	-70.868	-72.884	-71.624
16/12/2013	6:05:29 AM	-72.44	-72.676	-72.304	-73.412	-72.572	-74.328	-73.284	-72.2	-73.54
18/12/2013	6:05:33 AM	-72.2	-72.984	-72.32	-73.592	-74.5	-72.884	-73.916	-72.676	-72.272
21/12/2013	6:05:37 AM	-73.404	-72.944	-71.98	-72.468	-72.992	-71.156	-71.708	-73.04	-73.852
11/12/2013	6:05:51 AM	-72.136	-73.368	-72.184	-71.244	-72.956	-72.624	-74.62	-74.02	-72.116
14/12/2013	6:05:55 AM	-74.524	-73.16	-73.24	-73.544	-72.092	-72.528	-72.54	-72.788	-73.84
17/12/2013	6:05:59 AM	-71.372	-73.104	-73.284	-72.156	-71.936	-73.256	-73.04	-72.456	-73.296

APPENDEX .22

AlGhobrah - 12PM-6PM

Sample Radio Spectrum Traffic

		MHz								
Date	Time	310	315	320	325	330	335	340	345	350
		POWER IN dBm								
17/12/2013	12:00:01 PM	-72.68	-72.844	-71.964	-71.868	-74.268	-72.644	-71.436	-72.504	-72.976
19/12/2013	12:00:05 PM	-72.46	-73.384	-70.672	-73.872	-74.604	-71.424	-73.344	-72.532	-72.82
22/12/2013	12:00:09 PM	-71.604	-72.012	-72.892	-71.796	-73.332	-72.312	-71.796	-73.02	-73.072
10/12/2013	12:00:19 PM	-73.428	-72.444	-73.232	-73.264	-74.44	-74	-74.1	-74.44	-72.664
11/12/2013	12:00:23 PM	-71.548	-72.916	-72.632	-72.84	-73.256	-73.336	-73.008	-72.452	-73.844
15/12/2013	12:00:27 PM	-72.6	-71.464	-72.908	-73.116	-73.448	-74.312	-73.712	-71.872	-72.456
18/12/2013	12:00:31 PM	-72.208	-72.676	-74.364	-73.38	-72.14	-70.528	-71.508	-72.12	-74.396
20/12/2013	12:00:35 PM	-73.74	-73.056	-72.996	-73.6	-72.008	-74.16	-71.136	-72.96	-72.78
11/12/2013	12:00:49 PM	-74.48	-73.764	-72.208	-74.096	-74.348	-72.556	-73.316	-73.704	-73.072
12/12/2013	12:00:53 PM	-72.232	-74.372	-74.604	-73.688	-73.248	-72.516	-72.56	-72.604	-72.656
16/12/2013	12:00:57 PM	-73.42	-72.976	-73.096	-73.524	-72.968	-73.536	-72.188	-74.668	-72.112
18/12/2013	12:01:01 PM	-72.28	-73.348	-72.196	-72.12	-73.18	-72.284	-72.644	-72.58	-73.824
21/12/2013	12:01:05 PM	-72.408	-71.208	-72.912	-72.492	-71.38	-73.112	-73.108	-71.956	-72.996
11/12/2013	12:01:19 PM	-72.064	-72.424	-71.504	-72.5	-74.296	-75.376	-72.1	-73.74	-74.38
14/12/2013	12:01:23 PM	-71.668	-73.304	-73.86	-73.996	-72.552	-70.388	-72.432	-72.716	-74.184
17/12/2013	12:01:27 PM	-72.428	-72.104	-72.388	-72.824	-72.652	-73.508	-73.036	-72.316	-72.984
19/12/2013	12:01:31 PM	-73.832	-73.616	-72.936	-73.932	-73.132	-73.724	-72.212	-73.236	-72.54
22/12/2013	12:01:35 PM	-73.828	-72.196	-74.416	-72.68	-73.004	-73.988	-73.276	-71.116	-74.348
10/12/2013	12:01:45 PM	-73.276	-72.64	-73.436	-73.576	-73.22	-72.852	-73.016	-73.688	-72.584
11/12/2013	12:01:49 PM	-72.844	-73.904	-72.564	-72.98	-74.004	-72.344	-72.388	-71.336	-71.908
15/12/2013	12:01:53 PM	-73.588	-73.36	-73.704	-73.188	-74.768	-71.776	-73.328	-72.792	-72.688
18/12/2013	12:01:57 PM	-69.576	-72.228	-73.308	-72.632	-73.964	-73.352	-73.264	-73.528	-72.78
20/12/2013	12:02:01 PM	-72.148	-71.924	-72.572	-73.604	-73.604	-71.268	-71.82	-73.068	-73.804
11/12/2013	12:02:15 PM	-73.704	-74.172	-73.912	-72.276	-74.348	-73.412	-72.296	-72.672	-73.1
12/12/2013	12:02:19 PM	-72.176	-72.368	-72.532	-72.412	-74.86	-72.644	-71.604	-72.696	-72.82
16/12/2013	12:02:23 PM	-72.332	-74.8	-71.756	-72.368	-73.28	-72.964	-71.54	-73.728	-72.744
18/12/2013	12:02:27 PM	-72.5	-73.252	-70.364	-73.852	-72.472	-73.824	-71.82	-72.208	-73.468
21/12/2013	12:02:31 PM	-71.872	-71.308	-73.636	-71.732	-73.864	-72.972	-72.516	-72.148	-72.18
11/12/2013	12:02:45 PM	-73.148	-73.268	-72.536	-71.936	-73.052	-73.284	-73.82	-73.2	-72.196
14/12/2013	12:02:49 PM	-73.924	-71.984	-73.38	-72.784	-73.76	-73.392	-73.456	-73.588	-72.788
17/12/2013	12:02:53 PM	-73.392	-72.928	-71.944	-72.328	-73.024	-72.332	-74.66	-71.66	-72.204
19/12/2013	12:02:57 PM	-72.204	-72.88	-73.644	-72.224	-74	-74.932	-74.116	-72.476	-71.476
22/12/2013	12:03:01 PM	-72.632	-72.112	-72.76	-72.216	-72.568	-72.4	-71.796	-72.948	-70.996
10/12/2013	12:03:11 PM	-72.104	-74.576	-73.34	-73.444	-73.212	-72.968	-74.288	-71.852	-74.444
11/12/2013	12:03:15 PM	-71.336	-71.872	-71.06	-71.188	-71.448	-72.964	-72.712	-73.304	-72.776
15/12/2013	12:03:19 PM	-72.292	-72.684	-73.296	-73.772	-74.34	-73.196	-73.136	-72.62	-71.7
18/12/2013	12:03:23 PM	-73.784	-72.932	-71.848	-73.004	-73.052	-73.968	-72.756	-73.308	-72.316
20/12/2013	12:03:27 PM	-73.028	-73.464	-71.8	-72.184	-71.504	-73.664	-70.676	-73.144	-72.74
11/12/2013	12:03:41 PM	-72.868	-72.584	-73.244	-71.576	-73.48	-73.568	-73.972	-72.608	-73.936
12/12/2013	12:03:45 PM	-74.228	-72.46	-73.28	-73	-72.44	-72.856	-71.808	-74.128	-72.02
16/12/2013	12:03:49 PM	-73.052	-71.804	-71.784	-73.14	-72.972	-74.688	-72.184	-71.94	-73.62
18/12/2013	12:03:53 PM	-71.116	-72.696	-71.708	-72.124	-71.62	-73.136	-72.076	-72.576	-73.504
21/12/2013	12:03:57 PM	-71.732	-73.156	-72.352	-71.772	-73.036	-73.108	-73.292	-71.952	-72.896
11/12/2013	12:04:11 PM	-72.952	-73.212	-73.292	-72.148	-73.408	-72.512	-73.86	-71.912	-73.208
14/12/2013	12:04:15 PM	-72.68	-71.932	-73.072	-73.152	-74.216	-72.712	-73.076	-73.416	-72.228
17/12/2013	12:04:19 PM	-73.632	-72.548	-72.324	-71.556	-72.012	-73.34	-71.648	-72.5	-73.88
19/12/2013	12:04:23 PM	-70.996	-72.044	-73.048	-74.02	-73.288	-73.184	-72.044	-73.132	-71.216
22/12/2013	12:04:27 PM	-73	-72.064	-73.912	-73	-70.908	-72.992	-72.792	-73.004	-73.824
10/12/2013	12:04:37 PM	-73.528	-73.924	-72.524	-73.984	-73.968	-72.548	-73.008	-72.72	-73.452
11/12/2013	12:04:41 PM	-72.056	-73.4	-72.672	-71.876	-72.6	-73.128	-73.072	-71.532	-74.992
15/12/2013	12:04:45 PM	-73.208	-73.856	-73.58	-72.068	-72.432	-73.068	-73.596	-71.816	-72.976
18/12/2013	12:04:49 PM	-71.928	-72.472	-73.256	-74.22	-72.592	-72.72	-71.56	-73.292	-73.328
20/12/2013	12:04:53 PM	-74.956	-72.616	-71.796	-72.544	-73.336	-73.544	-72.072	-71.356	-73.356
11/12/2013	12:05:07 PM	-73.228	-73.472	-72.984	-71.436	-73.592	-74.196	-73.552	-72.3	-73.972
12/12/2013	12:05:11 PM	-74.468	-73.844	-72.988	-71.312	-73.208	-73.504	-73.764	-71.4	-72.924
16/12/2013	12:05:15 PM	-73.96	-73.456	-73.272	-73.38	-73.94	-74.216	-74.376	-73.216	-72.376
18/12/2013	12:05:19 PM	-71.86	-74.604	-72.844	-72.964	-72.316	-71.488	-71.512	-71.996	-73.28
21/12/2013	12:05:23 PM	-72.02	-72.26	-72.312	-71.92	-71.18	-72.832	-75.3	-71.376	-72.684
11/12/2013	12:05:37 PM	-71.072	-74.12	-71.528	-73.292	-73.352	-72.74	-73.096	-73.544	-73.812
14/12/2013	12:05:41 PM	-73.252	-73.204	-73.284	-72.516	-72.22	-71.772	-73.12	-74.172	-72.512
17/12/2013	12:05:45 PM	-73.94	-72.204	-72.632	-73.46	-72.448	-72.836	-72.708	-73.46	-73.896
19/12/2013	12:05:49 PM	-74.068	-73.708	-73.236	-74.244	-73.392	-71.472	-72.588	-71.964	-73.528
22/12/2013	12:05:53 PM	-75.56	-72.548	-72.208	-72.308	-72.032	-72.316	-71.952	-72.52	-72.516

APPENDEX .23

AlGhobrah - 6PM-12AM

Sample Radio Spectrum Traffic

		MHz								
Date	Time	355	360	365	370	375	380	385	390	395
		POWER IN dBm								
10/12/2013	6:00:05 PM	-71.024	-73.208	-73.656	-72.704	-73.964	-73.672	-73.476	-73.612	-73.056
11/12/2013	6:00:09 PM	-74.092	-73.944	-72.804	-72.236	-72.008	-72.26	-72.924	-72.168	-72.792
15/12/2013	6:00:13 PM	-74.072	-73.628	-74.86	-71.416	-72.872	-73.192	-73.584	-71.156	-71.9
18/12/2013	6:00:17 PM	-73.032	-70.804	-71.684	-71.044	-73.124	-74.028	-71.52	-71.328	-72.58
20/12/2013	6:00:21 PM	-73.004	-74.032	-73.252	-72.704	-72.54	-73.488	-72.688	-72.768	-73
11/12/2013	6:00:35 PM	-75.332	-73.4	-73.276	-72.748	-75.696	-73.128	-73.032	-73.124	-73.836
12/12/2013	6:00:39 PM	-73.892	-73.824	-73.236	-71.276	-72.872	-73.464	-72.808	-72.188	-71.816
16/12/2013	6:00:43 PM	-73.348	-73.516	-71.992	-72.536	-72.376	-73.896	-72.612	-71.528	-74.316
18/12/2013	6:00:47 PM	-72.48	-71.58	-72.24	-71.66	-73.576	-74.152	-73.092	-73.028	-71.776
21/12/2013	6:00:51 PM	-72.144	-72.38	-71.164	-72.376	-74.192	-72.368	-71.572	-73.892	-72.328
11/12/2013	6:01:05 PM	-73.412	-72.912	-72.776	-71.116	-71.284	-74.58	-73.196	-74.052	-74.152
14/12/2013	6:01:09 PM	-72.884	-72.652	-72.388	-70.396	-71.988	-73.116	-72.44	-73.904	-73.836
17/12/2013	6:01:13 PM	-72.068	-72.176	-73.248	-69.728	-73.948	-72.276	-70.892	-72.804	-73.816
19/12/2013	6:01:17 PM	-72.86	-73.148	-74.036	-71.444	-73.28	-72.604	-72.944	-72.844	-71.24
10/12/2013	6:01:31 PM	-73.612	-74.42	-73.692	-72.32	-73.66	-73.74	-73.944	-72.976	-72.812
11/12/2013	6:01:35 PM	-72.384	-72.904	-73.476	-71.888	-72.616	-74.792	-73.26	-72.98	-74.116
15/12/2013	6:01:39 PM	-73.072	-74.628	-72.572	-73.308	-71.9	-72.488	-72.896	-72.028	-73.132
18/12/2013	6:01:43 PM	-72.008	-72.8	-72.184	-72.26	-74.088	-72.196	-73.652	-73.196	-72.448
20/12/2013	6:01:47 PM	-72.332	-72.012	-71.756	-71.928	-73.748	-71.544	-72.072	-72.36	-72.3
11/12/2013	6:02:01 PM	-71.388	-73.656	-73.952	-72.232	-73.504	-74.192	-71.4	-71.996	-74.74
12/12/2013	6:02:05 PM	-72.884	-74.404	-72.08	-73.64	-73.26	-72.844	-73.784	-72.836	-72.616
16/12/2013	6:02:09 PM	-71.944	-72.22	-73.06	-73.344	-72.836	-74.5	-71.452	-71.096	-72.964
18/12/2013	6:02:13 PM	-72.56	-72.428	-70.328	-67.172	-74.076	-73.276	-71.348	-74.104	-72.2
21/12/2013	6:02:17 PM	-73.556	-72.896	-72.156	-72.072	-70.4	-71.136	-73.196	-73.852	-74.004
11/12/2013	6:02:31 PM	-73.14	-72.612	-71.928	-70.912	-72.956	-72.548	-73.236	-74.028	-72.46
14/12/2013	6:02:35 PM	-73.44	-72.404	-72.848	-71.828	-72.336	-72.356	-72.876	-73.528	-74.416
17/12/2013	6:02:39 PM	-72.944	-71.764	-72.324	-72.8	-73.22	-73.304	-73.008	-71.408	-73.324
19/12/2013	6:02:43 PM	-71.644	-71.492	-73.068	-72.748	-72.488	-71.54	-72.392	-72.276	-71.492
10/12/2013	6:02:57 PM	-72.008	-73.856	-73.336	-72.596	-72.92	-73.056	-74.088	-73.42	-73.104
11/12/2013	6:03:01 PM	-73.228	-73.62	-74.016	-71.676	-73.58	-74.584	-73.148	-73.02	-72.196
15/12/2013	6:03:05 PM	-71.116	-74.116	-69.252	-71.804	-72.836	-71.588	-72.468	-73.048	-72.7
18/12/2013	6:03:09 PM	-73.036	-72.884	-72.052	-73.528	-71.396	-72.616	-71.896	-73.288	-72.584
20/12/2013	6:03:13 PM	-71.808	-72.74	-73.252	-69.684	-74.056	-72.8	-71.604	-72.152	-72.572
11/12/2013	6:03:27 PM	-73.44	-72.66	-74.504	-71.504	-71.888	-72.028	-71.368	-74.1	-71.912
12/12/2013	6:03:31 PM	-72.24	-73.74	-73.756	-72.728	-71.496	-73.904	-71.792	-74.856	-72.992
16/12/2013	6:03:35 PM	-72.708	-71.872	-73.596	-69.472	-72.484	-71.8	-73.68	-72.696	-73.004
18/12/2013	6:03:39 PM	-72.72	-74.496	-72.204	-71.892	-73.176	-71.884	-71.524	-72.54	-73.964
21/12/2013	6:03:43 PM	-73.6	-73.332	-71.076	-70.148	-72.236	-73.732	-73.372	-71.804	-72.604
11/12/2013	6:03:57 PM	-71.676	-72.036	-71.856	-70.016	-73.444	-73.016	-71.248	-72.78	-74.252
14/12/2013	6:04:01 PM	-73.232	-73.632	-73.432	-71.408	-72.144	-72.712	-73.532	-73.612	-71.416
17/12/2013	6:04:05 PM	-73.6	-72.164	-73.216	-72.48	-71.98	-73.876	-72.228	-71.704	-73.456
19/12/2013	6:04:09 PM	-73.008	-72.94	-72.06	-72.604	-72.512	-72.076	-71.944	-72.664	-74.376
10/12/2013	6:04:23 PM	-74.824	-74.012	-72.68	-72.736	-72.748	-73.004	-75.3	-72.62	-73.736
11/12/2013	6:04:27 PM	-73.232	-73.688	-72.908	-71.868	-72.652	-72.38	-72.792	-73.048	-72.476
15/12/2013	6:04:31 PM	-71.972	-72.2	-71.932	-74.076	-72.96	-73.732	-72.3	-72.732	-71.82
18/12/2013	6:04:35 PM	-74.324	-73.116	-72.52	-71.664	-72.964	-72.02	-71.424	-72.212	-71.72
20/12/2013	6:04:39 PM	-71.572	-73.276	-73.776	-70.8	-71.92	-71.72	-71.032	-73.2	-74.012
11/12/2013	6:04:53 PM	-72.644	-74.048	-72.036	-72.936	-72.956	-73.484	-71.984	-72.484	-72.48
12/12/2013	6:04:57 PM	-73.628	-73	-73.508	-72.24	-72.004	-72.768	-72.456	-72.4	-73.136
16/12/2013	6:05:01 PM	-72.224	-71.776	-71.932	-71.468	-73.62	-72.248	-73.264	-72.732	-73.26
18/12/2013	6:05:05 PM	-73.64	-73.42	-72.784	-70.712	-72.848	-73.592	-72.78	-73.052	-71.472
21/12/2013	6:05:09 PM	-72.624	-72.544	-71.16	-71.636	-72.248	-72.796	-72.18	-73.228	-73.508
11/12/2013	6:05:23 PM	-72.488	-71.208	-72.18	-71.228	-73.188	-73.792	-73.348	-72.188	-73.388
14/12/2013	6:05:27 PM	-72.888	-72.94	-73.408	-70.38	-72.38	-72.804	-72.14	-71.808	-72.272
17/12/2013	6:05:31 PM	-73.504	-72.992	-74.412	-70.688	-73.14	-72.14	-71.884	-73.048	-72.104
19/12/2013	6:05:35 PM	-73.132	-72.228	-72.384	-72.808	-73.352	-74.044	-71.484	-72.58	-71.944
10/12/2013	6:05:49 PM	-72.5	-73.164	-73.944	-71.496	-73.244	-72.552	-71.896	-74.376	-74.176
11/12/2013	6:05:53 PM	-73.8	-73.904	-72.468	-73.212	-74.888	-72.924	-73.232	-71.764	-73.34
15/12/2013	6:05:57 PM	-71.82	-73.28	-72.032	-71.676	-72.584	-73.512	-73.2	-72.732	-73.224
18/12/2013	6:06:01 PM	-71.452	-73.944	-72.292	-73.676	-72.34	-74.02	-72.952	-71.036	-71.588
20/12/2013	6:06:05 PM	-74.016	-72.644	-72.164	-72.264	-71.66	-74.316	-73.872	-72.392	-72.064
11/12/2013	6:06:19 PM	-73.208	-74.3	-70.504	-72.636	-73.768	-71.996	-73.052	-73.1	-71.76
12/12/2013	6:06:23 PM	-71.176	-71.596	-73.312	-71.936	-73.708	-73.664	-75.272	-72.164	-73.084

APPENDEX .24

AlKhodh - 12AM-6AM

Sample Radio Spectrum Traffic

		MHz								
Date	Time	400	405	410	415	420	425	430	435	440
		POWER IN dBm								
8/3/2014	12:00:01 AM	-99.578	-103.737	-103.652	-99.069	-103.055	-102.917	-100.190	-106.298	-102.533
11/3/2014	12:00:05 AM	-97.654	-104.770	-104.675	-96.905	-103.719	-103.542	-98.903	-109.354	-102.962
03/14/2014	12:00:09 AM	-95.730	-105.804	-105.698	-94.740	-104.382	-104.168	-97.617	-112.410	-103.391
03/17/2014	12:00:13 AM	-93.806	-106.838	-106.721	-92.576	-105.046	-104.793	-96.330	-115.465	-103.820
3/3/2014	12:00:23 AM	-102.660	-101.908	-102.676	-102.360	-102.052	-102.156	-103.076	-101.896	-101.544
6/3/2014	12:00:27 AM	-100.861	-103.048	-102.970	-100.512	-102.613	-102.500	-101.048	-104.261	-102.247
9/3/2014	12:00:31 AM	-98.937	-104.081	-103.993	-98.347	-103.276	-103.125	-99.761	-107.317	-102.676
12/3/2014	12:00:35 AM	-97.013	-105.115	-105.016	-96.183	-103.940	-103.751	-98.474	-110.373	-103.105
03/15/2014	12:00:39 AM	-95.089	-106.149	-106.039	-94.018	-104.604	-104.376	-97.187	-113.429	-103.534
4/3/2014	12:00:53 AM	-103.460	-100.172	-101.260	-101.524	-100.740	-102.428	-102.672	-102.168	-101.964
7/3/2014	12:00:57 AM	-100.219	-103.392	-103.311	-99.790	-102.834	-102.708	-100.619	-105.280	-102.390
10/3/2014	12:01:01 AM	-98.295	-104.426	-104.334	-97.626	-103.498	-103.334	-99.332	-108.336	-102.819
03/13/2014	12:01:05 AM	-96.371	-105.460	-105.357	-95.461	-104.161	-103.959	-98.045	-111.392	-103.248
03/16/2014	12:01:09 AM	-94.447	-106.493	-106.380	-93.297	-104.825	-104.585	-96.758	-114.448	-103.677
5/3/2014	12:01:23 AM	-101.836	-102.172	-102.072	-102.440	-102.448	-102.320	-102.300	-102.004	-102.472
8/3/2014	12:01:27 AM	-99.578	-103.737	-103.652	-99.068	-103.055	-102.917	-100.190	-106.299	-102.533
11/3/2014	12:01:31 AM	-97.654	-104.771	-104.675	-96.904	-103.719	-103.542	-98.903	-109.355	-102.962
03/14/2014	12:01:35 AM	-95.730	-105.804	-105.698	-94.739	-104.383	-104.168	-97.616	-112.411	-103.391
03/17/2014	12:01:39 AM	-93.805	-106.838	-106.722	-92.575	-105.046	-104.793	-96.329	-115.466	-103.820
3/3/2014	12:01:49 AM	-101.928	-101.396	-102.496	-102.392	-102.832	-102.468	-101.888	-102.152	-101.112
6/3/2014	12:01:53 AM	-100.860	-103.048	-102.970	-100.511	-102.613	-102.500	-101.048	-104.262	-102.247
9/3/2014	12:01:57 AM	-98.936	-104.082	-103.993	-98.347	-103.277	-103.126	-99.761	-107.318	-102.676
12/3/2014	12:02:01 AM	-97.012	-105.115	-105.016	-96.182	-103.940	-103.751	-98.474	-110.374	-103.105
03/15/2014	12:02:05 AM	-95.088	-106.149	-106.040	-94.018	-104.604	-104.376	-97.187	-113.430	-103.534
4/3/2014	12:02:19 AM	-102.272	-101.348	-101.620	-102.816	-101.564	-102.044	-101.312	-101.972	-101.684
7/3/2014	12:02:23 AM	-100.218	-103.393	-103.311	-99.789	-102.834	-102.709	-100.618	-105.281	-102.390
10/3/2014	12:02:27 AM	-98.294	-104.426	-104.334	-97.625	-103.498	-103.334	-99.332	-108.337	-102.819
03/13/2014	12:02:31 AM	-96.370	-105.460	-105.358	-95.460	-104.162	-103.959	-98.045	-111.393	-103.248
03/16/2014	12:02:35 AM	-94.446	-106.494	-106.381	-93.296	-104.825	-104.585	-96.758	-114.449	-103.677
5/3/2014	12:02:49 AM	-102.436	-100.980	-102.804	-101.208	-101.428	-102.484	-100.708	-102.452	-101.396
8/3/2014	12:02:53 AM	-99.577	-103.737	-103.653	-99.068	-103.055	-102.917	-100.189	-106.300	-102.533
11/3/2014	12:02:57 AM	-97.653	-104.771	-104.676	-96.903	-103.719	-103.543	-98.903	-109.356	-102.962
03/14/2014	12:03:01 AM	-95.729	-105.805	-105.699	-94.739	-104.383	-104.168	-97.616	-112.412	-103.391
03/17/2014	12:03:05 AM	-93.805	-106.838	-106.722	-92.574	-105.047	-104.793	-96.329	-115.468	-103.820
3/3/2014	12:03:15 AM	-103.432	-101.936	-102.312	-100.808	-102.672	-101.876	-102.092	-102.584	-102.728
6/3/2014	12:03:19 AM	-100.859	-103.048	-102.971	-100.510	-102.613	-102.500	-101.047	-104.263	-102.247
9/3/2014	12:03:23 AM	-98.935	-104.082	-103.994	-98.346	-103.277	-103.126	-99.760	-107.319	-102.676
12/3/2014	12:03:27 AM	-97.011	-105.116	-105.017	-96.181	-103.940	-103.751	-98.473	-110.375	-103.105
03/15/2014	12:03:31 AM	-95.087	-106.149	-106.040	-94.017	-104.604	-104.376	-97.187	-113.431	-103.534
4/3/2014	12:03:45 AM	-101.764	-102.480	-102.168	-102.136	-102.516	-102.152	-102.612	-99.864	-101.208
7/3/2014	12:03:49 AM	-100.218	-103.393	-103.312	-99.789	-102.834	-102.709	-100.618	-105.282	-102.390
10/3/2014	12:03:53 AM	-98.294	-104.427	-104.335	-97.624	-103.498	-103.334	-99.331	-108.338	-102.819
03/13/2014	12:03:57 AM	-96.370	-105.460	-105.358	-95.460	-104.162	-103.960	-98.044	-111.394	-103.248
03/16/2014	12:04:01 AM	-94.446	-106.494	-106.381	-93.295	-104.825	-104.585	-96.758	-114.450	-103.677
5/3/2014	12:04:15 AM	-103.248	-102.812	-103.208	-101.020	-103.064	-102.912	-102.632	-102.848	-101.800
8/3/2014	12:04:19 AM	-99.576	-103.738	-103.653	-99.067	-103.056	-102.917	-100.189	-106.301	-102.533
11/3/2014	12:04:23 AM	-97.652	-104.771	-104.676	-96.902	-103.719	-103.543	-98.902	-109.357	-102.962
03/14/2014	12:04:27 AM	-95.728	-105.805	-105.699	-94.738	-104.383	-104.168	-97.615	-112.413	-103.391
03/17/2014	12:04:31 AM	-93.804	-106.839	-106.722	-92.573	-105.047	-104.794	-96.328	-115.469	-103.820
3/3/2014	12:04:41 AM	-104.116	-102.652	-101.976	-103.180	-102.188	-101.912	-99.784	-102.888	-102.872
6/3/2014	12:04:45 AM	-100.859	-103.049	-102.971	-100.510	-102.613	-102.501	-101.047	-104.264	-102.247
9/3/2014	12:04:49 AM	-98.935	-104.082	-103.994	-98.345	-103.277	-103.126	-99.760	-107.320	-102.676
12/3/2014	12:04:53 AM	-97.011	-105.116	-105.017	-96.181	-103.941	-103.751	-98.473	-110.376	-103.105
03/15/2014	12:04:57 AM	-95.087	-106.150	-106.040	-94.016	-104.604	-104.377	-97.186	-113.432	-103.534
4/3/2014	12:05:11 AM	-101.808	-102.568	-102.652	-101.596	-102.108	-102.056	-102.480	-101.756	-102.820
7/3/2014	12:05:15 AM	-100.217	-103.393	-103.312	-99.788	-102.835	-102.709	-100.618	-105.283	-102.390
10/3/2014	12:05:19 AM	-98.293	-104.427	-104.335	-97.623	-103.498	-103.334	-99.331	-108.339	-102.819
03/13/2014	12:05:23 AM	-96.369	-105.461	-105.358	-95.459	-104.162	-103.960	-98.044	-111.395	-103.248
03/16/2014	12:05:27 AM	-94.445	-106.494	-106.381	-93.294	-104.826	-104.585	-96.757	-114.451	-103.677
5/3/2014	12:05:41 AM	-102.116	-102.044	-102.020	-102.824	-103.180	-102.712	-102.704	-101.612	-102.732
8/3/2014	12:05:45 AM	-99.576	-103.738	-103.653	-99.066	-103.056	-102.918	-100.189	-106.302	-102.533
11/3/2014	12:05:49 AM	-97.652	-104.772	-104.676	-96.902	-103.720	-103.543	-98.902	-109.358	-102.962
03/14/2014	12:05:53 AM	-95.728	-105.805	-105.699	-94.737	-104.383	-104.168	-97.615	-112.414	-103.391

APPENDEX .25

AlKhodh - 6AM-12PM

Sample Radio Spectrum Traffic

		MHz								
Date	Time	445	450	455	460	465	470	475	480	485
		POWER IN dBm								
3/3/2014	06:00:09 AM	-102.768	-101.352	-101.412	-100.244	-101.636	-101.372	-102.480	-101.644	-99.628
6/3/2014	06:00:13 AM	-100.042	-102.297	-101.653	-100.866	-103.928	-100.242	-102.223	-105.197	-101.832
9/3/2014	06:00:17 AM	-97.850	-102.857	-101.448	-99.732	-106.544	-98.436	-102.783	-109.353	-101.999
12/3/2014	06:00:21 AM	-95.658	-103.416	-101.244	-98.598	-109.159	-96.630	-103.344	-113.509	-102.166
03/15/2014	06:00:25 AM	-93.466	-103.975	-101.039	-97.464	-111.775	-94.824	-103.904	-117.665	-102.332
4/3/2014	06:00:39 AM	-101.744	-101.888	-100.052	-102.236	-101.952	-102.064	-101.932	-102.452	-101.408
7/3/2014	06:00:43 AM	-99.311	-102.484	-101.585	-100.488	-104.800	-99.639	-102.410	-106.583	-101.888
10/3/2014	06:00:47 AM	-97.119	-103.043	-101.380	-99.354	-107.416	-97.833	-102.970	-110.739	-102.055
03/13/2014	06:00:51 AM	-94.927	-103.602	-101.176	-98.220	-110.032	-96.028	-103.531	-114.895	-102.221
03/16/2014	06:00:55 AM	-92.735	-104.161	-100.971	-97.086	-112.647	-94.222	-104.091	-119.050	-102.388
5/3/2014	06:01:09 AM	-101.876	-102.328	-100.540	-101.120	-102.056	-102.196	-100.724	-102.052	-100.780
8/3/2014	06:01:13 AM	-98.580	-102.670	-101.516	-100.110	-105.672	-99.037	-102.596	-107.969	-101.943
11/3/2014	06:01:17 AM	-96.388	-103.229	-101.312	-98.976	-108.288	-97.231	-103.157	-112.125	-102.110
03/14/2014	06:01:21 AM	-94.196	-103.789	-101.108	-97.842	-110.904	-95.425	-103.718	-116.280	-102.277
03/17/2014	06:01:25 AM	-92.004	-104.348	-100.903	-96.708	-113.519	-93.620	-104.278	-120.436	-102.443
3/3/2014	06:01:35 AM	-101.120	-101.556	-101.656	-101.968	-102.364	-101.772	-101.728	-102.200	-100.564
6/3/2014	06:01:39 AM	-100.041	-102.298	-101.653	-100.865	-103.929	-100.241	-102.223	-105.199	-101.832
9/3/2014	06:01:43 AM	-97.849	-102.857	-101.448	-99.731	-106.544	-98.435	-102.783	-109.355	-101.999
12/3/2014	06:01:47 AM	-95.657	-103.416	-101.244	-98.598	-109.160	-96.629	-103.344	-113.510	-102.166
03/15/2014	06:01:51 AM	-93.465	-103.975	-101.039	-97.464	-111.776	-94.823	-103.905	-117.666	-102.332
4/3/2014	06:02:05 AM	-102.848	-101.764	-101.296	-102.876	-102.004	-102.276	-102.152	-102.104	-100.916
7/3/2014	06:02:09 AM	-99.310	-102.484	-101.585	-100.487	-104.801	-99.639	-102.410	-106.585	-101.888
10/3/2014	06:02:13 AM	-97.118	-103.043	-101.380	-99.353	-107.417	-97.833	-102.970	-110.740	-102.055
03/13/2014	06:02:17 AM	-94.926	-103.602	-101.176	-98.220	-110.032	-96.027	-103.531	-114.896	-102.221
03/16/2014	06:02:21 AM	-92.734	-104.161	-100.971	-97.086	-112.648	-94.221	-104.092	-119.052	-102.388
5/3/2014	06:02:35 AM	-102.152	-101.512	-102.128	-100.408	-100.068	-101.380	-101.808	-101.440	-99.688
8/3/2014	06:02:39 AM	-98.579	-102.671	-101.516	-100.109	-105.673	-99.037	-102.597	-107.970	-101.944
11/3/2014	06:02:43 AM	-96.387	-103.230	-101.312	-98.975	-108.289	-97.231	-103.157	-112.126	-102.110
03/14/2014	06:02:47 AM	-94.195	-103.789	-101.108	-97.842	-110.905	-95.425	-103.718	-116.282	-102.277
03/17/2014	06:02:51 AM	-92.003	-104.348	-100.903	-96.708	-113.520	-93.619	-104.278	-120.437	-102.443
3/3/2014	06:03:01 AM	-102.420	-101.576	-101.152	-102.820	-102.472	-102.044	-102.348	-101.728	-101.468
6/3/2014	06:03:05 AM	-100.040	-102.298	-101.653	-100.865	-103.930	-100.240	-102.223	-105.200	-101.832
9/3/2014	06:03:09 AM	-97.848	-102.857	-101.448	-99.731	-106.545	-98.434	-102.784	-109.356	-101.999
12/3/2014	06:03:13 AM	-95.656	-103.416	-101.244	-98.597	-109.161	-96.629	-103.344	-113.512	-102.166
03/15/2014	06:03:17 AM	-93.464	-103.975	-101.039	-97.464	-111.777	-94.823	-103.905	-117.667	-102.332
4/3/2014	06:03:31 AM	-100.484	-101.340	-102.624	-102.124	-101.928	-102.636	-100.488	-102.548	-101.332
7/3/2014	06:03:35 AM	-99.309	-102.484	-101.585	-100.487	-104.802	-99.638	-102.410	-106.586	-101.888
10/3/2014	06:03:39 AM	-97.117	-103.043	-101.380	-99.353	-107.418	-97.832	-102.971	-110.742	-102.055
03/13/2014	06:03:43 AM	-94.925	-103.602	-101.176	-98.219	-110.033	-96.026	-103.531	-114.897	-102.221
03/16/2014	06:03:47 AM	-92.733	-104.162	-100.971	-97.085	-112.649	-94.221	-104.092	-119.053	-102.388
5/3/2014	06:04:01 AM	-101.016	-102.320	-101.812	-102.028	-100.736	-102.312	-101.284	-101.784	-102.380
8/3/2014	06:04:05 AM	-98.579	-102.671	-101.516	-100.109	-105.674	-99.036	-102.597	-107.972	-101.944
11/3/2014	06:04:09 AM	-96.387	-103.230	-101.312	-98.975	-108.290	-97.230	-103.157	-112.127	-102.110
03/14/2014	06:04:13 AM	-94.195	-103.789	-101.107	-97.841	-110.905	-95.424	-103.718	-116.283	-102.277
03/17/2014	06:04:17 AM	-92.003	-104.348	-100.903	-96.707	-113.521	-93.618	-104.279	-120.439	-102.444
3/3/2014	06:04:27 AM	-101.332	-101.332	-102.032	-101.052	-102.436	-101.936	-103.284	-102.444	-101.592
6/3/2014	06:04:31 AM	-100.040	-102.298	-101.653	-100.865	-103.930	-100.240	-102.223	-105.202	-101.832
9/3/2014	06:04:35 AM	-97.848	-102.857	-101.448	-99.731	-106.546	-98.434	-102.784	-109.357	-101.999
12/3/2014	06:04:39 AM	-95.656	-103.416	-101.244	-98.597	-109.162	-96.628	-103.344	-113.513	-102.166
03/15/2014	06:04:43 AM	-93.464	-103.975	-101.039	-97.463	-111.778	-94.822	-103.905	-117.669	-102.332
4/3/2014	06:04:57 AM	-102.444	-101.304	-100.304	-101.952	-101.276	-101.152	-101.624	-102.228	-100.832
7/3/2014	06:05:01 AM	-99.309	-102.484	-101.584	-100.486	-104.803	-99.638	-102.410	-106.587	-101.888
10/3/2014	06:05:05 AM	-97.117	-103.044	-101.380	-99.353	-107.418	-97.832	-102.971	-110.743	-102.055
03/13/2014	06:05:09 AM	-94.925	-103.603	-101.176	-98.219	-110.034	-96.026	-103.531	-114.899	-102.221
03/16/2014	06:05:13 AM	-92.733	-104.162	-100.971	-97.085	-112.650	-94.220	-104.092	-119.054	-102.388
5/3/2014	06:05:27 AM	-101.744	-102.760	-102.328	-102.008	-102.444	-102.572	-102.240	-101.440	-101.996
8/3/2014	06:05:31 AM	-98.578	-102.671	-101.516	-100.108	-105.675	-99.035	-102.597	-107.973	-101.944
11/3/2014	06:05:35 AM	-96.386	-103.230	-101.312	-98.975	-108.291	-97.230	-103.158	-112.129	-102.110
03/14/2014	06:05:39 AM	-94.194	-103.789	-101.107	-97.841	-110.906	-95.424	-103.718	-116.284	-102.277
03/17/2014	06:05:43 AM	-92.002	-104.348	-100.903	-96.707	-113.522	-93.618	-104.279	-120.440	-102.444
3/3/2014	06:05:53 AM	-101.844	-102.124	-100.844	-102.356	-102.520	-102.844	-102.360	-102.704	-100.612
6/3/2014	06:05:57 AM	-100.039	-102.298	-101.653	-100.864	-103.931	-100.239	-102.223	-105.203	-101.833
9/3/2014	06:06:01 AM	-97.847	-102.857	-101.448	-99.730	-106.547	-98.433	-102.784	-109.359	-101.999

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AlKhodh 12PM-6PM

Sample Radio Spectrum Traffic

		MHz								
Date	Time	490	495	500	505	510	515	520	525	530
		POWER IN dBm								
9/3/2014	12:00:03 PM	-98.289	-102.260	-102.066	-96.570	-101.619	-100.100	-110.337	-105.468	-103.117
12/3/2014	12:00:07 PM	-96.498	-102.562	-102.284	-93.907	-101.603	-99.281	-114.903	-107.487	-103.914
03/15/2014	12:00:11 PM	-94.706	-102.865	-102.502	-91.243	-101.587	-98.462	-119.468	-109.507	-104.711
4/3/2014	12:00:25 PM	-102.228	-100.644	-102.344	-101.496	-101.424	-102.000	-101.888	-99.944	-100.060
7/3/2014	12:00:29 PM	-99.484	-102.058	-101.921	-98.346	-101.630	-100.645	-107.293	-104.122	-102.586
10/3/2014	12:00:33 PM	-97.692	-102.361	-102.139	-95.682	-101.614	-99.827	-111.859	-106.141	-103.383
03/13/2014	12:00:37 PM	-95.900	-102.663	-102.357	-93.019	-101.598	-99.008	-116.425	-108.161	-104.180
03/16/2014	12:00:41 PM	-94.108	-102.966	-102.575	-90.355	-101.582	-98.189	-120.991	-110.180	-104.977
5/3/2014	12:00:55 PM	-91.921	-102.907	-102.602	-87.335	-101.266	-97.394	-126.230	-112.694	-105.557
8/3/2014	12:00:59 PM	-98.886	-102.159	-101.994	-97.457	-101.625	-100.372	-108.816	-104.795	-102.852
11/3/2014	12:01:03 PM	-97.094	-102.462	-102.212	-94.794	-101.609	-99.554	-113.382	-106.815	-103.649
03/14/2014	12:01:07 PM	-95.303	-102.764	-102.430	-92.131	-101.593	-98.735	-117.947	-108.834	-104.446
03/17/2014	12:01:11 PM	-93.511	-103.067	-102.647	-89.467	-101.576	-97.916	-122.513	-110.853	-105.243
4/3/2014	12:01:21 PM	-102.348	-101.932	-101.792	-101.708	-102.148	-100.784	-99.560	-101.536	-101.604
6/3/2014	12:01:25 PM	-100.081	-101.957	-101.848	-99.233	-101.635	-100.918	-105.773	-103.449	-102.320
9/3/2014	12:01:29 PM	-98.289	-102.260	-102.066	-96.569	-101.619	-100.099	-110.338	-105.469	-103.117
12/3/2014	12:01:33 PM	-96.497	-102.563	-102.284	-93.906	-101.603	-99.281	-114.904	-107.488	-103.914
03/15/2014	12:01:37 PM	-94.705	-102.865	-102.502	-91.242	-101.587	-98.462	-119.470	-109.507	-104.712
4/3/2014	12:01:51 PM	-103.464	-100.936	-102.588	-102.148	-100.344	-101.640	-101.920	-101.264	-100.176
7/3/2014	12:01:55 PM	-99.483	-102.058	-101.921	-98.345	-101.630	-100.645	-107.295	-104.122	-102.586
10/3/2014	12:01:59 PM	-97.691	-102.361	-102.139	-95.681	-101.614	-99.826	-111.861	-106.142	-103.383
03/13/2014	12:02:03 PM	-95.900	-102.664	-102.357	-93.018	-101.598	-99.008	-116.426	-108.161	-104.180
03/16/2014	12:02:07 PM	-94.108	-102.966	-102.575	-90.354	-101.582	-98.189	-120.992	-110.181	-104.977
5/3/2014	12:02:21 PM	-91.843	-102.913	-102.610	-87.223	-101.263	-97.362	-126.422	-112.782	-105.588
8/3/2014	12:02:25 PM	-98.886	-102.159	-101.994	-97.457	-101.625	-100.372	-108.817	-104.796	-102.852
11/3/2014	12:02:29 PM	-97.094	-102.462	-102.212	-94.793	-101.609	-99.553	-113.383	-106.815	-103.649
03/14/2014	12:02:33 PM	-95.302	-102.765	-102.430	-92.130	-101.592	-98.735	-117.949	-108.835	-104.446
03/17/2014	12:02:37 PM	-93.510	-103.067	-102.648	-89.466	-101.576	-97.916	-122.515	-110.854	-105.243
3/3/2014	12:02:47 PM	-101.824	-101.032	-102.756	-102.252	-101.436	-101.820	-102.012	-100.912	-101.740
6/3/2014	12:02:51 PM	-100.080	-101.957	-101.848	-99.232	-101.635	-100.918	-105.774	-103.450	-102.320
9/3/2014	12:02:55 PM	-98.288	-102.260	-102.066	-96.568	-101.619	-100.099	-110.340	-105.469	-103.118
12/3/2014	12:02:59 PM	-96.496	-102.563	-102.284	-93.905	-101.603	-99.280	-114.906	-107.489	-103.915
03/15/2014	12:03:03 PM	-94.705	-102.866	-102.502	-91.242	-101.587	-98.462	-119.471	-109.508	-104.712
4/3/2014	12:03:17 PM	-101.940	-102.284	-101.440	-100.480	-102.368	-102.572	-102.308	-101.688	-102.044
7/3/2014	12:03:21 PM	-99.483	-102.058	-101.921	-98.344	-101.630	-100.645	-107.297	-104.123	-102.586
10/3/2014	12:03:25 PM	-97.691	-102.361	-102.139	-95.680	-101.614	-99.826	-111.862	-106.143	-103.383
03/13/2014	12:03:29 PM	-95.899	-102.664	-102.357	-93.017	-101.598	-99.008	-116.428	-108.162	-104.181
03/16/2014	12:03:33 PM	-94.107	-102.966	-102.575	-90.353	-101.582	-98.189	-120.994	-110.181	-104.978
5/3/2014	12:03:47 PM	-91.765	-102.920	-102.618	-87.111	-101.260	-97.329	-126.615	-112.870	-105.618
8/3/2014	12:03:51 PM	-98.885	-102.159	-101.994	-97.456	-101.625	-100.372	-108.819	-104.797	-102.852
11/3/2014	12:03:55 PM	-97.093	-102.462	-102.212	-94.792	-101.609	-99.553	-113.385	-106.816	-103.649
03/14/2014	12:03:59 PM	-95.301	-102.765	-102.430	-92.129	-101.592	-98.735	-117.950	-108.835	-104.446
03/17/2014	12:04:03 PM	-93.510	-103.067	-102.648	-89.465	-101.576	-97.916	-122.516	-110.855	-105.244
3/3/2014	12:04:13 PM	-101.088	-102.348	-102.072	-102.288	-102.384	-102.348	-101.980	-101.936	-102.680
6/3/2014	12:04:17 PM	-100.080	-101.957	-101.849	-99.231	-101.635	-100.918	-105.776	-103.450	-102.321
9/3/2014	12:04:21 PM	-98.288	-102.260	-102.066	-96.568	-101.619	-100.099	-110.341	-105.470	-103.118
12/3/2014	12:04:25 PM	-96.496	-102.563	-102.284	-93.904	-101.603	-99.280	-114.907	-107.489	-103.915
03/15/2014	12:04:29 PM	-94.704	-102.866	-102.502	-91.241	-101.587	-98.462	-119.473	-109.509	-104.712
4/3/2014	12:04:43 PM	-101.832	-102.428	-102.056	-102.192	-101.424	-101.752	-100.508	-103.076	-101.644
7/3/2014	12:04:47 PM	-99.482	-102.058	-101.921	-98.343	-101.630	-100.645	-107.298	-104.124	-102.586
10/3/2014	12:04:51 PM	-97.690	-102.361	-102.139	-95.679	-101.614	-99.826	-111.864	-106.143	-103.384
03/13/2014	12:04:55 PM	-95.898	-102.664	-102.357	-93.016	-101.598	-99.007	-116.429	-108.163	-104.181
03/16/2014	12:04:59 PM	-94.106	-102.967	-102.575	-90.353	-101.582	-98.189	-120.995	-110.182	-104.978
5/3/2014	12:05:13 PM	-91.687	-102.926	-102.625	-86.998	-101.256	-97.297	-126.807	-112.957	-105.648
8/3/2014	12:05:17 PM	-98.885	-102.159	-101.994	-97.455	-101.625	-100.372	-108.820	-104.797	-102.852
11/3/2014	12:05:21 PM	-97.093	-102.462	-102.212	-94.791	-101.609	-99.553	-113.386	-106.817	-103.649
03/14/2014	12:05:25 PM	-95.301	-102.765	-102.430	-92.128	-101.592	-98.734	-117.952	-108.836	-104.447
03/17/2014	12:05:29 PM	-93.509	-103.068	-102.648	-89.464	-101.576	-97.916	-122.518	-110.855	-105.244
3/3/2014	12:05:39 PM	-100.796	-102.568	-101.588	-101.288	-101.076	-102.048	-101.496	-101.880	-102.936
6/3/2014	12:05:43 PM	-100.079	-101.957	-101.849	-99.230	-101.635	-100.917	-105.777	-103.451	-102.321
9/3/2014	12:05:47 PM	-98.287	-102.260	-102.067	-96.567	-101.619	-100.099	-110.343	-105.471	-103.118
12/3/2014	12:05:51 PM	-96.495	-102.563	-102.284	-93.903	-101.603	-99.280	-114.909	-107.490	-103.915
03/15/2014	12:05:55 PM	-94.703	-102.866	-102.502	-91.240	-101.587	-98.461	-119.474	-109.509	-104.712

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AlKhodh - 6PM-12AM

Sample Radio Spectrum Traffic

		MHz								
Date	Time	535	540	545	550	555	560	565	570	575
		POWER IN dBm								
4/3/2014	06:00:11 PM	-102.104	-101.832	-102.596	-99.904	-101.384	-101.648	-101.508	-101.112	-100.932
7/3/2014	06:00:15 PM	-106.210	-102.049	-97.914	-102.622	-99.917	-105.118	-96.558	-102.301	-101.145
10/3/2014	06:00:19 PM	-109.707	-102.435	-95.208	-103.474	-98.764	-107.862	-92.915	-103.014	-102.505
03/13/2014	06:00:23 PM	-113.203	-102.821	-92.502	-104.327	-97.611	-110.606	-89.272	-103.727	-103.864
03/16/2014	06:00:27 PM	-116.700	-103.206	-89.797	-105.180	-96.459	-113.349	-85.629	-104.439	-105.224
5/3/2014	06:00:41 PM	-103.879	-101.792	-99.717	-102.053	-100.685	-103.290	-98.986	-101.827	-100.239
8/3/2014	06:00:45 PM	-107.376	-102.178	-97.011	-102.906	-99.533	-106.033	-95.343	-102.539	-101.598
11/3/2014	06:00:49 PM	-110.873	-102.564	-94.306	-103.759	-98.380	-108.777	-91.700	-103.252	-102.958
03/14/2014	06:00:53 PM	-114.369	-102.949	-91.600	-104.612	-97.227	-111.521	-88.058	-103.964	-104.318
03/17/2014	06:00:57 PM	-117.866	-103.335	-88.895	-105.464	-96.074	-114.264	-84.415	-104.677	-105.678
3/3/2014	06:01:07 PM	-100.424	-101.768	-101.304	-101.016	-101.380	-101.580	-100.172	-102.016	-100.224
6/3/2014	06:01:11 PM	-105.045	-101.921	-98.815	-102.337	-100.301	-104.205	-97.771	-102.064	-100.692
9/3/2014	06:01:15 PM	-108.542	-102.307	-96.109	-103.190	-99.148	-106.948	-94.128	-102.777	-102.052
12/3/2014	06:01:19 PM	-112.039	-102.692	-93.404	-104.043	-97.995	-109.692	-90.486	-103.489	-103.412
03/15/2014	06:01:23 PM	-115.535	-103.078	-90.698	-104.896	-96.843	-112.436	-86.843	-104.202	-104.771
4/3/2014	06:01:37 PM	-101.760	-101.232	-101.548	-101.524	-101.948	-100.996	-102.136	-102.124	-99.888
7/3/2014	06:01:41 PM	-106.211	-102.050	-97.913	-102.622	-99.917	-105.119	-96.556	-102.302	-101.146
10/3/2014	06:01:45 PM	-109.708	-102.435	-95.207	-103.475	-98.764	-107.863	-92.914	-103.014	-102.505
03/13/2014	06:01:49 PM	-113.205	-102.821	-92.502	-104.327	-97.611	-110.607	-89.271	-103.727	-103.865
03/16/2014	06:01:53 PM	-116.701	-103.206	-89.796	-105.180	-96.458	-113.350	-85.628	-104.439	-105.225
5/3/2014	06:02:07 PM	-103.880	-101.793	-99.716	-102.053	-100.685	-103.291	-98.985	-101.827	-100.239
8/3/2014	06:02:11 PM	-107.377	-102.178	-97.010	-102.906	-99.532	-106.034	-95.342	-102.539	-101.599
11/3/2014	06:02:15 PM	-110.874	-102.564	-94.305	-103.759	-98.379	-108.778	-91.699	-103.252	-102.959
03/14/2014	06:02:19 PM	-114.371	-102.949	-91.599	-104.612	-97.227	-111.522	-88.056	-103.964	-104.318
03/17/2014	06:02:23 PM	-117.867	-103.335	-88.894	-105.465	-96.074	-114.265	-84.414	-104.677	-105.678
3/3/2014	06:02:33 PM	-101.788	-102.116	-102.152	-101.928	-101.760	-101.000	-102.964	-101.944	-98.256
6/3/2014	06:02:37 PM	-105.046	-101.921	-98.814	-102.338	-100.301	-104.205	-97.770	-102.064	-100.693
9/3/2014	06:02:41 PM	-108.543	-102.307	-96.108	-103.191	-99.148	-106.949	-94.127	-102.777	-102.052
12/3/2014	06:02:45 PM	-112.040	-102.692	-93.403	-104.043	-97.995	-109.693	-90.484	-103.489	-103.412
03/15/2014	06:02:49 PM	-115.537	-103.078	-90.697	-104.896	-96.842	-112.436	-86.842	-104.202	-104.772
4/3/2014	06:03:03 PM	-100.792	-101.684	-100.860	-101.832	-100.912	-102.016	-100.548	-101.316	-100.320
7/3/2014	06:03:07 PM	-106.212	-102.050	-97.912	-102.622	-99.916	-105.120	-96.555	-102.302	-101.146
10/3/2014	06:03:11 PM	-109.709	-102.435	-95.206	-103.475	-98.763	-107.864	-92.912	-103.014	-102.506
03/13/2014	06:03:15 PM	-113.206	-102.821	-92.501	-104.328	-97.611	-110.608	-89.270	-103.727	-103.865
03/16/2014	06:03:19 PM	-116.703	-103.206	-89.795	-105.181	-96.458	-113.351	-85.627	-104.440	-105.225
5/3/2014	06:03:33 PM	-103.882	-101.793	-99.715	-102.054	-100.685	-103.292	-98.983	-101.827	-100.240
8/3/2014	06:03:37 PM	-107.378	-102.178	-97.010	-102.906	-99.532	-106.035	-95.341	-102.540	-101.599
11/3/2014	06:03:41 PM	-110.875	-102.564	-94.304	-103.759	-98.379	-108.779	-91.698	-103.252	-102.959
03/14/2014	06:03:45 PM	-114.372	-102.949	-91.599	-104.612	-97.226	-111.522	-88.055	-103.965	-104.319
03/17/2014	06:03:49 PM	-117.868	-103.335	-88.893	-105.465	-96.074	-114.266	-84.412	-104.677	-105.678
3/3/2014	06:03:59 PM	-100.392	-101.712	-102.008	-100.356	-102.424	-101.452	-101.132	-101.848	-97.580
6/3/2014	06:04:03 PM	-105.048	-101.921	-98.813	-102.338	-100.300	-104.206	-97.769	-102.065	-100.693
9/3/2014	06:04:07 PM	-108.544	-102.307	-96.107	-103.191	-99.148	-106.950	-94.126	-102.777	-102.053
12/3/2014	06:04:11 PM	-112.041	-102.692	-93.402	-104.044	-97.995	-109.694	-90.483	-103.490	-103.412
03/15/2014	06:04:15 PM	-115.538	-103.078	-90.696	-104.896	-96.842	-112.437	-86.840	-104.202	-104.772
4/3/2014	06:04:29 PM	-101.108	-100.564	-101.224	-101.744	-102.376	-102.452	-100.104	-102.284	-97.780
7/3/2014	06:04:33 PM	-106.214	-102.050	-97.911	-102.622	-99.916	-105.121	-96.554	-102.302	-101.146
10/3/2014	06:04:37 PM	-109.710	-102.435	-95.205	-103.475	-98.763	-107.865	-92.911	-103.015	-102.506
03/13/2014	06:04:41 PM	-113.207	-102.821	-92.500	-104.328	-97.610	-110.609	-89.269	-103.727	-103.866
03/16/2014	06:04:45 PM	-116.704	-103.207	-89.794	-105.181	-96.458	-113.352	-85.626	-104.440	-105.226
5/3/2014	06:04:59 PM	-103.883	-101.793	-99.714	-102.054	-100.684	-103.292	-98.982	-101.827	-100.240
8/3/2014	06:05:03 PM	-107.379	-102.178	-97.009	-102.907	-99.532	-106.036	-95.339	-102.540	-101.600
11/3/2014	06:05:07 PM	-110.876	-102.564	-94.303	-103.760	-98.379	-108.780	-91.697	-103.252	-102.960
03/14/2014	06:05:11 PM	-114.373	-102.950	-91.598	-104.612	-97.226	-111.523	-88.054	-103.965	-104.319
03/17/2014	06:05:15 PM	-117.870	-103.335	-88.892	-105.465	-96.073	-114.267	-84.411	-104.677	-105.679
3/3/2014	06:05:25 PM	-102.296	-101.648	-101.584	-102.692	-101.300	-100.768	-101.716	-102.404	-99.876
6/3/2014	06:05:29 PM	-105.049	-101.921	-98.812	-102.338	-100.300	-104.207	-97.767	-102.065	-100.694
9/3/2014	06:05:33 PM	-108.545	-102.307	-96.107	-103.191	-99.147	-106.951	-94.125	-102.777	-102.053
12/3/2014	06:05:37 PM	-112.042	-102.693	-93.401	-104.044	-97.994	-109.695	-90.482	-103.490	-103.413
03/15/2014	06:05:41 PM	-115.539	-103.078	-90.695	-104.897	-96.842	-112.438	-86.839	-104.202	-104.773
4/3/2014	06:05:55 PM	-100.904	-100.912	-101.448	-100.652	-101.336	-102.276	-101.436	-101.864	-98.248
7/3/2014	06:05:59 PM	-106.215	-102.050	-97.910	-102.623	-99.916	-105.122	-96.553	-102.302	-101.147
10/3/2014	06:06:03 PM	-109.711	-102.436	-95.204	-103.476	-98.763	-107.866	-92.910	-103.015	-102.507

APPENDEX .28

Salalah - 12AM-6AM

Sample Radio Spectrum Traffic

		MHz								
Date	Time	580	585	590	595	600	605	610	615	620
		POWER IN dBm								
8/16/2014	12:00:01 AM	-101.493	-101.406	-101.414	-101.348	-101.280	-101.232	-101.189	-101.082	-101.090
8/19/2014	12:00:05 AM	-101.448	-101.321	-101.372	-101.283	-101.222	-101.154	-101.121	-100.964	-101.021
8/22/2014	12:00:09 AM	-101.403	-101.235	-101.331	-101.217	-101.164	-101.076	-101.053	-100.846	-100.952
8/25/2014	12:00:13 AM	-101.358	-101.149	-101.289	-101.152	-101.106	-100.997	-100.984	-100.728	-100.882
8/14/2014	12:00:27 AM	-101.448	-102.288	-102.520	-101.908	-100.360	-101.312	-100.624	-100.948	-101.264
8/17/2014	12:00:31 AM	-101.478	-101.378	-101.400	-101.327	-101.261	-101.206	-101.166	-101.042	-101.067
8/20/2014	12:00:35 AM	-101.433	-101.292	-101.359	-101.261	-101.203	-101.128	-101.098	-100.925	-100.998
8/23/2014	12:00:39 AM	-101.388	-101.206	-101.317	-101.196	-101.145	-101.050	-101.030	-100.807	-100.929
8/26/2014	12:00:43 AM	-101.343	-101.120	-101.275	-101.130	-101.087	-100.971	-100.962	-100.689	-100.859
8/12/2014	12:00:53 AM	-101.836	-102.112	-102.288	-101.100	-100.252	-100.972	-101.004	-101.100	-100.988
8/15/2014	12:00:57 AM	-101.509	-101.435	-101.428	-101.370	-101.299	-101.258	-101.212	-101.121	-101.113
8/18/2014	12:01:01 AM	-101.463	-101.349	-101.386	-101.305	-101.241	-101.180	-101.143	-101.003	-101.044
8/21/2014	12:01:05 AM	-101.418	-101.263	-101.345	-101.239	-101.183	-101.102	-101.075	-100.885	-100.975
8/24/2014	12:01:09 AM	-101.373	-101.178	-101.303	-101.174	-101.125	-101.023	-101.007	-100.768	-100.906
8/13/2014	12:01:23 AM	-101.728	-101.104	-102.040	-101.556	-100.328	-100.488	-100.476	-101.132	-101.796
8/16/2014	12:01:27 AM	-101.493	-101.406	-101.414	-101.348	-101.280	-101.232	-101.189	-101.081	-101.090
8/19/2014	12:01:31 AM	-101.448	-101.320	-101.372	-101.283	-101.222	-101.154	-101.121	-100.964	-101.021
8/22/2014	12:01:35 AM	-101.403	-101.235	-101.331	-101.217	-101.164	-101.076	-101.053	-100.846	-100.952
8/25/2014	12:01:39 AM	-101.358	-101.149	-101.289	-101.152	-101.106	-100.997	-100.984	-100.728	-100.882
8/14/2014	12:01:53 AM	-101.416	-102.064	-101.168	-101.524	-101.052	-100.600	-102.204	-100.788	-100.032
8/17/2014	12:01:57 AM	-101.478	-101.378	-101.400	-101.326	-101.260	-101.206	-101.166	-101.042	-101.067
8/20/2014	12:02:01 AM	-101.433	-101.292	-101.358	-101.261	-101.203	-101.128	-101.098	-100.925	-100.998
8/23/2014	12:02:05 AM	-101.388	-101.206	-101.317	-101.196	-101.145	-101.050	-101.030	-100.807	-100.929
8/26/2014	12:02:09 AM	-101.343	-101.120	-101.275	-101.130	-101.087	-100.971	-100.962	-100.689	-100.859
8/12/2014	12:02:19 AM	-101.216	-99.952	-101.728	-101.340	-102.212	-101.624	-102.512	-102.220	-101.904
8/15/2014	12:02:23 AM	-101.509	-101.435	-101.428	-101.370	-101.299	-101.258	-101.212	-101.121	-101.113
8/18/2014	12:02:27 AM	-101.463	-101.349	-101.386	-101.305	-101.241	-101.180	-101.143	-101.003	-101.044
8/21/2014	12:02:31 AM	-101.418	-101.263	-101.345	-101.239	-101.183	-101.102	-101.075	-100.885	-100.975
8/24/2014	12:02:35 AM	-101.373	-101.178	-101.303	-101.174	-101.125	-101.023	-101.007	-100.768	-100.905
8/13/2014	12:02:49 AM	-101.868	-101.568	-101.408	-100.796	-102.596	-101.224	-99.532	-102.468	-101.388
8/16/2014	12:02:53 AM	-101.493	-101.406	-101.414	-101.348	-101.280	-101.232	-101.189	-101.081	-101.090
8/19/2014	12:02:57 AM	-101.448	-101.320	-101.372	-101.283	-101.222	-101.154	-101.121	-100.964	-101.021
8/22/2014	12:03:01 AM	-101.403	-101.235	-101.331	-101.217	-101.164	-101.076	-101.053	-100.846	-100.952
8/25/2014	12:03:05 AM	-101.358	-101.149	-101.289	-101.152	-101.106	-100.997	-100.984	-100.728	-100.882
8/14/2014	12:03:19 AM	-101.484	-101.312	-101.828	-101.752	-101.576	-101.528	-101.700	-101.240	-101.464
8/17/2014	12:03:23 AM	-101.478	-101.378	-101.400	-101.326	-101.260	-101.206	-101.166	-101.042	-101.067
8/20/2014	12:03:27 AM	-101.433	-101.292	-101.358	-101.261	-101.203	-101.128	-101.098	-100.925	-100.998
8/23/2014	12:03:31 AM	-101.388	-101.206	-101.317	-101.196	-101.145	-101.049	-101.030	-100.807	-100.929
8/26/2014	12:03:35 AM	-101.343	-101.120	-101.275	-101.130	-101.087	-100.971	-100.962	-100.689	-100.859
8/12/2014	12:03:45 AM	-102.556	-101.208	-99.932	-101.188	-101.736	-102.376	-101.560	-101.988	-100.904
8/15/2014	12:03:49 AM	-101.509	-101.435	-101.428	-101.370	-101.299	-101.258	-101.212	-101.121	-101.113
8/18/2014	12:03:53 AM	-101.463	-101.349	-101.386	-101.305	-101.241	-101.180	-101.143	-101.003	-101.044
8/21/2014	12:03:57 AM	-101.418	-101.263	-101.345	-101.239	-101.183	-101.102	-101.075	-100.885	-100.975
8/24/2014	12:04:01 AM	-101.373	-101.178	-101.303	-101.174	-101.125	-101.023	-101.007	-100.768	-100.905
8/13/2014	12:04:15 AM	-102.468	-100.736	-101.936	-101.188	-102.288	-100.816	-100.412	-100.464	-102.012
8/16/2014	12:04:19 AM	-101.493	-101.406	-101.414	-101.348	-101.280	-101.232	-101.189	-101.081	-101.090
8/19/2014	12:04:23 AM	-101.448	-101.320	-101.372	-101.283	-101.222	-101.154	-101.121	-100.964	-101.021
8/22/2014	12:04:27 AM	-101.403	-101.235	-101.331	-101.217	-101.164	-101.076	-101.053	-100.846	-100.952
8/25/2014	12:04:31 AM	-101.358	-101.149	-101.289	-101.152	-101.106	-100.997	-100.984	-100.728	-100.882
8/14/2014	12:04:45 AM	-101.408	-100.584	-101.772	-100.884	-102.300	-101.240	-100.572	-101.436	-102.084
8/17/2014	12:04:49 AM	-101.478	-101.378	-101.400	-101.326	-101.260	-101.206	-101.166	-101.042	-101.067
8/20/2014	12:04:53 AM	-101.433	-101.292	-101.358	-101.261	-101.203	-101.128	-101.098	-100.924	-100.998
8/23/2014	12:04:57 AM	-101.388	-101.206	-101.317	-101.196	-101.145	-101.049	-101.030	-100.807	-100.928
8/26/2014	12:05:01 AM	-101.343	-101.120	-101.275	-101.130	-101.087	-100.971	-100.962	-100.689	-100.859
8/12/2014	12:05:11 AM	-100.216	-101.560	-102.264	-102.080	-101.884	-101.712	-101.484	-100.736	-102.012
8/15/2014	12:05:15 AM	-101.509	-101.435	-101.428	-101.370	-101.299	-101.258	-101.212	-101.121	-101.113
8/18/2014	12:05:19 AM	-101.463	-101.349	-101.386	-101.305	-101.241	-101.180	-101.143	-101.003	-101.044
8/21/2014	12:05:23 AM	-101.418	-101.263	-101.345	-101.239	-101.183	-101.102	-101.075	-100.885	-100.975
8/24/2014	12:05:27 AM	-101.373	-101.177	-101.303	-101.174	-101.125	-101.023	-101.007	-100.768	-100.905
8/13/2014	12:05:41 AM	-101.332	-101.768	-100.224	-102.752	-99.848	-101.732	-100.608	-101.940	-101.504
8/16/2014	12:05:45 AM	-101.493	-101.406	-101.414	-101.348	-101.280	-101.232	-101.189	-101.081	-101.090
8/19/2014	12:05:49 AM	-101.448	-101.320	-101.372	-101.283	-101.222	-101.154	-101.121	-100.964	-101.021
8/22/2014	12:05:53 AM	-101.403	-101.235	-101.331	-101.217	-101.164	-101.076	-101.053	-100.846	-100.952

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Salalah - 6AM-12PM

Sample Radio Spectrum Traffic

		MHz								
Date	Time	625	630	635	640	645	650	655	660	665
		POWER IN dBm								
8/14/2014	06:00:13 AM	-101.992	-102.396	-100.764	-102.052	-101.288	-100.708	-100.808	-100.720	-101.580
8/17/2014	06:00:17 AM	-101.060	-100.944	-100.951	-100.861	-100.888	-100.714	-100.854	-100.773	-100.548
8/20/2014	06:00:21 AM	-101.023	-100.852	-100.902	-100.763	-100.869	-100.585	-100.848	-100.768	-100.407
8/23/2014	06:00:25 AM	-100.985	-100.760	-100.853	-100.666	-100.849	-100.456	-100.841	-100.762	-100.266
8/26/2014	06:00:29 AM	-100.948	-100.668	-100.804	-100.568	-100.830	-100.327	-100.835	-100.757	-100.125
8/12/2014	06:00:39 AM	-99.156	-101.500	-99.860	-100.772	-102.048	-101.060	-100.688	-101.764	-101.936
8/15/2014	06:00:43 AM	-101.085	-101.006	-100.983	-100.926	-100.901	-100.800	-100.858	-100.777	-100.642
8/18/2014	06:00:47 AM	-101.048	-100.914	-100.934	-100.828	-100.882	-100.671	-100.852	-100.771	-100.501
8/21/2014	06:00:51 AM	-101.010	-100.822	-100.885	-100.731	-100.862	-100.542	-100.845	-100.766	-100.360
8/24/2014	06:00:55 AM	-100.973	-100.730	-100.836	-100.633	-100.843	-100.413	-100.839	-100.761	-100.219
8/13/2014	06:01:09 AM	-101.028	-100.172	-101.696	-100.936	-99.500	-101.688	-101.452	-100.388	-101.640
8/16/2014	06:01:13 AM	-101.073	-100.975	-100.967	-100.893	-100.895	-100.757	-100.856	-100.775	-100.595
8/19/2014	06:01:17 AM	-101.035	-100.883	-100.918	-100.796	-100.875	-100.628	-100.850	-100.770	-100.454
8/22/2014	06:01:21 AM	-100.998	-100.791	-100.869	-100.698	-100.856	-100.499	-100.843	-100.764	-100.313
8/25/2014	06:01:25 AM	-100.960	-100.699	-100.820	-100.601	-100.836	-100.370	-100.837	-100.759	-100.172
8/14/2014	06:01:39 AM	-100.000	-101.992	-101.828	-100.232	-100.004	-101.092	-100.856	-100.900	-100.508
8/17/2014	06:01:43 AM	-101.060	-100.944	-100.951	-100.861	-100.888	-100.714	-100.854	-100.773	-100.548
8/20/2014	06:01:47 AM	-101.023	-100.852	-100.902	-100.763	-100.869	-100.585	-100.848	-100.768	-100.407
8/23/2014	06:01:51 AM	-100.985	-100.760	-100.853	-100.666	-100.849	-100.456	-100.841	-100.762	-100.266
8/26/2014	06:01:55 AM	-100.948	-100.668	-100.804	-100.568	-100.830	-100.327	-100.835	-100.757	-100.125
8/12/2014	06:02:05 AM	-102.128	-100.604	-101.136	-100.432	-101.420	-101.724	-100.180	-100.192	-100.516
8/15/2014	06:02:09 AM	-101.085	-101.005	-100.983	-100.926	-100.901	-100.800	-100.858	-100.777	-100.642
8/18/2014	06:02:13 AM	-101.048	-100.914	-100.934	-100.828	-100.882	-100.671	-100.852	-100.771	-100.501
8/21/2014	06:02:17 AM	-101.010	-100.822	-100.885	-100.731	-100.862	-100.542	-100.845	-100.766	-100.360
8/24/2014	06:02:21 AM	-100.973	-100.730	-100.836	-100.633	-100.843	-100.413	-100.839	-100.761	-100.219
8/13/2014	06:02:35 AM	-102.168	-100.308	-101.252	-99.708	-101.512	-101.884	-101.280	-101.268	-100.896
8/16/2014	06:02:39 AM	-101.073	-100.975	-100.967	-100.893	-100.895	-100.757	-100.856	-100.775	-100.595
8/19/2014	06:02:43 AM	-101.035	-100.883	-100.918	-100.796	-100.875	-100.628	-100.850	-100.770	-100.454
8/22/2014	06:02:47 AM	-100.998	-100.791	-100.869	-100.698	-100.856	-100.499	-100.843	-100.764	-100.313
8/25/2014	06:02:51 AM	-100.960	-100.699	-100.820	-100.601	-100.836	-100.370	-100.837	-100.759	-100.172
8/14/2014	06:03:05 AM	-101.584	-101.568	-100.964	-100.080	-102.220	-101.836	-98.340	-100.340	-100.460
8/17/2014	06:03:09 AM	-101.060	-100.944	-100.951	-100.861	-100.888	-100.714	-100.854	-100.773	-100.548
8/20/2014	06:03:13 AM	-101.023	-100.852	-100.902	-100.763	-100.869	-100.585	-100.848	-100.768	-100.407
8/23/2014	06:03:17 AM	-100.985	-100.760	-100.853	-100.666	-100.849	-100.456	-100.841	-100.762	-100.266
8/26/2014	06:03:21 AM	-100.948	-100.668	-100.804	-100.568	-100.830	-100.327	-100.835	-100.757	-100.125
8/12/2014	06:03:31 AM	-102.220	-101.672	-100.736	-101.512	-100.204	-100.856	-100.508	-99.472	-100.760
8/15/2014	06:03:35 AM	-101.085	-101.005	-100.983	-100.926	-100.901	-100.800	-100.858	-100.777	-100.642
8/18/2014	06:03:39 AM	-101.048	-100.914	-100.934	-100.828	-100.882	-100.671	-100.852	-100.771	-100.501
8/21/2014	06:03:43 AM	-101.010	-100.822	-100.885	-100.731	-100.862	-100.542	-100.845	-100.766	-100.360
8/24/2014	06:03:47 AM	-100.973	-100.730	-100.836	-100.633	-100.843	-100.413	-100.839	-100.761	-100.219
8/13/2014	06:04:01 AM	-101.516	-101.080	-100.428	-101.456	-100.484	-101.364	-101.724	-100.660	-100.100
8/16/2014	06:04:05 AM	-101.073	-100.975	-100.967	-100.893	-100.895	-100.757	-100.856	-100.775	-100.595
8/19/2014	06:04:09 AM	-101.035	-100.883	-100.918	-100.796	-100.875	-100.628	-100.850	-100.770	-100.454
8/22/2014	06:04:13 AM	-100.998	-100.791	-100.869	-100.698	-100.856	-100.499	-100.843	-100.764	-100.313
8/25/2014	06:04:17 AM	-100.960	-100.699	-100.820	-100.601	-100.836	-100.370	-100.837	-100.759	-100.172
8/14/2014	06:04:31 AM	-101.148	-100.384	-100.496	-101.028	-101.796	-101.028	-102.112	-101.556	-100.232
8/17/2014	06:04:35 AM	-101.060	-100.944	-100.951	-100.861	-100.888	-100.714	-100.854	-100.773	-100.548
8/20/2014	06:04:39 AM	-101.023	-100.852	-100.902	-100.763	-100.869	-100.585	-100.848	-100.768	-100.407
8/23/2014	06:04:43 AM	-100.985	-100.760	-100.853	-100.666	-100.849	-100.456	-100.841	-100.762	-100.266
8/26/2014	06:04:47 AM	-100.948	-100.668	-100.804	-100.568	-100.830	-100.327	-100.835	-100.757	-100.125
8/12/2014	06:04:57 AM	-101.128	-101.224	-100.408	-101.780	-100.720	-101.372	-100.928	-99.892	-100.516
8/15/2014	06:05:01 AM	-101.085	-101.005	-100.983	-100.926	-100.901	-100.800	-100.858	-100.777	-100.642
8/18/2014	06:05:05 AM	-101.048	-100.913	-100.934	-100.828	-100.882	-100.671	-100.852	-100.771	-100.501
8/21/2014	06:05:09 AM	-101.010	-100.822	-100.885	-100.731	-100.862	-100.542	-100.845	-100.766	-100.360
8/24/2014	06:05:13 AM	-100.973	-100.730	-100.836	-100.633	-100.843	-100.413	-100.839	-100.761	-100.219
8/13/2014	06:05:27 AM	-101.660	-100.540	-101.404	-101.320	-99.892	-101.664	-101.148	-100.404	-101.568
8/16/2014	06:05:31 AM	-101.073	-100.975	-100.967	-100.893	-100.895	-100.757	-100.856	-100.775	-100.595
8/19/2014	06:05:35 AM	-101.035	-100.883	-100.918	-100.796	-100.875	-100.628	-100.850	-100.770	-100.454
8/22/2014	06:05:39 AM	-100.998	-100.791	-100.869	-100.698	-100.856	-100.499	-100.843	-100.764	-100.313
8/25/2014	06:05:43 AM	-100.960	-100.699	-100.820	-100.601	-100.836	-100.370	-100.837	-100.759	-100.172
8/14/2014	06:05:57 AM	-101.156	-101.536	-101.096	-101.192	-100.768	-101.628	-101.316	-99.056	-101.816
8/17/2014	06:06:01 AM	-101.060	-100.944	-100.951	-100.861	-100.888	-100.714	-100.854	-100.773	-100.548
8/20/2014	06:06:05 AM	-101.023	-100.852	-100.902	-100.763	-100.869	-100.585	-100.848	-100.768	-100.407

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Salalah - 12PM-6PM

Sample Radio Spectrum Traffic

		MHz								
Date	Time	670	675	680	685	690	695	700	705	710
		POWER IN dBm								
8/17/2014	12:00:03 PM	-100.436	-100.541	-100.605	-100.318	-100.482	-100.425	-100.210	-100.396	-100.345
8/20/2014	12:00:07 PM	-100.270	-100.455	-100.607	-100.157	-100.462	-100.382	-100.093	-100.418	-100.367
8/23/2014	12:00:11 PM	-100.105	-100.369	-100.609	-99.997	-100.442	-100.338	-99.976	-100.439	-100.389
8/12/2014	12:00:25 PM	-100.148	-99.900	-99.372	-100.992	-101.044	-100.412	-100.220	-99.472	-98.756
8/15/2014	12:00:29 PM	-100.547	-100.599	-100.604	-100.425	-100.496	-100.454	-100.288	-100.382	-100.331
8/18/2014	12:00:33 PM	-100.381	-100.512	-100.606	-100.264	-100.476	-100.411	-100.171	-100.403	-100.353
8/21/2014	12:00:37 PM	-100.215	-100.426	-100.607	-100.104	-100.456	-100.367	-100.054	-100.425	-100.375
8/24/2014	12:00:41 PM	-100.049	-100.340	-100.609	-99.944	-100.435	-100.324	-99.937	-100.447	-100.397
8/13/2014	12:00:55 PM	-99.636	-101.156	-100.384	-101.152	-100.404	-101.304	-101.264	-100.808	-100.712
8/16/2014	12:00:59 PM	-100.491	-100.570	-100.605	-100.371	-100.489	-100.440	-100.249	-100.389	-100.338
8/19/2014	12:01:03 PM	-100.326	-100.484	-100.606	-100.211	-100.469	-100.396	-100.132	-100.411	-100.360
8/22/2014	12:01:07 PM	-100.160	-100.397	-100.608	-100.051	-100.449	-100.353	-100.015	-100.432	-100.382
8/25/2014	12:01:11 PM	-99.994	-100.311	-100.610	-99.890	-100.429	-100.309	-99.898	-100.454	-100.404
8/11/2014	12:01:21 PM	-102.184	-102.472	-101.816	-101.768	-101.324	-99.944	-102.032	-101.692	-100.924
8/14/2014	12:01:25 PM	-101.604	-100.372	-100.636	-100.808	-98.500	-100.364	-98.872	-102.272	-100.856
8/17/2014	12:01:29 PM	-100.436	-100.541	-100.605	-100.318	-100.482	-100.425	-100.210	-100.396	-100.345
8/20/2014	12:01:33 PM	-100.270	-100.455	-100.607	-100.157	-100.462	-100.382	-100.093	-100.418	-100.367
8/23/2014	12:01:37 PM	-100.104	-100.369	-100.609	-99.997	-100.442	-100.338	-99.976	-100.439	-100.389
8/12/2014	12:01:51 PM	-101.328	-101.156	-101.460	-100.548	-101.116	-100.628	-101.180	-100.944	-100.212
8/15/2014	12:01:55 PM	-100.547	-100.599	-100.604	-100.424	-100.496	-100.454	-100.288	-100.382	-100.331
8/18/2014	12:01:59 PM	-100.381	-100.512	-100.606	-100.264	-100.476	-100.411	-100.171	-100.403	-100.353
8/21/2014	12:02:03 PM	-100.215	-100.426	-100.607	-100.104	-100.455	-100.367	-100.054	-100.425	-100.375
8/24/2014	12:02:07 PM	-100.049	-100.340	-100.609	-99.944	-100.435	-100.324	-99.937	-100.447	-100.397
8/13/2014	12:02:21 PM	-100.836	-102.196	-101.436	-99.220	-101.696	-100.296	-100.376	-99.492	-99.076
8/16/2014	12:02:25 PM	-100.491	-100.570	-100.605	-100.371	-100.489	-100.440	-100.249	-100.389	-100.338
8/19/2014	12:02:29 PM	-100.326	-100.484	-100.606	-100.211	-100.469	-100.396	-100.132	-100.411	-100.360
8/22/2014	12:02:33 PM	-100.160	-100.397	-100.608	-100.051	-100.449	-100.353	-100.015	-100.432	-100.382
8/25/2014	12:02:37 PM	-99.994	-100.311	-100.610	-99.890	-100.429	-100.309	-99.898	-100.454	-100.404
8/11/2014	12:02:47 PM	-101.128	-100.832	-102.136	-101.448	-100.220	-100.924	-100.396	-100.892	-99.924
8/14/2014	12:02:51 PM	-101.720	-100.316	-100.940	-101.500	-101.388	-99.524	-99.904	-100.752	-101.560
8/17/2014	12:02:55 PM	-100.436	-100.541	-100.605	-100.318	-100.482	-100.425	-100.210	-100.396	-100.345
8/20/2014	12:02:59 PM	-100.270	-100.455	-100.607	-100.157	-100.462	-100.382	-100.093	-100.418	-100.367
8/23/2014	12:03:03 PM	-100.104	-100.369	-100.609	-99.997	-100.442	-100.338	-99.976	-100.439	-100.389
8/12/2014	12:03:17 PM	-101.092	-101.400	-100.740	-100.316	-100.192	-101.764	-101.204	-100.528	-98.856
8/15/2014	12:03:21 PM	-100.547	-100.599	-100.604	-100.424	-100.496	-100.454	-100.288	-100.382	-100.331
8/18/2014	12:03:25 PM	-100.381	-100.512	-100.606	-100.264	-100.476	-100.411	-100.171	-100.403	-100.353
8/21/2014	12:03:29 PM	-100.215	-100.426	-100.607	-100.104	-100.455	-100.367	-100.054	-100.425	-100.375
8/24/2014	12:03:33 PM	-100.049	-100.340	-100.609	-99.944	-100.435	-100.324	-99.937	-100.447	-100.397
8/13/2014	12:03:47 PM	-101.204	-100.768	-101.108	-101.232	-100.844	-99.672	-100.032	-99.704	-99.572
8/16/2014	12:03:51 PM	-100.491	-100.570	-100.605	-100.371	-100.489	-100.440	-100.249	-100.389	-100.338
8/19/2014	12:03:55 PM	-100.325	-100.484	-100.606	-100.211	-100.469	-100.396	-100.132	-100.411	-100.360
8/22/2014	12:03:59 PM	-100.160	-100.397	-100.608	-100.051	-100.449	-100.353	-100.015	-100.432	-100.382
8/25/2014	12:04:03 PM	-99.994	-100.311	-100.610	-99.890	-100.429	-100.309	-99.898	-100.454	-100.404
8/11/2014	12:04:13 PM	-101.620	-101.820	-98.488	-100.464	-101.444	-100.532	-100.176	-101.176	-99.344
8/14/2014	12:04:17 PM	-100.652	-100.496	-99.880	-99.308	-100.424	-100.756	-100.824	-100.612	-100.152
8/17/2014	12:04:21 PM	-100.436	-100.541	-100.605	-100.318	-100.482	-100.425	-100.210	-100.396	-100.345
8/20/2014	12:04:25 PM	-100.270	-100.455	-100.607	-100.157	-100.462	-100.382	-100.093	-100.418	-100.367
8/23/2014	12:04:29 PM	-100.104	-100.369	-100.609	-99.997	-100.442	-100.338	-99.976	-100.439	-100.389
8/12/2014	12:04:43 PM	-99.496	-99.512	-100.324	-99.704	-99.896	-101.648	-100.488	-100.516	-99.728
8/15/2014	12:04:47 PM	-100.547	-100.599	-100.604	-100.424	-100.496	-100.454	-100.288	-100.382	-100.331
8/18/2014	12:04:51 PM	-100.381	-100.512	-100.606	-100.264	-100.476	-100.411	-100.171	-100.403	-100.353
8/21/2014	12:04:55 PM	-100.215	-100.426	-100.607	-100.104	-100.455	-100.367	-100.054	-100.425	-100.375
8/24/2014	12:04:59 PM	-100.049	-100.340	-100.609	-99.944	-100.435	-100.324	-99.937	-100.447	-100.397
8/13/2014	12:05:13 PM	-99.232	-101.424	-100.996	-101.072	-100.500	-99.924	-100.444	-100.404	-102.056
8/16/2014	12:05:17 PM	-100.491	-100.570	-100.605	-100.371	-100.489	-100.440	-100.249	-100.389	-100.338
8/19/2014	12:05:21 PM	-100.325	-100.484	-100.606	-100.211	-100.469	-100.396	-100.132	-100.411	-100.360
8/22/2014	12:05:25 PM	-100.160	-100.397	-100.608	-100.050	-100.449	-100.353	-100.015	-100.432	-100.382
8/25/2014	12:05:29 PM	-99.994	-100.311	-100.610	-99.890	-100.429	-100.309	-99.898	-100.454	-100.404
8/11/2014	12:05:39 PM	-101.444	-100.576	-100.672	-101.528	-99.904	-99.852	-100.876	-101.804	-100.232
8/14/2014	12:05:43 PM	-101.376	-98.736	-100.420	-99.804	-100.424	-99.572	-100.800	-100.372	-100.844
8/17/2014	12:05:47 PM	-100.436	-100.541	-100.605	-100.318	-100.482	-100.425	-100.210	-100.396	-100.345
8/20/2014	12:05:51 PM	-100.270	-100.455	-100.607	-100.157	-100.462	-100.382	-100.093	-100.418	-100.367
8/23/2014	12:05:55 PM	-100.104	-100.369	-100.609	-99.997	-100.442	-100.338	-99.976	-100.439	-100.389

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Salalah - 6PM-12AM

Sample Radio Spectrum Traffic

Date	Time	715	720	725	730	735	740	745	750	755
		POWER IN dBm								
8/12/2014	06:00:11 PM	-98.904	-99.992	-100.332	-100.472	-100.500	-100.512	-100.736	-99.976	-100.092
8/15/2014	06:00:15 PM	-100.181	-100.146	-100.068	-100.008	-99.995	-99.956	-99.913	-99.854	-99.863
8/18/2014	06:00:19 PM	-100.089	-100.070	-99.955	-99.880	-99.910	-99.849	-99.828	-99.686	-99.711
8/21/2014	06:00:23 PM	-99.997	-99.994	-99.843	-99.751	-99.824	-99.743	-99.744	-99.518	-99.559
8/24/2014	06:00:27 PM	-99.905	-99.918	-99.730	-99.623	-99.739	-99.636	-99.659	-99.351	-99.407
8/13/2014	06:00:41 PM	-100.896	-100.280	-100.140	-99.824	-99.112	-100.168	-99.172	-99.664	-99.428
8/16/2014	06:00:45 PM	-100.150	-100.121	-100.031	-99.965	-99.966	-99.920	-99.885	-99.798	-99.812
8/19/2014	06:00:49 PM	-100.058	-100.045	-99.918	-99.837	-99.881	-99.814	-99.800	-99.630	-99.660
8/22/2014	06:00:53 PM	-99.966	-99.969	-99.805	-99.709	-99.796	-99.707	-99.716	-99.462	-99.508
8/25/2014	06:00:57 PM	-99.874	-99.893	-99.692	-99.580	-99.711	-99.601	-99.631	-99.295	-99.356
8/11/2014	06:01:07 PM	-100.404	-100.664	-100.000	-98.644	-99.032	-97.412	-98.912	-101.488	-101.296
8/14/2014	06:01:11 PM	-100.211	-100.171	-100.106	-100.051	-100.023	-99.991	-99.941	-99.910	-99.914
8/17/2014	06:01:15 PM	-100.119	-100.095	-99.993	-99.922	-99.938	-99.885	-99.857	-99.742	-99.762
8/20/2014	06:01:19 PM	-100.028	-100.020	-99.880	-99.794	-99.853	-99.778	-99.772	-99.574	-99.610
8/23/2014	06:01:23 PM	-99.936	-99.944	-99.767	-99.666	-99.768	-99.672	-99.687	-99.406	-99.458
8/12/2014	06:01:37 PM	-99.988	-101.172	-99.740	-100.920	-100.848	-101.088	-99.872	-99.404	-100.608
8/15/2014	06:01:41 PM	-100.181	-100.146	-100.068	-100.008	-99.995	-99.956	-99.913	-99.854	-99.863
8/18/2014	06:01:45 PM	-100.089	-100.070	-99.955	-99.880	-99.910	-99.849	-99.828	-99.686	-99.711
8/21/2014	06:01:49 PM	-99.997	-99.994	-99.842	-99.751	-99.824	-99.743	-99.744	-99.518	-99.559
8/24/2014	06:01:53 PM	-99.905	-99.918	-99.730	-99.623	-99.739	-99.636	-99.659	-99.350	-99.407
8/13/2014	06:02:07 PM	-99.436	-100.740	-99.404	-99.144	-100.752	-101.104	-99.908	-99.208	-99.700
8/16/2014	06:02:11 PM	-100.150	-100.121	-100.031	-99.965	-99.966	-99.920	-99.885	-99.798	-99.812
8/19/2014	06:02:15 PM	-100.058	-100.045	-99.918	-99.837	-99.881	-99.814	-99.800	-99.630	-99.660
8/22/2014	06:02:19 PM	-99.966	-99.969	-99.805	-99.709	-99.796	-99.707	-99.716	-99.462	-99.508
8/25/2014	06:02:23 PM	-99.874	-99.893	-99.692	-99.580	-99.711	-99.601	-99.631	-99.295	-99.356
8/11/2014	06:02:33 PM	-99.336	-100.372	-99.524	-99.656	-100.624	-100.976	-99.540	-99.292	-100.808
8/14/2014	06:02:37 PM	-100.211	-100.171	-100.106	-100.051	-100.023	-99.991	-99.941	-99.910	-99.914
8/17/2014	06:02:41 PM	-100.119	-100.095	-99.993	-99.922	-99.938	-99.885	-99.857	-99.742	-99.762
8/20/2014	06:02:45 PM	-100.028	-100.020	-99.880	-99.794	-99.853	-99.778	-99.772	-99.574	-99.610
8/23/2014	06:02:49 PM	-99.936	-99.944	-99.767	-99.666	-99.768	-99.672	-99.687	-99.406	-99.457
8/12/2014	06:03:03 PM	-100.628	-98.152	-100.408	-100.196	-100.316	-101.180	-100.000	-99.904	-100.144
8/15/2014	06:03:07 PM	-100.181	-100.146	-100.068	-100.008	-99.995	-99.955	-99.913	-99.854	-99.863
8/18/2014	06:03:11 PM	-100.089	-100.070	-99.955	-99.880	-99.910	-99.849	-99.828	-99.686	-99.711
8/21/2014	06:03:15 PM	-99.997	-99.994	-99.842	-99.751	-99.824	-99.743	-99.744	-99.518	-99.559
8/24/2014	06:03:19 PM	-99.905	-99.918	-99.730	-99.623	-99.739	-99.636	-99.659	-99.350	-99.407
8/13/2014	06:03:33 PM	-99.084	-101.300	-101.024	-100.352	-98.628	-99.740	-100.828	-100.768	-98.892
8/16/2014	06:03:37 PM	-100.150	-100.121	-100.031	-99.965	-99.966	-99.920	-99.885	-99.798	-99.812
8/19/2014	06:03:41 PM	-100.058	-100.045	-99.918	-99.837	-99.881	-99.814	-99.800	-99.630	-99.660
8/22/2014	06:03:45 PM	-99.966	-99.969	-99.805	-99.709	-99.796	-99.707	-99.716	-99.462	-99.508
8/25/2014	06:03:49 PM	-99.874	-99.893	-99.692	-99.580	-99.711	-99.601	-99.631	-99.294	-99.356
8/11/2014	06:03:59 PM	-100.280	-99.624	-100.592	-99.588	-100.692	-100.936	-100.008	-100.108	-99.872
8/14/2014	06:04:03 PM	-100.211	-100.171	-100.106	-100.051	-100.023	-99.991	-99.941	-99.910	-99.914
8/17/2014	06:04:07 PM	-100.119	-100.095	-99.993	-99.922	-99.938	-99.885	-99.857	-99.742	-99.762
8/20/2014	06:04:11 PM	-100.028	-100.019	-99.880	-99.794	-99.853	-99.778	-99.772	-99.574	-99.609
8/23/2014	06:04:15 PM	-99.936	-99.944	-99.767	-99.666	-99.768	-99.672	-99.687	-99.406	-99.457
8/12/2014	06:04:29 PM	-99.556	-100.508	-99.560	-99.324	-100.028	-100.188	-99.640	-99.868	-99.264
8/15/2014	06:04:33 PM	-100.181	-100.146	-100.068	-100.008	-99.995	-99.955	-99.913	-99.854	-99.863
8/18/2014	06:04:37 PM	-100.089	-100.070	-99.955	-99.880	-99.910	-99.849	-99.828	-99.686	-99.711
8/21/2014	06:04:41 PM	-99.997	-99.994	-99.842	-99.751	-99.824	-99.743	-99.744	-99.518	-99.559
8/24/2014	06:04:45 PM	-99.905	-99.918	-99.730	-99.623	-99.739	-99.636	-99.659	-99.350	-99.407
8/13/2014	06:04:59 PM	-99.892	-100.476	-100.364	-99.760	-100.544	-99.432	-98.048	-100.388	-99.272
8/16/2014	06:05:03 PM	-100.150	-100.121	-100.031	-99.965	-99.966	-99.920	-99.885	-99.798	-99.812
8/19/2014	06:05:07 PM	-100.058	-100.045	-99.918	-99.837	-99.881	-99.814	-99.800	-99.630	-99.660
8/22/2014	06:05:11 PM	-99.966	-99.969	-99.805	-99.709	-99.796	-99.707	-99.716	-99.462	-99.508
8/25/2014	06:05:15 PM	-99.874	-99.893	-99.692	-99.580	-99.711	-99.601	-99.631	-99.294	-99.356
8/11/2014	06:05:25 PM	-101.088	-100.788	-99.480	-100.648	-100.240	-99.152	-98.380	-100.696	-99.804
8/14/2014	06:05:29 PM	-100.211	-100.171	-100.106	-100.051	-100.023	-99.991	-99.941	-99.910	-99.914
8/17/2014	06:05:33 PM	-100.119	-100.095	-99.993	-99.922	-99.938	-99.885	-99.857	-99.742	-99.761
8/20/2014	06:05:37 PM	-100.027	-100.019	-99.880	-99.794	-99.853	-99.778	-99.772	-99.574	-99.609
8/23/2014	06:05:41 PM	-99.936	-99.944	-99.767	-99.666	-99.768	-99.672	-99.687	-99.406	-99.457
8/12/2014	06:05:55 PM	-100.636	-98.988	-99.000	-100.096	-99.980	-99.896	-99.040	-98.552	-100.492
8/15/2014	06:05:59 PM	-100.181	-100.146	-100.068	-100.008	-99.995	-99.955	-99.913	-99.854	-99.863
8/18/2014	06:06:03 PM	-100.089	-100.070	-99.955	-99.880	-99.910	-99.849	-99.828	-99.686	-99.711

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Ibri - 12AM-6AM

Sample Radio Spectrum Traffic

		MHz								
Date	Time	760	765	770	775	780	785	790	795	800
		POWER IN dBm								
06/04/2014	12:00:01 AM	-79.996	-79.884	-81.356	-79.008	-78.680	-79.212	-79.868	-80.340	-80.960
09/04/2014	12:00:05 AM	-78.624	-80.568	-79.292	-80.184	-79.740	-80.936	-81.792	-79.584	-79.580
12/04/2014	12:00:09 AM	-80.872	-80.248	-81.208	-80.240	-78.920	-80.520	-78.356	-81.128	-82.076
15/04/2014	12:00:13 AM	-79.884	-80.924	-80.196	-81.728	-80.872	-80.964	-82.004	-80.620	-79.028
04/04/2014	12:00:27 AM	-80.344	-79.768	-79.752	-79.972	-78.968	-79.904	-80.180	-79.912	-80.288
07/04/2014	12:00:31 AM	-80.600	-78.948	-78.588	-79.308	-80.280	-80.768	-78.636	-78.564	-80.160
10/04/2014	12:00:35 AM	-78.840	-81.088	-81.176	-80.460	-81.008	-80.596	-80.852	-79.668	-81.120
13/04/2014	12:00:39 AM	-80.508	-79.092	-78.964	-78.932	-80.576	-79.556	-82.248	-79.004	-79.172
16/04/2014	12:00:43 AM	-81.644	-78.976	-80.048	-80.108	-79.228	-80.072	-80.060	-82.116	-82.288
02/04/2014	12:00:53 AM	-81.916	-79.716	-81.520	-79.888	-81.268	-81.848	-80.628	-77.752	-79.344
05/04/2014	12:00:57 AM	-80.264	-79.732	-79.544	-81.300	-80.656	-80.968	-78.920	-79.856	-80.632
08/04/2014	12:01:01 AM	-79.180	-80.216	-80.668	-79.664	-80.720	-81.432	-80.860	-81.032	-79.220
11/04/2014	12:01:05 AM	-79.104	-80.548	-80.124	-80.132	-81.044	-79.796	-79.936	-81.484	-80.348
14/04/2014	12:01:09 AM	-80.404	-80.664	-80.660	-80.072	-80.588	-80.060	-79.884	-80.400	-80.600
03/04/2014	12:01:23 AM	-79.412	-79.516	-80.248	-80.536	-80.464	-80.472	-79.220	-80.668	-78.932
06/04/2014	12:01:27 AM	-81.492	-82.132	-80.328	-81.648	-79.600	-80.024	-80.192	-80.872	-78.368
09/04/2014	12:01:31 AM	-80.780	-80.300	-78.760	-80.864	-79.924	-81.396	-78.424	-80.288	-80.624
12/04/2014	12:01:35 AM	-79.552	-79.532	-81.204	-79.516	-81.244	-79.368	-79.912	-79.776	-81.348
15/04/2014	12:01:39 AM	-80.164	-80.144	-80.412	-80.860	-79.616	-80.984	-80.268	-80.124	-79.524
04/04/2014	12:01:53 AM	-80.268	-80.068	-81.228	-79.524	-79.284	-80.296	-80.724	-80.516	-80.088
07/04/2014	12:01:57 AM	-78.444	-80.372	-79.520	-79.440	-80.400	-79.228	-79.760	-78.700	-80.852
10/04/2014	12:02:01 AM	-80.792	-79.256	-78.992	-80.152	-78.852	-79.908	-80.480	-80.588	-81.648
13/04/2014	12:02:05 AM	-79.784	-80.004	-80.732	-82.172	-79.632	-81.148	-81.452	-79.808	-80.296
16/04/2014	12:02:09 AM	-79.836	-78.708	-80.920	-82.004	-79.536	-78.428	-80.772	-79.628	-79.416
02/04/2014	12:02:19 AM	-78.256	-80.272	-80.492	-79.912	-81.584	-79.496	-79.116	-79.228	-81.524
05/04/2014	12:02:23 AM	-80.240	-78.972	-80.696	-79.672	-79.920	-80.756	-80.672	-79.820	-78.748
08/04/2014	12:02:27 AM	-80.572	-80.440	-80.236	-80.940	-81.448	-80.380	-80.572	-80.120	-80.224
11/04/2014	12:02:31 AM	-81.312	-78.840	-80.396	-80.032	-80.592	-80.388	-80.112	-79.932	-78.976
14/04/2014	12:02:35 AM	-79.984	-81.060	-81.272	-79.460	-79.208	-80.820	-80.176	-81.232	-79.752
03/04/2014	12:02:49 AM	-81.324	-79.348	-80.304	-81.328	-80.388	-80.236	-79.644	-79.480	-80.228
06/04/2014	12:02:53 AM	-80.160	-78.496	-80.916	-79.500	-79.140	-80.820	-79.340	-80.096	-79.932
09/04/2014	12:02:57 AM	-79.760	-81.748	-79.656	-79.024	-79.432	-80.512	-81.788	-80.096	-81.092
12/04/2014	12:03:01 AM	-80.276	-81.616	-81.956	-79.444	-81.856	-81.268	-82.136	-80.288	-80.168
15/04/2014	12:03:05 AM	-80.756	-79.504	-81.316	-80.108	-80.344	-80.724	-80.736	-80.060	-79.888
04/04/2014	12:03:19 AM	-79.812	-80.012	-79.408	-79.448	-78.008	-78.292	-78.220	-82.144	-79.844
07/04/2014	12:03:23 AM	-78.164	-79.476	-80.124	-80.192	-81.924	-79.296	-79.432	-79.628	-80.388
10/04/2014	12:03:27 AM	-80.680	-79.808	-80.472	-80.980	-79.964	-80.956	-80.688	-81.004	-80.304
13/04/2014	12:03:31 AM	-80.956	-81.008	-81.504	-80.380	-80.916	-80.584	-81.216	-82.700	-82.304
16/04/2014	12:03:35 AM	-81.488	-80.560	-79.892	-80.776	-80.816	-78.636	-80.168	-80.404	-80.992
02/04/2014	12:03:45 AM	-78.852	-79.352	-81.436	-79.076	-81.596	-80.124	-79.400	-77.988	-79.788
05/04/2014	12:03:49 AM	-79.412	-80.476	-80.288	-79.296	-81.316	-78.132	-80.216	-80.500	-81.492
08/04/2014	12:03:53 AM	-80.176	-80.780	-79.124	-79.676	-78.380	-79.884	-81.048	-79.520	-79.856
11/04/2014	12:03:57 AM	-79.900	-80.344	-81.660	-80.636	-81.512	-80.392	-80.496	-79.664	-82.048
14/04/2014	12:04:01 AM	-80.728	-80.440	-81.228	-81.428	-81.308	-81.512	-80.000	-79.820	-80.748
03/04/2014	12:04:15 AM	-80.020	-79.300	-81.840	-81.280	-80.416	-80.248	-80.164	-79.960	-79.728
06/04/2014	12:04:19 AM	-79.800	-79.708	-80.112	-80.784	-80.388	-80.828	-80.380	-80.540	-80.976
09/04/2014	12:04:23 AM	-79.560	-80.524	-81.196	-80.264	-80.312	-81.304	-80.304	-81.540	-81.076
12/04/2014	12:04:27 AM	-79.412	-80.132	-80.056	-79.860	-80.256	-81.324	-78.596	-79.860	-79.580
15/04/2014	12:04:31 AM	-80.728	-80.920	-81.496	-80.044	-80.156	-80.388	-81.340	-80.012	-80.420
04/04/2014	12:04:45 AM	-80.824	-78.144	-80.312	-78.564	-82.152	-78.652	-79.972	-79.064	-78.580
07/04/2014	12:04:49 AM	-81.128	-80.544	-79.444	-80.796	-81.596	-79.960	-79.300	-79.972	-80.132
10/04/2014	12:04:53 AM	-79.408	-79.420	-80.252	-79.708	-79.348	-79.868	-80.580	-79.936	-81.480
13/04/2014	12:04:57 AM	-78.752	-81.320	-79.488	-81.248	-79.736	-80.580	-80.512	-80.712	-80.284
16/04/2014	12:05:01 AM	-79.756	-80.768	-80.524	-81.036	-80.616	-80.600	-80.372	-79.864	-80.088
02/04/2014	12:05:11 AM	-79.072	-80.072	-79.456	-79.760	-79.400	-79.956	-79.340	-80.772	-80.704
05/04/2014	12:05:15 AM	-78.848	-78.432	-80.532	-77.564	-79.820	-80.548	-80.860	-80.684	-79.904
08/04/2014	12:05:19 AM	-80.712	-81.936	-80.436	-79.120	-78.800	-80.580	-79.880	-79.544	-79.812
11/04/2014	12:05:23 AM	-81.124	-80.964	-80.568	-81.284	-80.972	-81.140	-79.096	-80.912	-80.632
14/04/2014	12:05:27 AM	-81.036	-79.460	-79.964	-79.708	-80.380	-80.392	-79.296	-79.928	-79.692
03/04/2014	12:05:41 AM	-79.368	-77.348	-79.620	-79.432	-79.360	-81.448	-80.676	-78.880	-80.764
06/04/2014	12:05:45 AM	-80.968	-80.060	-80.308	-79.744	-78.580	-80.044	-79.872	-79.328	-78.680
09/04/2014	12:05:49 AM	-81.168	-79.972	-80.836	-79.692	-80.284	-80.372	-81.096	-80.944	-80.172
12/04/2014	12:05:53 AM	-79.388	-80.192	-81.892	-80.856	-79.752	-79.664	-80.092	-80.040	-80.256

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Ibri - 6AM-12PM

Sample Radio Spectrum Traffic

		MHz								
Date	Time	805	810	815	820	825	830	835	840	845
		POWER IN dBm								
04/04/2014	06:00:13 AM	-81.404	-80.280	-78.672	-78.860	-82.292	-81.396	-81.220	-80.368	-80.960
07/04/2014	06:00:17 AM	-79.892	-80.120	-79.636	-78.776	-79.136	-81.992	-80.520	-79.656	-79.716
10/04/2014	06:00:21 AM	-78.904	-82.664	-79.904	-80.656	-80.780	-79.744	-81.744	-82.796	-80.004
13/04/2014	06:00:25 AM	-80.044	-80.940	-81.320	-82.724	-82.492	-81.932	-83.400	-80.384	-80.292
16/04/2014	06:00:29 AM	-81.076	-80.404	-82.216	-81.792	-79.848	-81.364	-81.632	-81.864	-79.944
02/04/2014	06:00:39 AM	-79.800	-80.112	-79.792	-81.624	-81.140	-80.568	-79.276	-79.860	-79.552
05/04/2014	06:00:43 AM	-80.280	-81.264	-79.092	-80.868	-78.880	-80.304	-82.164	-79.932	-80.820
08/04/2014	06:00:47 AM	-80.696	-79.940	-81.852	-80.120	-82.212	-80.752	-82.052	-81.600	-81.736
11/04/2014	06:00:51 AM	-80.708	-80.640	-82.684	-81.776	-81.396	-81.180	-80.300	-81.576	-82.308
14/04/2014	06:00:55 AM	-79.964	-80.188	-81.300	-81.692	-80.680	-80.664	-80.900	-80.036	-81.464
03/04/2014	06:01:09 AM	-80.452	-78.700	-79.812	-81.308	-77.980	-80.644	-79.348	-80.796	-81.528
06/04/2014	06:01:13 AM	-78.852	-79.864	-80.708	-79.244	-80.864	-80.064	-80.188	-78.652	-79.084
09/04/2014	06:01:17 AM	-81.560	-80.728	-80.912	-80.688	-79.572	-80.844	-81.540	-81.548	-81.920
12/04/2014	06:01:21 AM	-78.788	-79.444	-80.424	-81.204	-80.968	-82.328	-82.760	-81.612	-82.576
15/04/2014	06:01:25 AM	-81.524	-80.392	-80.276	-81.360	-80.132	-81.392	-80.948	-82.728	-80.976
04/04/2014	06:01:39 AM	-79.808	-79.812	-80.920	-80.884	-79.312	-80.516	-81.636	-80.276	-80.120
07/04/2014	06:01:43 AM	-81.944	-80.092	-79.936	-80.076	-81.800	-81.172	-81.864	-80.516	-81.752
10/04/2014	06:01:47 AM	-79.516	-80.712	-79.556	-81.236	-80.316	-82.608	-81.928	-81.736	-82.080
13/04/2014	06:01:51 AM	-79.932	-79.044	-80.932	-80.096	-80.436	-81.328	-80.980	-82.016	-81.100
16/04/2014	06:01:55 AM	-80.568	-79.228	-81.128	-80.780	-78.724	-80.224	-81.604	-81.864	-81.160
02/04/2014	06:02:05 AM	-79.056	-81.356	-80.884	-79.500	-80.552	-80.980	-80.932	-80.912	-80.472
05/04/2014	06:02:09 AM	-80.944	-78.928	-80.552	-79.860	-79.832	-81.276	-80.232	-80.860	-82.076
08/04/2014	06:02:13 AM	-79.812	-80.152	-80.988	-80.452	-80.468	-80.960	-80.496	-80.956	-81.476
11/04/2014	06:02:17 AM	-79.744	-80.052	-80.880	-81.568	-80.176	-81.700	-81.868	-80.964	-81.604
14/04/2014	06:02:21 AM	-83.044	-80.644	-80.372	-80.476	-80.648	-80.764	-82.724	-81.704	-80.912
03/04/2014	06:02:35 AM	-80.120	-80.268	-79.568	-80.004	-80.176	-79.908	-80.180	-80.792	-79.800
06/04/2014	06:02:39 AM	-80.424	-80.496	-80.168	-80.924	-80.636	-81.620	-80.872	-81.060	-80.008
09/04/2014	06:02:43 AM	-81.600	-81.168	-82.516	-81.404	-81.800	-79.232	-81.296	-81.612	-80.440
12/04/2014	06:02:47 AM	-79.632	-79.348	-80.960	-81.748	-81.220	-81.560	-81.204	-80.804	-81.888
15/04/2014	06:02:51 AM	-80.428	-80.676	-79.992	-81.652	-80.956	-82.748	-81.372	-80.484	-81.664
04/04/2014	06:03:05 AM	-80.184	-80.216	-79.936	-81.604	-81.112	-82.100	-80.520	-80.344	-81.448
07/04/2014	06:03:09 AM	-80.728	-81.436	-80.500	-81.020	-80.164	-80.820	-81.240	-81.532	-82.536
10/04/2014	06:03:13 AM	-81.396	-82.152	-80.800	-82.620	-81.556	-80.580	-80.140	-81.332	-82.100
13/04/2014	06:03:17 AM	-81.364	-81.384	-80.080	-79.204	-79.952	-80.036	-81.288	-81.636	-80.832
16/04/2014	06:03:21 AM	-81.788	-81.040	-81.668	-81.440	-82.060	-79.776	-79.556	-80.208	-81.332
02/04/2014	06:03:31 AM	-80.028	-79.996	-80.572	-80.032	-81.716	-80.532	-80.840	-81.088	-82.656
05/04/2014	06:03:35 AM	-79.960	-79.368	-79.564	-79.396	-77.684	-81.728	-79.808	-79.968	-81.056
08/04/2014	06:03:39 AM	-79.356	-80.120	-81.952	-80.716	-80.764	-82.508	-80.316	-80.676	-81.660
11/04/2014	06:03:43 AM	-80.840	-79.880	-80.288	-80.488	-81.484	-80.676	-81.864	-80.824	-81.640
14/04/2014	06:03:47 AM	-79.632	-78.860	-80.084	-80.132	-80.420	-80.324	-80.980	-80.972	-82.164
03/04/2014	06:04:01 AM	-79.232	-80.436	-80.820	-80.796	-80.368	-82.188	-78.552	-79.436	-80.724
06/04/2014	06:04:05 AM	-81.196	-80.668	-78.972	-80.328	-81.292	-79.864	-81.604	-81.952	-80.248
09/04/2014	06:04:09 AM	-82.296	-80.000	-80.208	-80.720	-80.672	-81.612	-80.188	-82.500	-81.260
12/04/2014	06:04:13 AM	-81.580	-81.988	-79.316	-81.576	-81.396	-81.504	-80.424	-79.308	-80.964
15/04/2014	06:04:17 AM	-80.976	-77.876	-81.928	-81.712	-79.620	-81.052	-79.816	-80.584	-82.032
04/04/2014	06:04:31 AM	-81.044	-79.976	-79.800	-81.532	-81.696	-80.240	-81.656	-81.488	-81.192
07/04/2014	06:04:35 AM	-80.336	-81.068	-78.344	-80.304	-81.036	-82.160	-81.308	-81.384	-83.088
10/04/2014	06:04:39 AM	-81.404	-80.152	-81.568	-80.916	-81.380	-80.372	-81.668	-80.064	-81.708
13/04/2014	06:04:43 AM	-80.204	-78.712	-80.084	-80.656	-81.416	-80.648	-80.732	-80.696	-79.736
16/04/2014	06:04:47 AM	-80.532	-80.288	-79.908	-81.412	-80.980	-80.528	-81.296	-82.412	-80.956
02/04/2014	06:04:57 AM	-78.512	-79.432	-79.804	-81.424	-80.460	-80.788	-79.508	-78.676	-82.676
05/04/2014	06:05:01 AM	-79.972	-80.056	-80.512	-80.448	-80.716	-79.984	-81.012	-81.140	-80.268
08/04/2014	06:05:05 AM	-79.576	-80.588	-81.252	-80.928	-81.584	-81.344	-80.228	-80.692	-81.836
11/04/2014	06:05:09 AM	-78.040	-80.644	-82.916	-79.872	-80.000	-81.288	-82.388	-80.496	-81.368
14/04/2014	06:05:13 AM	-79.976	-80.924	-81.736	-80.188	-79.336	-78.864	-82.052	-82.176	-81.512
03/04/2014	06:05:27 AM	-81.624	-79.372	-79.740	-79.616	-79.436	-81.892	-81.336	-81.216	-80.176
06/04/2014	06:05:31 AM	-79.104	-80.608	-79.748	-80.816	-79.328	-83.188	-79.436	-81.624	-81.256
09/04/2014	06:05:35 AM	-79.144	-78.188	-81.764	-81.116	-80.164	-81.680	-82.368	-81.868	-80.768
12/04/2014	06:05:39 AM	-80.608	-81.100	-81.024	-80.376	-80.360	-81.472	-81.928	-81.508	-82.060
15/04/2014	06:05:43 AM	-81.448	-79.520	-79.136	-80.528	-80.724	-81.368	-81.948	-81.556	-80.884
04/04/2014	06:05:57 AM	-79.948	-79.380	-80.908	-81.100	-81.260	-80.720	-79.672	-81.156	-80.028
07/04/2014	06:06:01 AM	-80.936	-79.984	-82.320	-80.484	-80.112	-79.756	-82.192	-79.024	-81.648
10/04/2014	06:06:05 AM	-78.808	-81.212	-81.516	-81.376	-81.148	-81.208	-81.672	-80.604	-80.180

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Ibri - 12PM-6PM

Sample Radio Spectrum Traffic

		MHz								
Date	Time	850	855	860	865	870	875	880	885	890
		POWER IN dBm								
07/04/2014	12:00:03 PM	-83.264	-81.916	-81.876	-82.292	-66.648	-62.616	-61.744	-63.784	-58.044
10/04/2014	12:00:07 PM	-82.756	-80.156	-79.620	-80.968	-77.684	-62.340	-59.496	-64.388	-63.352
13/04/2014	12:00:11 PM	-82.184	-82.828	-81.084	-79.700	-78.912	-62.268	-64.740	-61.096	-58.588
02/04/2014	12:00:25 PM	-80.456	-80.112	-80.692	-83.228	-68.140	-62.512	-60.992	-60.816	-54.956
05/04/2014	12:00:29 PM	-82.088	-81.568	-80.284	-83.560	-62.440	-59.656	-61.220	-59.316	-61.660
08/04/2014	12:00:33 PM	-80.884	-82.352	-81.640	-82.036	-64.864	-59.520	-61.992	-65.572	-59.832
11/04/2014	12:00:37 PM	-82.704	-80.496	-82.672	-82.256	-76.564	-60.420	-64.800	-67.916	-62.020
14/04/2014	12:00:41 PM	-80.776	-82.116	-81.440	-82.536	-79.836	-62.588	-64.424	-65.128	-58.344
03/04/2014	12:00:55 PM	-78.660	-82.108	-81.312	-82.564	-66.304	-58.472	-60.836	-67.700	-59.048
06/04/2014	12:00:59 PM	-82.332	-80.524	-80.332	-82.272	-62.988	-56.628	-57.960	-59.024	-57.336
09/04/2014	12:01:03 PM	-80.164	-81.240	-83.904	-82.604	-63.604	-59.376	-58.964	-70.420	-64.212
12/04/2014	12:01:07 PM	-79.372	-81.460	-82.176	-81.320	-79.036	-63.420	-65.264	-67.952	-61.908
15/04/2014	12:01:11 PM	-81.728	-80.944	-81.028	-82.052	-71.116	-61.824	-63.056	-66.784	-60.792
04/04/2014	12:01:25 PM	-81.488	-81.472	-81.584	-79.120	-73.864	-57.524	-59.364	-60.532	-56.728
07/04/2014	12:01:29 PM	-81.560	-79.644	-81.136	-80.928	-78.556	-61.816	-63.640	-64.040	-65.968
10/04/2014	12:01:33 PM	-81.760	-79.700	-81.168	-81.416	-72.116	-58.196	-63.292	-69.164	-63.080
13/04/2014	12:01:37 PM	-83.160	-80.584	-81.372	-80.360	-62.540	-59.120	-64.284	-61.604	-59.028
02/04/2014	12:01:51 PM	-80.964	-81.452	-81.684	-80.812	-67.700	-61.108	-62.252	-59.700	-56.972
05/04/2014	12:01:55 PM	-81.280	-81.196	-83.180	-81.552	-78.468	-59.832	-61.028	-64.796	-61.836
08/04/2014	12:01:59 PM	-82.100	-80.708	-81.728	-81.808	-68.400	-62.040	-62.612	-63.016	-55.316
11/04/2014	12:02:03 PM	-81.048	-81.008	-80.388	-81.464	-77.864	-61.792	-62.172	-65.652	-61.040
14/04/2014	12:02:07 PM	-81.908	-81.392	-80.720	-83.412	-69.016	-62.916	-66.856	-59.196	-55.716
03/04/2014	12:02:21 PM	-80.400	-81.156	-82.096	-82.500	-66.820	-60.752	-59.748	-67.260	-61.324
06/04/2014	12:02:25 PM	-80.396	-80.928	-80.944	-81.912	-75.164	-59.792	-58.716	-58.300	-55.580
09/04/2014	12:02:29 PM	-81.540	-81.476	-82.272	-81.388	-62.660	-59.616	-62.376	-65.904	-57.228
12/04/2014	12:02:33 PM	-80.176	-82.404	-82.104	-81.856	-68.432	-63.180	-66.804	-66.732	-63.664
15/04/2014	12:02:37 PM	-82.068	-80.592	-80.200	-83.888	-61.000	-61.988	-63.480	-61.664	-60.760
04/04/2014	12:02:51 PM	-81.956	-80.256	-82.332	-82.028	-64.708	-59.256	-61.548	-63.408	-55.540
07/04/2014	12:02:55 PM	-80.692	-80.812	-82.272	-83.208	-77.944	-62.268	-62.556	-64.432	-60.772
10/04/2014	12:02:59 PM	-80.908	-80.812	-81.220	-80.552	-68.804	-58.872	-65.276	-63.668	-60.248
13/04/2014	12:03:03 PM	-81.576	-81.808	-80.968	-82.304	-65.104	-59.900	-63.776	-60.808	-58.932
02/04/2014	12:03:17 PM	-81.460	-80.332	-81.608	-80.680	-65.984	-61.240	-59.556	-60.052	-57.420
05/04/2014	12:03:21 PM	-80.848	-82.488	-80.292	-80.356	-66.300	-60.384	-60.988	-60.996	-57.204
08/04/2014	12:03:25 PM	-81.480	-83.368	-81.320	-83.108	-65.632	-57.512	-62.344	-67.148	-63.756
11/04/2014	12:03:29 PM	-80.328	-81.992	-82.200	-82.796	-75.720	-61.496	-61.944	-66.556	-66.892
14/04/2014	12:03:33 PM	-80.256	-81.432	-82.364	-79.692	-67.768	-62.428	-63.032	-70.460	-63.652
03/04/2014	12:03:47 PM	-80.812	-80.948	-82.900	-81.104	-68.904	-60.620	-61.644	-67.476	-61.540
06/04/2014	12:03:51 PM	-81.960	-80.068	-79.728	-82.124	-64.980	-58.260	-60.972	-57.984	-56.124
09/04/2014	12:03:55 PM	-80.888	-81.104	-81.244	-82.764	-61.580	-60.764	-61.348	-66.776	-58.132
12/04/2014	12:03:59 PM	-81.260	-81.428	-83.316	-81.308	-68.364	-62.824	-61.468	-66.900	-62.388
15/04/2014	12:04:03 PM	-80.040	-80.732	-82.708	-80.820	-73.880	-60.312	-63.992	-65.908	-57.268
04/04/2014	12:04:17 PM	-79.328	-79.272	-79.260	-81.188	-75.608	-60.808	-61.964	-68.396	-58.504
07/04/2014	12:04:21 PM	-81.124	-82.432	-81.416	-80.716	-79.628	-62.408	-61.736	-63.808	-61.064
10/04/2014	12:04:25 PM	-80.776	-81.488	-81.024	-81.104	-78.000	-60.284	-59.872	-62.568	-59.044
13/04/2014	12:04:29 PM	-81.260	-81.948	-81.420	-81.792	-67.508	-63.424	-61.076	-65.956	-58.704
02/04/2014	12:04:43 PM	-80.284	-79.704	-81.020	-81.304	-66.404	-59.892	-62.656	-64.732	-56.500
05/04/2014	12:04:47 PM	-81.564	-80.576	-81.204	-80.828	-66.684	-58.456	-59.448	-63.600	-57.604
08/04/2014	12:04:51 PM	-80.392	-80.900	-80.916	-82.088	-64.264	-60.396	-62.536	-63.860	-57.260
11/04/2014	12:04:55 PM	-81.076	-82.836	-82.908	-80.864	-67.756	-61.612	-61.988	-66.860	-65.476
14/04/2014	12:04:59 PM	-80.384	-81.448	-81.864	-82.636	-68.064	-62.088	-65.656	-60.072	-54.336
03/04/2014	12:05:13 PM	-80.800	-80.440	-80.524	-82.668	-78.144	-60.812	-60.728	-66.076	-57.116
06/04/2014	12:05:17 PM	-81.512	-81.228	-80.128	-80.536	-65.000	-56.120	-59.468	-58.396	-57.300
09/04/2014	12:05:21 PM	-81.088	-81.604	-81.876	-82.304	-60.628	-58.848	-61.244	-62.672	-60.824
12/04/2014	12:05:25 PM	-83.472	-82.088	-80.528	-82.440	-79.824	-62.280	-65.476	-64.448	-59.164
15/04/2014	12:05:29 PM	-81.484	-81.568	-80.848	-81.824	-76.956	-62.852	-64.848	-68.140	-58.452
01/04/2014	12:05:39 PM	-81.864	-80.768	-81.336	-78.684	-64.156	-57.804	-58.428	-61.752	-59.212
04/04/2014	12:05:43 PM	-82.224	-82.048	-82.316	-81.532	-76.804	-59.380	-61.528	-63.572	-59.204
07/04/2014	12:05:47 PM	-82.440	-81.280	-81.476	-81.432	-75.264	-59.672	-62.112	-61.004	-57.108
10/04/2014	12:05:51 PM	-80.916	-82.192	-82.800	-79.140	-65.128	-59.592	-61.060	-65.716	-63.444
13/04/2014	12:05:55 PM	-80.892	-81.048	-81.268	-81.592	-68.860	-62.768	-63.076	-63.588	-54.560
02/04/2014	12:06:09 PM	-80.860	-79.336	-78.828	-81.340	-80.572	-61.280	-61.640	-63.088	-55.392
05/04/2014	12:06:13 PM	-82.452	-81.188	-80.184	-82.112	-66.064	-56.252	-58.560	-58.692	-57.804
08/04/2014	12:06:17 PM	-81.644	-80.264	-80.492	-82.748	-63.260	-62.180	-62.012	-68.224	-57.672

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Ibri - 6PM-12AM

Sample Radio Spectrum Traffic

		MHz								
Date	Time	895	900	905	910	915	920	925	930	935
		POWER IN dBm								
02/04/2014	06:00:11 PM	-60.552	-77.972	-81.892	-80.504	-83.032	-80.912	-81.760	-79.804	-80.672
05/04/2014	06:00:15 PM	-58.612	-80.784	-81.504	-82.348	-81.144	-82.792	-81.376	-81.572	-81.740
08/04/2014	06:00:19 PM	-69.632	-83.164	-84.044	-82.216	-80.960	-82.616	-82.848	-82.412	-82.500
11/04/2014	06:00:23 PM	-72.120	-82.068	-81.648	-82.064	-82.296	-82.792	-82.216	-83.480	-81.184
14/04/2014	06:00:27 PM	-56.108	-75.992	-81.872	-81.788	-82.164	-80.584	-81.820	-83.024	-81.736
03/04/2014	06:00:41 PM	-71.060	-82.536	-80.920	-82.268	-80.416	-80.660	-82.996	-80.884	-79.360
06/04/2014	06:00:45 PM	-69.472	-82.136	-81.084	-81.928	-82.560	-80.764	-82.420	-81.408	-80.928
09/04/2014	06:00:49 PM	-62.932	-82.352	-82.152	-81.816	-82.884	-82.676	-83.168	-82.524	-83.516
12/04/2014	06:00:53 PM	-76.976	-80.660	-82.384	-81.756	-81.132	-81.252	-81.660	-82.788	-82.296
15/04/2014	06:00:57 PM	-62.668	-82.412	-83.604	-82.896	-82.604	-82.452	-83.036	-82.384	-80.880
01/04/2014	06:01:07 PM	-60.544	-82.096	-80.812	-80.704	-81.564	-82.076	-81.852	-81.240	-81.272
04/04/2014	06:01:11 PM	-57.464	-82.148	-81.724	-81.088	-82.224	-81.848	-81.736	-81.240	-82.104
07/04/2014	06:01:15 PM	-60.604	-82.140	-80.768	-82.848	-81.792	-81.844	-82.012	-80.660	-81.688
10/04/2014	06:01:19 PM	-66.684	-81.448	-80.904	-80.736	-82.724	-82.864	-81.484	-80.796	-80.528
13/04/2014	06:01:23 PM	-56.936	-76.724	-81.532	-83.636	-81.352	-83.804	-81.048	-82.652	-82.764
02/04/2014	06:01:37 PM	-55.660	-79.704	-81.984	-82.004	-82.560	-81.368	-82.788	-82.432	-80.832
05/04/2014	06:01:41 PM	-60.144	-77.720	-80.820	-80.932	-83.380	-82.712	-82.268	-82.936	-80.476
08/04/2014	06:01:45 PM	-66.348	-81.816	-81.928	-83.208	-82.836	-80.840	-82.904	-81.132	-82.520
11/04/2014	06:01:49 PM	-76.436	-81.512	-81.704	-81.988	-81.556	-82.368	-81.452	-81.000	-80.312
14/04/2014	06:01:53 PM	-57.160	-75.836	-81.576	-80.816	-81.140	-82.600	-81.276	-81.368	-81.776
03/04/2014	06:02:07 PM	-66.172	-79.500	-82.004	-79.708	-81.012	-80.872	-82.204	-81.848	-79.600
06/04/2014	06:02:11 PM	-55.668	-82.252	-80.132	-82.900	-82.592	-82.100	-82.196	-81.840	-81.276
09/04/2014	06:02:15 PM	-54.412	-82.244	-81.732	-82.608	-81.304	-80.884	-82.332	-81.488	-81.648
12/04/2014	06:02:19 PM	-59.432	-81.544	-80.424	-81.308	-82.868	-81.640	-82.028	-81.868	-82.020
15/04/2014	06:02:23 PM	-64.872	-81.144	-82.040	-83.420	-80.636	-81.060	-82.284	-82.816	-81.780
01/04/2014	06:02:33 PM	-69.772	-81.948	-79.528	-81.084	-82.732	-82.720	-82.960	-82.164	-82.396
04/04/2014	06:02:37 PM	-55.340	-81.276	-80.388	-81.200	-81.932	-82.808	-81.996	-80.608	-81.356
07/04/2014	06:02:41 PM	-52.532	-75.632	-83.032	-82.036	-82.268	-82.720	-82.328	-82.516	-81.320
10/04/2014	06:02:45 PM	-69.556	-80.392	-81.704	-81.456	-82.288	-81.816	-82.888	-81.436	-80.552
13/04/2014	06:02:49 PM	-70.348	-81.312	-81.984	-81.036	-81.412	-82.304	-81.964	-80.656	-82.708
02/04/2014	06:03:03 PM	-72.868	-80.616	-82.284	-82.256	-81.684	-80.796	-82.260	-81.628	-82.152
05/04/2014	06:03:07 PM	-66.664	-82.660	-81.060	-81.580	-80.864	-82.068	-80.652	-81.732	-80.664
08/04/2014	06:03:11 PM	-67.284	-77.608	-82.120	-81.948	-81.148	-82.796	-81.364	-82.712	-80.956
11/04/2014	06:03:15 PM	-78.484	-81.900	-82.088	-82.632	-81.192	-81.544	-81.808	-82.364	-81.840
14/04/2014	06:03:19 PM	-60.040	-81.832	-81.612	-82.340	-83.656	-82.456	-82.172	-80.788	-83.600
03/04/2014	06:03:33 PM	-53.880	-81.536	-82.348	-80.876	-82.952	-81.748	-82.864	-82.480	-80.196
06/04/2014	06:03:37 PM	-55.192	-78.476	-81.968	-81.544	-81.112	-81.832	-80.808	-82.448	-79.704
09/04/2014	06:03:41 PM	-65.120	-80.948	-81.592	-82.200	-82.712	-82.384	-81.988	-81.172	-82.200
12/04/2014	06:03:45 PM	-79.328	-79.776	-81.268	-82.260	-82.900	-82.652	-80.428	-81.036	-82.404
15/04/2014	06:03:49 PM	-70.632	-83.164	-82.900	-80.988	-81.260	-81.496	-81.580	-82.696	-82.648
01/04/2014	06:03:59 PM	-59.060	-82.668	-80.468	-81.804	-81.448	-81.716	-81.272	-80.664	-81.996
04/04/2014	06:04:03 PM	-58.944	-83.168	-80.860	-80.276	-81.828	-82.000	-81.144	-81.952	-81.372
07/04/2014	06:04:07 PM	-66.008	-82.072	-84.516	-81.760	-82.592	-79.856	-83.224	-82.052	-82.828
10/04/2014	06:04:11 PM	-58.040	-78.344	-81.224	-82.068	-81.388	-81.856	-81.816	-83.344	-82.684
13/04/2014	06:04:15 PM	-70.480	-81.968	-81.560	-81.588	-81.468	-82.152	-80.316	-81.080	-80.812
02/04/2014	06:04:29 PM	-55.992	-81.528	-82.188	-82.808	-81.536	-81.880	-80.544	-81.156	-81.828
05/04/2014	06:04:33 PM	-59.376	-80.008	-81.480	-81.360	-81.500	-81.868	-80.664	-80.860	-82.068
08/04/2014	06:04:37 PM	-61.956	-82.880	-82.644	-81.348	-81.260	-81.236	-81.316	-82.748	-81.760
11/04/2014	06:04:41 PM	-76.588	-82.644	-81.768	-84.524	-81.116	-81.264	-82.684	-82.560	-83.084
14/04/2014	06:04:45 PM	-58.732	-80.172	-82.048	-81.512	-81.072	-82.240	-83.824	-81.548	-81.788
03/04/2014	06:04:59 PM	-56.020	-77.956	-82.956	-82.780	-81.684	-81.708	-81.456	-81.012	-81.056
06/04/2014	06:05:03 PM	-62.776	-80.372	-80.392	-81.276	-83.656	-81.980	-81.848	-81.372	-81.416
09/04/2014	06:05:07 PM	-56.028	-83.300	-82.172	-83.764	-83.104	-82.644	-80.992	-81.884	-80.640
12/04/2014	06:05:11 PM	-75.736	-81.824	-80.900	-81.384	-81.284	-82.752	-82.924	-80.856	-81.808
15/04/2014	06:05:15 PM	-76.684	-82.012	-83.124	-81.144	-82.400	-84.016	-83.040	-82.592	-81.664
01/04/2014	06:05:25 PM	-65.804	-81.072	-82.400	-82.548	-82.128	-81.580	-82.068	-82.704	-81.028
04/04/2014	06:05:29 PM	-55.224	-75.428	-82.576	-82.048	-81.780	-82.076	-81.984	-80.824	-80.764
07/04/2014	06:05:33 PM	-75.876	-82.020	-82.912	-83.012	-82.272	-82.760	-80.904	-84.828	-83.684
10/04/2014	06:05:37 PM	-74.468	-82.784	-83.028	-83.528	-81.808	-82.240	-82.148	-80.832	-83.348
13/04/2014	06:05:41 PM	-75.524	-80.300	-82.240	-83.124	-82.740	-81.004	-81.504	-81.340	-81.000
02/04/2014	06:05:55 PM	-54.948	-81.144	-82.372	-81.664	-82.096	-81.320	-81.200	-81.284	-83.328
05/04/2014	06:05:59 PM	-72.212	-81.484	-81.552	-81.676	-83.248	-81.136	-81.260	-79.960	-81.696
08/04/2014	06:06:03 PM	-56.188	-81.372	-81.616	-81.132	-82.268	-81.952	-82.212	-79.472	-79.772

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AlKhodh - 12PM-6PM

Sample Radio Spectrum Traffic

		MHz								
Date	Time	490	495	500	505	510	515	520	525	530
		POWER IN dBm								
9/3/2014	12:00:03 PM	-98.289	-102.260	-102.066	-96.570	-101.619	-100.100	-110.337	-105.468	-103.117
12/3/2014	12:00:07 PM	-96.498	-102.562	-102.284	-93.907	-101.603	-99.281	-114.903	-107.487	-103.914
03/15/2014	12:00:11 PM	-94.706	-102.865	-102.502	-91.243	-101.587	-98.462	-119.468	-109.507	-104.711
4/3/2014	12:00:25 PM	-102.228	-100.644	-102.344	-101.496	-101.424	-102.000	-101.888	-99.944	-100.060
7/3/2014	12:00:29 PM	-99.484	-102.058	-101.921	-98.346	-101.630	-100.645	-107.293	-104.122	-102.586
10/3/2014	12:00:33 PM	-97.692	-102.361	-102.139	-95.682	-101.614	-99.827	-111.859	-106.141	-103.383
03/13/2014	12:00:37 PM	-95.900	-102.663	-102.357	-93.019	-101.598	-99.008	-116.425	-108.161	-104.180
03/16/2014	12:00:41 PM	-94.108	-102.966	-102.575	-90.355	-101.582	-98.189	-120.991	-110.180	-104.977
5/3/2014	12:00:55 PM	-91.921	-102.907	-102.602	-87.335	-101.266	-97.394	-126.230	-112.694	-105.557
8/3/2014	12:00:59 PM	-98.886	-102.159	-101.994	-97.457	-101.625	-100.372	-108.816	-104.795	-102.852
11/3/2014	12:01:03 PM	-97.094	-102.462	-102.212	-94.794	-101.609	-99.554	-113.382	-106.815	-103.649
03/14/2014	12:01:07 PM	-95.303	-102.764	-102.430	-92.131	-101.593	-98.735	-117.947	-108.834	-104.446
03/17/2014	12:01:11 PM	-93.511	-103.067	-102.647	-89.467	-101.576	-97.916	-122.513	-110.853	-105.243
4/3/2014	12:01:21 PM	-102.348	-101.932	-101.792	-101.708	-102.148	-100.784	-99.560	-101.536	-101.604
6/3/2014	12:01:25 PM	-100.081	-101.957	-101.848	-99.233	-101.635	-100.918	-105.773	-103.449	-102.320
9/3/2014	12:01:29 PM	-98.289	-102.260	-102.066	-96.569	-101.619	-100.099	-110.338	-105.469	-103.117
12/3/2014	12:01:33 PM	-96.497	-102.563	-102.284	-93.906	-101.603	-99.281	-114.904	-107.488	-103.914
03/15/2014	12:01:37 PM	-94.705	-102.865	-102.502	-91.242	-101.587	-98.462	-119.470	-109.507	-104.712
4/3/2014	12:01:51 PM	-103.464	-100.936	-102.588	-102.148	-100.344	-101.640	-101.920	-101.264	-100.176
7/3/2014	12:01:55 PM	-99.483	-102.058	-101.921	-98.345	-101.630	-100.645	-107.295	-104.122	-102.586
10/3/2014	12:01:59 PM	-97.691	-102.361	-102.139	-95.681	-101.614	-99.826	-111.861	-106.142	-103.383
03/13/2014	12:02:03 PM	-95.900	-102.664	-102.357	-93.018	-101.598	-99.008	-116.426	-108.161	-104.180
03/16/2014	12:02:07 PM	-94.108	-102.966	-102.575	-90.354	-101.582	-98.189	-120.992	-110.181	-104.977
5/3/2014	12:02:21 PM	-91.843	-102.913	-102.610	-87.223	-101.263	-97.362	-126.422	-112.782	-105.588
8/3/2014	12:02:25 PM	-98.886	-102.159	-101.994	-97.457	-101.625	-100.372	-108.817	-104.796	-102.852
11/3/2014	12:02:29 PM	-97.094	-102.462	-102.212	-94.793	-101.609	-99.553	-113.383	-106.815	-103.649
03/14/2014	12:02:33 PM	-95.302	-102.765	-102.430	-92.130	-101.592	-98.735	-117.949	-108.835	-104.446
03/17/2014	12:02:37 PM	-93.510	-103.067	-102.648	-89.466	-101.576	-97.916	-122.515	-110.854	-105.243
3/3/2014	12:02:47 PM	-101.824	-101.032	-102.756	-102.252	-101.436	-101.820	-102.012	-100.912	-101.740
6/3/2014	12:02:51 PM	-100.080	-101.957	-101.848	-99.232	-101.635	-100.918	-105.774	-103.450	-102.320
9/3/2014	12:02:55 PM	-98.288	-102.260	-102.066	-96.568	-101.619	-100.099	-110.340	-105.469	-103.118
12/3/2014	12:02:59 PM	-96.496	-102.563	-102.284	-93.905	-101.603	-99.280	-114.906	-107.489	-103.915
03/15/2014	12:03:03 PM	-94.705	-102.866	-102.502	-91.242	-101.587	-98.462	-119.471	-109.508	-104.712
4/3/2014	12:03:17 PM	-101.940	-102.284	-101.440	-100.480	-102.368	-102.572	-102.308	-101.688	-102.044
7/3/2014	12:03:21 PM	-99.483	-102.058	-101.921	-98.344	-101.630	-100.645	-107.297	-104.123	-102.586
10/3/2014	12:03:25 PM	-97.691	-102.361	-102.139	-95.680	-101.614	-99.826	-111.862	-106.143	-103.383
03/13/2014	12:03:29 PM	-95.899	-102.664	-102.357	-93.017	-101.598	-99.008	-116.428	-108.162	-104.181
03/16/2014	12:03:33 PM	-94.107	-102.966	-102.575	-90.353	-101.582	-98.189	-120.994	-110.181	-104.978
5/3/2014	12:03:47 PM	-91.765	-102.920	-102.618	-87.111	-101.260	-97.329	-126.615	-112.870	-105.618
8/3/2014	12:03:51 PM	-98.885	-102.159	-101.994	-97.456	-101.625	-100.372	-108.819	-104.797	-102.852
11/3/2014	12:03:55 PM	-97.093	-102.462	-102.212	-94.792	-101.609	-99.553	-113.385	-106.816	-103.649
03/14/2014	12:03:59 PM	-95.301	-102.765	-102.430	-92.129	-101.592	-98.735	-117.950	-108.835	-104.446
03/17/2014	12:04:03 PM	-93.510	-103.067	-102.648	-89.465	-101.576	-97.916	-122.516	-110.855	-105.244
3/3/2014	12:04:13 PM	-101.088	-102.348	-102.072	-102.288	-102.384	-102.348	-101.980	-101.936	-102.680
6/3/2014	12:04:17 PM	-100.080	-101.957	-101.849	-99.231	-101.635	-100.918	-105.776	-103.450	-102.321
9/3/2014	12:04:21 PM	-98.288	-102.260	-102.066	-96.568	-101.619	-100.099	-110.341	-105.470	-103.118
12/3/2014	12:04:25 PM	-96.496	-102.563	-102.284	-93.904	-101.603	-99.280	-114.907	-107.489	-103.915
03/15/2014	12:04:29 PM	-94.704	-102.866	-102.502	-91.241	-101.587	-98.462	-119.473	-109.509	-104.712
4/3/2014	12:04:43 PM	-101.832	-102.428	-102.056	-102.192	-101.424	-101.752	-100.508	-103.076	-101.644
7/3/2014	12:04:47 PM	-99.482	-102.058	-101.921	-98.343	-101.630	-100.645	-107.298	-104.124	-102.586
10/3/2014	12:04:51 PM	-97.690	-102.361	-102.139	-95.679	-101.614	-99.826	-111.864	-106.143	-103.384
03/13/2014	12:04:55 PM	-95.898	-102.664	-102.357	-93.016	-101.598	-99.007	-116.429	-108.163	-104.181
03/16/2014	12:04:59 PM	-94.106	-102.967	-102.575	-90.353	-101.582	-98.189	-120.995	-110.182	-104.978
5/3/2014	12:05:13 PM	-91.687	-102.926	-102.625	-86.998	-101.256	-97.297	-126.807	-112.957	-105.648
8/3/2014	12:05:17 PM	-98.885	-102.159	-101.994	-97.455	-101.625	-100.372	-108.820	-104.797	-102.852
11/3/2014	12:05:21 PM	-97.093	-102.462	-102.212	-94.791	-101.609	-99.553	-113.386	-106.817	-103.649
03/14/2014	12:05:25 PM	-95.301	-102.765	-102.430	-92.128	-101.592	-98.734	-117.952	-108.836	-104.447
03/17/2014	12:05:29 PM	-93.509	-103.068	-102.648	-89.464	-101.576	-97.916	-122.518	-110.855	-105.244
3/3/2014	12:05:39 PM	-100.796	-102.568	-101.588	-101.288	-101.076	-102.048	-101.496	-101.880	-102.936
6/3/2014	12:05:43 PM	-100.079	-101.957	-101.849	-99.230	-101.635	-100.917	-105.777	-103.451	-102.321
9/3/2014	12:05:47 PM	-98.287	-102.260	-102.067	-96.567	-101.619	-100.099	-110.343	-105.471	-103.118
12/3/2014	12:05:51 PM	-96.495	-102.563	-102.284	-93.903	-101.603	-99.280	-114.909	-107.490	-103.915
03/15/2014	12:05:55 PM	-94.703	-102.866	-102.502	-91.240	-101.587	-98.461	-119.474	-109.509	-104.712

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AlKhodh 6PM-12AM

Sample Radio Spectrum Traffic

		MHz								
Date	Time	535	540	545	550	555	560	565	570	575
		POWER IN dBm								
4/3/2014	06:00:11 PM	-102.104	-101.832	-102.596	-99.904	-101.384	-101.648	-101.508	-101.112	-100.932
7/3/2014	06:00:15 PM	-106.210	-102.049	-97.914	-102.622	-99.917	-105.118	-96.558	-102.301	-101.145
10/3/2014	06:00:19 PM	-109.707	-102.435	-95.208	-103.474	-98.764	-107.862	-92.915	-103.014	-102.505
03/13/2014	06:00:23 PM	-113.203	-102.821	-92.502	-104.327	-97.611	-110.606	-89.272	-103.727	-103.864
03/16/2014	06:00:27 PM	-116.700	-103.206	-89.797	-105.180	-96.459	-113.349	-85.629	-104.439	-105.224
5/3/2014	06:00:41 PM	-103.879	-101.792	-99.717	-102.053	-100.685	-103.290	-98.986	-101.827	-100.239
8/3/2014	06:00:45 PM	-107.376	-102.178	-97.011	-102.906	-99.533	-106.033	-95.343	-102.539	-101.598
11/3/2014	06:00:49 PM	-110.873	-102.564	-94.306	-103.759	-98.380	-108.777	-91.700	-103.252	-102.958
03/14/2014	06:00:53 PM	-114.369	-102.949	-91.600	-104.612	-97.227	-111.521	-88.058	-103.964	-104.318
03/17/2014	06:00:57 PM	-117.866	-103.335	-88.895	-105.464	-96.074	-114.264	-84.415	-104.677	-105.678
3/3/2014	06:01:07 PM	-100.424	-101.768	-101.304	-101.016	-101.380	-101.580	-100.172	-102.016	-100.224
6/3/2014	06:01:11 PM	-105.045	-101.921	-98.815	-102.337	-100.301	-104.205	-97.771	-102.064	-100.692
9/3/2014	06:01:15 PM	-108.542	-102.307	-96.109	-103.190	-99.148	-106.948	-94.128	-102.777	-102.052
12/3/2014	06:01:19 PM	-112.039	-102.692	-93.404	-104.043	-97.995	-109.692	-90.486	-103.489	-103.412
03/15/2014	06:01:23 PM	-115.535	-103.078	-90.698	-104.896	-96.843	-112.436	-86.843	-104.202	-104.771
4/3/2014	06:01:37 PM	-101.760	-101.232	-101.548	-101.524	-101.948	-100.996	-102.136	-102.124	-99.888
7/3/2014	06:01:41 PM	-106.211	-102.050	-97.913	-102.622	-99.917	-105.119	-96.556	-102.302	-101.146
10/3/2014	06:01:45 PM	-109.708	-102.435	-95.207	-103.475	-98.764	-107.863	-92.914	-103.014	-102.505
03/13/2014	06:01:49 PM	-113.205	-102.821	-92.502	-104.327	-97.611	-110.607	-89.271	-103.727	-103.865
03/16/2014	06:01:53 PM	-116.701	-103.206	-89.796	-105.180	-96.458	-113.350	-85.628	-104.439	-105.225
5/3/2014	06:02:07 PM	-103.880	-101.793	-99.716	-102.053	-100.685	-103.291	-98.985	-101.827	-100.239
8/3/2014	06:02:11 PM	-107.377	-102.178	-97.010	-102.906	-99.532	-106.034	-95.342	-102.539	-101.599
11/3/2014	06:02:15 PM	-110.874	-102.564	-94.305	-103.759	-98.379	-108.778	-91.699	-103.252	-102.959
03/14/2014	06:02:19 PM	-114.371	-102.949	-91.599	-104.612	-97.227	-111.522	-88.056	-103.964	-104.318
03/17/2014	06:02:23 PM	-117.867	-103.335	-88.894	-105.465	-96.074	-114.265	-84.414	-104.677	-105.678
3/3/2014	06:02:33 PM	-101.788	-102.116	-102.152	-101.928	-101.760	-101.000	-102.964	-101.944	-98.256
6/3/2014	06:02:37 PM	-105.046	-101.921	-98.814	-102.338	-100.301	-104.205	-97.770	-102.064	-100.693
9/3/2014	06:02:41 PM	-108.543	-102.307	-96.108	-103.191	-99.148	-106.949	-94.127	-102.777	-102.052
12/3/2014	06:02:45 PM	-112.040	-102.692	-93.403	-104.043	-97.995	-109.693	-90.484	-103.489	-103.412
03/15/2014	06:02:49 PM	-115.537	-103.078	-90.697	-104.896	-96.842	-112.436	-86.842	-104.202	-104.772
4/3/2014	06:03:03 PM	-100.792	-101.684	-100.860	-101.832	-100.912	-102.016	-100.548	-101.316	-100.320
7/3/2014	06:03:07 PM	-106.212	-102.050	-97.912	-102.622	-99.916	-105.120	-96.555	-102.302	-101.146
10/3/2014	06:03:11 PM	-109.709	-102.435	-95.206	-103.475	-98.763	-107.864	-92.912	-103.014	-102.506
03/13/2014	06:03:15 PM	-113.206	-102.821	-92.501	-104.328	-97.611	-110.608	-89.270	-103.727	-103.865
03/16/2014	06:03:19 PM	-116.703	-103.206	-89.795	-105.181	-96.458	-113.351	-85.627	-104.440	-105.225
5/3/2014	06:03:33 PM	-103.882	-101.793	-99.715	-102.054	-100.685	-103.292	-98.983	-101.827	-100.240
8/3/2014	06:03:37 PM	-107.378	-102.178	-97.010	-102.906	-99.532	-106.035	-95.341	-102.540	-101.599
11/3/2014	06:03:41 PM	-110.875	-102.564	-94.304	-103.759	-98.379	-108.779	-91.698	-103.252	-102.959
03/14/2014	06:03:45 PM	-114.372	-102.949	-91.599	-104.612	-97.226	-111.522	-88.055	-103.965	-104.319
03/17/2014	06:03:49 PM	-117.868	-103.335	-88.893	-105.465	-96.074	-114.266	-84.412	-104.677	-105.678
3/3/2014	06:03:59 PM	-100.392	-101.712	-102.008	-100.356	-102.424	-101.452	-101.132	-101.848	-97.580
6/3/2014	06:04:03 PM	-105.048	-101.921	-98.813	-102.338	-100.300	-104.206	-97.769	-102.065	-100.693
9/3/2014	06:04:07 PM	-108.544	-102.307	-96.107	-103.191	-99.148	-106.950	-94.126	-102.777	-102.053
12/3/2014	06:04:11 PM	-112.041	-102.692	-93.402	-104.044	-97.995	-109.694	-90.483	-103.490	-103.412
03/15/2014	06:04:15 PM	-115.538	-103.078	-90.696	-104.896	-96.842	-112.437	-86.840	-104.202	-104.772
4/3/2014	06:04:29 PM	-101.108	-100.564	-101.224	-101.744	-102.376	-102.452	-100.104	-102.284	-97.780
7/3/2014	06:04:33 PM	-106.214	-102.050	-97.911	-102.622	-99.916	-105.121	-96.554	-102.302	-101.146
10/3/2014	06:04:37 PM	-109.710	-102.435	-95.205	-103.475	-98.763	-107.865	-92.911	-103.015	-102.506
03/13/2014	06:04:41 PM	-113.207	-102.821	-92.500	-104.328	-97.610	-110.609	-89.269	-103.727	-103.866
03/16/2014	06:04:45 PM	-116.704	-103.207	-89.794	-105.181	-96.458	-113.352	-85.626	-104.440	-105.226
5/3/2014	06:04:59 PM	-103.883	-101.793	-99.714	-102.054	-100.684	-103.292	-98.982	-101.827	-100.240
8/3/2014	06:05:03 PM	-107.379	-102.178	-97.009	-102.907	-99.532	-106.036	-95.339	-102.540	-101.600
11/3/2014	06:05:07 PM	-110.876	-102.564	-94.303	-103.760	-98.379	-108.780	-91.697	-103.252	-102.960
03/14/2014	06:05:11 PM	-114.373	-102.950	-91.598	-104.612	-97.226	-111.523	-88.054	-103.965	-104.319
03/17/2014	06:05:15 PM	-117.870	-103.335	-88.892	-105.465	-96.073	-114.267	-84.411	-104.677	-105.679
3/3/2014	06:05:25 PM	-102.296	-101.648	-101.584	-102.692	-101.300	-100.768	-101.716	-102.404	-99.876
6/3/2014	06:05:29 PM	-105.049	-101.921	-98.812	-102.338	-100.300	-104.207	-97.767	-102.065	-100.694
9/3/2014	06:05:33 PM	-108.545	-102.307	-96.107	-103.191	-99.147	-106.951	-94.125	-102.777	-102.053
12/3/2014	06:05:37 PM	-112.042	-102.693	-93.401	-104.044	-97.994	-109.695	-90.482	-103.490	-103.413
03/15/2014	06:05:41 PM	-115.539	-103.078	-90.695	-104.897	-96.842	-112.438	-86.839	-104.202	-104.773
4/3/2014	06:05:55 PM	-100.904	-100.912	-101.448	-100.652	-101.336	-102.276	-101.436	-101.864	-98.248
7/3/2014	06:05:59 PM	-106.215	-102.050	-97.910	-102.623	-99.916	-105.122	-96.553	-102.302	-101.147
10/3/2014	06:06:03 PM	-109.711	-102.436	-95.204	-103.476	-98.763	-107.866	-92.910	-103.015	-102.507

APPENDEX .38

Salalah - 12AM-6AM

Sample Radio Spectrum Traffic

		MHz								
Date	Time	580	585	590	595	600	605	610	615	620
		POWER IN dBm								
8/16/2014	12:00:01 AM	-101.493	-101.406	-101.414	-101.348	-101.280	-101.232	-101.189	-101.082	-101.090
8/19/2014	12:00:05 AM	-101.448	-101.321	-101.372	-101.283	-101.222	-101.154	-101.121	-100.964	-101.021
8/22/2014	12:00:09 AM	-101.403	-101.235	-101.331	-101.217	-101.164	-101.076	-101.053	-100.846	-100.952
8/25/2014	12:00:13 AM	-101.358	-101.149	-101.289	-101.152	-101.106	-100.997	-100.984	-100.728	-100.882
8/14/2014	12:00:27 AM	-101.448	-102.288	-102.520	-101.908	-100.360	-101.312	-100.624	-100.948	-101.264
8/17/2014	12:00:31 AM	-101.478	-101.378	-101.400	-101.327	-101.261	-101.206	-101.166	-101.042	-101.067
8/20/2014	12:00:35 AM	-101.433	-101.292	-101.359	-101.261	-101.203	-101.128	-101.098	-100.925	-100.998
8/23/2014	12:00:39 AM	-101.388	-101.206	-101.317	-101.196	-101.145	-101.050	-101.030	-100.807	-100.929
8/26/2014	12:00:43 AM	-101.343	-101.120	-101.275	-101.130	-101.087	-100.971	-100.962	-100.689	-100.859
8/12/2014	12:00:53 AM	-101.836	-102.112	-102.288	-101.100	-100.252	-100.972	-101.004	-101.100	-100.988
8/15/2014	12:00:57 AM	-101.509	-101.435	-101.428	-101.370	-101.299	-101.258	-101.212	-101.121	-101.113
8/18/2014	12:01:01 AM	-101.463	-101.349	-101.386	-101.305	-101.241	-101.180	-101.143	-101.003	-101.044
8/21/2014	12:01:05 AM	-101.418	-101.263	-101.345	-101.239	-101.183	-101.102	-101.075	-100.885	-100.975
8/24/2014	12:01:09 AM	-101.373	-101.178	-101.303	-101.174	-101.125	-101.023	-101.007	-100.768	-100.906
8/13/2014	12:01:23 AM	-101.728	-101.104	-102.040	-101.556	-100.328	-100.488	-100.476	-101.132	-101.796
8/16/2014	12:01:27 AM	-101.493	-101.406	-101.414	-101.348	-101.280	-101.232	-101.189	-101.081	-101.090
8/19/2014	12:01:31 AM	-101.448	-101.320	-101.372	-101.283	-101.222	-101.154	-101.121	-100.964	-101.021
8/22/2014	12:01:35 AM	-101.403	-101.235	-101.331	-101.217	-101.164	-101.076	-101.053	-100.846	-100.952
8/25/2014	12:01:39 AM	-101.358	-101.149	-101.289	-101.152	-101.106	-100.997	-100.984	-100.728	-100.882
8/14/2014	12:01:53 AM	-101.416	-102.064	-101.168	-101.524	-101.052	-100.600	-102.204	-100.788	-100.032
8/17/2014	12:01:57 AM	-101.478	-101.378	-101.400	-101.326	-101.260	-101.206	-101.166	-101.042	-101.067
8/20/2014	12:02:01 AM	-101.433	-101.292	-101.358	-101.261	-101.203	-101.128	-101.098	-100.925	-100.998
8/23/2014	12:02:05 AM	-101.388	-101.206	-101.317	-101.196	-101.145	-101.050	-101.030	-100.807	-100.929
8/26/2014	12:02:09 AM	-101.343	-101.120	-101.275	-101.130	-101.087	-100.971	-100.962	-100.689	-100.859
8/12/2014	12:02:19 AM	-101.216	-99.952	-101.728	-101.340	-102.212	-101.624	-102.512	-102.220	-101.904
8/15/2014	12:02:23 AM	-101.509	-101.435	-101.428	-101.370	-101.299	-101.258	-101.212	-101.121	-101.113
8/18/2014	12:02:27 AM	-101.463	-101.349	-101.386	-101.305	-101.241	-101.180	-101.143	-101.003	-101.044
8/21/2014	12:02:31 AM	-101.418	-101.263	-101.345	-101.239	-101.183	-101.102	-101.075	-100.885	-100.975
8/24/2014	12:02:35 AM	-101.373	-101.178	-101.303	-101.174	-101.125	-101.023	-101.007	-100.768	-100.905
8/13/2014	12:02:49 AM	-101.868	-101.568	-101.408	-100.796	-102.596	-101.224	-99.532	-102.468	-101.388
8/16/2014	12:02:53 AM	-101.493	-101.406	-101.414	-101.348	-101.280	-101.232	-101.189	-101.081	-101.090
8/19/2014	12:02:57 AM	-101.448	-101.320	-101.372	-101.283	-101.222	-101.154	-101.121	-100.964	-101.021
8/22/2014	12:03:01 AM	-101.403	-101.235	-101.331	-101.217	-101.164	-101.076	-101.053	-100.846	-100.952
8/25/2014	12:03:05 AM	-101.358	-101.149	-101.289	-101.152	-101.106	-100.997	-100.984	-100.728	-100.882
8/14/2014	12:03:19 AM	-101.484	-101.312	-101.828	-101.752	-101.576	-101.528	-101.700	-101.240	-101.464
8/17/2014	12:03:23 AM	-101.478	-101.378	-101.400	-101.326	-101.260	-101.206	-101.166	-101.042	-101.067
8/20/2014	12:03:27 AM	-101.433	-101.292	-101.358	-101.261	-101.203	-101.128	-101.098	-100.925	-100.998
8/23/2014	12:03:31 AM	-101.388	-101.206	-101.317	-101.196	-101.145	-101.049	-101.030	-100.807	-100.929
8/26/2014	12:03:35 AM	-101.343	-101.120	-101.275	-101.130	-101.087	-100.971	-100.962	-100.689	-100.859
8/12/2014	12:03:45 AM	-102.556	-101.208	-99.932	-101.188	-101.736	-102.376	-101.560	-101.988	-100.904
8/15/2014	12:03:49 AM	-101.509	-101.435	-101.428	-101.370	-101.299	-101.258	-101.212	-101.121	-101.113
8/18/2014	12:03:53 AM	-101.463	-101.349	-101.386	-101.305	-101.241	-101.180	-101.143	-101.003	-101.044
8/21/2014	12:03:57 AM	-101.418	-101.263	-101.345	-101.239	-101.183	-101.102	-101.075	-100.885	-100.975
8/24/2014	12:04:01 AM	-101.373	-101.178	-101.303	-101.174	-101.125	-101.023	-101.007	-100.768	-100.905
8/13/2014	12:04:15 AM	-102.468	-100.736	-101.936	-101.188	-102.288	-100.816	-100.412	-100.464	-102.012
8/16/2014	12:04:19 AM	-101.493	-101.406	-101.414	-101.348	-101.280	-101.232	-101.189	-101.081	-101.090
8/19/2014	12:04:23 AM	-101.448	-101.320	-101.372	-101.283	-101.222	-101.154	-101.121	-100.964	-101.021
8/22/2014	12:04:27 AM	-101.403	-101.235	-101.331	-101.217	-101.164	-101.076	-101.053	-100.846	-100.952
8/25/2014	12:04:31 AM	-101.358	-101.149	-101.289	-101.152	-101.106	-100.997	-100.984	-100.728	-100.882
8/14/2014	12:04:45 AM	-101.408	-100.584	-101.772	-100.884	-102.300	-101.240	-100.572	-101.436	-102.084
8/17/2014	12:04:49 AM	-101.478	-101.378	-101.400	-101.326	-101.260	-101.206	-101.166	-101.042	-101.067
8/20/2014	12:04:53 AM	-101.433	-101.292	-101.358	-101.261	-101.203	-101.128	-101.098	-100.924	-100.998
8/23/2014	12:04:57 AM	-101.388	-101.206	-101.317	-101.196	-101.145	-101.049	-101.030	-100.807	-100.928
8/26/2014	12:05:01 AM	-101.343	-101.120	-101.275	-101.130	-101.087	-100.971	-100.962	-100.689	-100.859
8/12/2014	12:05:11 AM	-100.216	-101.560	-102.264	-102.080	-101.884	-101.712	-101.484	-100.736	-102.012
8/15/2014	12:05:15 AM	-101.509	-101.435	-101.428	-101.370	-101.299	-101.258	-101.212	-101.121	-101.113
8/18/2014	12:05:19 AM	-101.463	-101.349	-101.386	-101.305	-101.241	-101.180	-101.143	-101.003	-101.044
8/21/2014	12:05:23 AM	-101.418	-101.263	-101.345	-101.239	-101.183	-101.102	-101.075	-100.885	-100.975
8/24/2014	12:05:27 AM	-101.373	-101.177	-101.303	-101.174	-101.125	-101.023	-101.007	-100.768	-100.905
8/13/2014	12:05:41 AM	-101.332	-101.768	-100.224	-102.752	-99.848	-101.732	-100.608	-101.940	-101.504
8/16/2014	12:05:45 AM	-101.493	-101.406	-101.414	-101.348	-101.280	-101.232	-101.189	-101.081	-101.090
8/19/2014	12:05:49 AM	-101.448	-101.320	-101.372	-101.283	-101.222	-101.154	-101.121	-100.964	-101.021
8/22/2014	12:05:53 AM	-101.403	-101.235	-101.331	-101.217	-101.164	-101.076	-101.053	-100.846	-100.952

APPENDEX .39

Salalah - 6AM-12PM

Sample Radio Spectrum Traffic

		MHz								
Date	Time	625	630	635	640	645	650	655	660	665
		POWER IN dBm								
8/14/2014	06:00:13 AM	-101.992	-102.396	-100.764	-102.052	-101.288	-100.708	-100.808	-100.720	-101.580
8/17/2014	06:00:17 AM	-101.060	-100.944	-100.951	-100.861	-100.888	-100.714	-100.854	-100.773	-100.548
8/20/2014	06:00:21 AM	-101.023	-100.852	-100.902	-100.763	-100.869	-100.585	-100.848	-100.768	-100.407
8/23/2014	06:00:25 AM	-100.985	-100.760	-100.853	-100.666	-100.849	-100.456	-100.841	-100.762	-100.266
8/26/2014	06:00:29 AM	-100.948	-100.668	-100.804	-100.568	-100.830	-100.327	-100.835	-100.757	-100.125
8/12/2014	06:00:39 AM	-99.156	-101.500	-99.860	-100.772	-102.048	-101.060	-100.688	-101.764	-101.936
8/15/2014	06:00:43 AM	-101.085	-101.006	-100.983	-100.926	-100.901	-100.800	-100.858	-100.777	-100.642
8/18/2014	06:00:47 AM	-101.048	-100.914	-100.934	-100.828	-100.882	-100.671	-100.852	-100.771	-100.501
8/21/2014	06:00:51 AM	-101.010	-100.822	-100.885	-100.731	-100.862	-100.542	-100.845	-100.766	-100.360
8/24/2014	06:00:55 AM	-100.973	-100.730	-100.836	-100.633	-100.843	-100.413	-100.839	-100.761	-100.219
8/13/2014	06:01:09 AM	-101.028	-100.172	-101.696	-100.936	-99.500	-101.688	-101.452	-100.388	-101.640
8/16/2014	06:01:13 AM	-101.073	-100.975	-100.967	-100.893	-100.895	-100.757	-100.856	-100.775	-100.595
8/19/2014	06:01:17 AM	-101.035	-100.883	-100.918	-100.796	-100.875	-100.628	-100.850	-100.770	-100.454
8/22/2014	06:01:21 AM	-100.998	-100.791	-100.869	-100.698	-100.856	-100.499	-100.843	-100.764	-100.313
8/25/2014	06:01:25 AM	-100.960	-100.699	-100.820	-100.601	-100.836	-100.370	-100.837	-100.759	-100.172
8/14/2014	06:01:39 AM	-100.000	-101.992	-101.828	-100.232	-100.004	-101.092	-100.856	-100.900	-100.508
8/17/2014	06:01:43 AM	-101.060	-100.944	-100.951	-100.861	-100.888	-100.714	-100.854	-100.773	-100.548
8/20/2014	06:01:47 AM	-101.023	-100.852	-100.902	-100.763	-100.869	-100.585	-100.848	-100.768	-100.407
8/23/2014	06:01:51 AM	-100.985	-100.760	-100.853	-100.666	-100.849	-100.456	-100.841	-100.762	-100.266
8/26/2014	06:01:55 AM	-100.948	-100.668	-100.804	-100.568	-100.830	-100.327	-100.835	-100.757	-100.125
8/12/2014	06:02:05 AM	-102.128	-100.604	-101.136	-100.432	-101.420	-101.724	-100.180	-100.192	-100.516
8/15/2014	06:02:09 AM	-101.085	-101.005	-100.983	-100.926	-100.901	-100.800	-100.858	-100.777	-100.642
8/18/2014	06:02:13 AM	-101.048	-100.914	-100.934	-100.828	-100.882	-100.671	-100.852	-100.771	-100.501
8/21/2014	06:02:17 AM	-101.010	-100.822	-100.885	-100.731	-100.862	-100.542	-100.845	-100.766	-100.360
8/24/2014	06:02:21 AM	-100.973	-100.730	-100.836	-100.633	-100.843	-100.413	-100.839	-100.761	-100.219
8/13/2014	06:02:35 AM	-102.168	-100.308	-101.252	-99.708	-101.512	-101.884	-101.280	-101.268	-100.896
8/16/2014	06:02:39 AM	-101.073	-100.975	-100.967	-100.893	-100.895	-100.757	-100.856	-100.775	-100.595
8/19/2014	06:02:43 AM	-101.035	-100.883	-100.918	-100.796	-100.875	-100.628	-100.850	-100.770	-100.454
8/22/2014	06:02:47 AM	-100.998	-100.791	-100.869	-100.698	-100.856	-100.499	-100.843	-100.764	-100.313
8/25/2014	06:02:51 AM	-100.960	-100.699	-100.820	-100.601	-100.836	-100.370	-100.837	-100.759	-100.172
8/14/2014	06:03:05 AM	-101.584	-101.568	-100.964	-100.080	-102.220	-101.836	-98.340	-100.340	-100.460
8/17/2014	06:03:09 AM	-101.060	-100.944	-100.951	-100.861	-100.888	-100.714	-100.854	-100.773	-100.548
8/20/2014	06:03:13 AM	-101.023	-100.852	-100.902	-100.763	-100.869	-100.585	-100.848	-100.768	-100.407
8/23/2014	06:03:17 AM	-100.985	-100.760	-100.853	-100.666	-100.849	-100.456	-100.841	-100.762	-100.266
8/26/2014	06:03:21 AM	-100.948	-100.668	-100.804	-100.568	-100.830	-100.327	-100.835	-100.757	-100.125
8/12/2014	06:03:31 AM	-102.220	-101.672	-100.736	-101.512	-100.204	-100.856	-100.508	-99.472	-100.760
8/15/2014	06:03:35 AM	-101.085	-101.005	-100.983	-100.926	-100.901	-100.800	-100.858	-100.777	-100.642
8/18/2014	06:03:39 AM	-101.048	-100.914	-100.934	-100.828	-100.882	-100.671	-100.852	-100.771	-100.501
8/21/2014	06:03:43 AM	-101.010	-100.822	-100.885	-100.731	-100.862	-100.542	-100.845	-100.766	-100.360
8/24/2014	06:03:47 AM	-100.973	-100.730	-100.836	-100.633	-100.843	-100.413	-100.839	-100.761	-100.219
8/13/2014	06:04:01 AM	-101.516	-101.080	-100.428	-101.456	-100.484	-101.364	-101.724	-100.660	-100.100
8/16/2014	06:04:05 AM	-101.073	-100.975	-100.967	-100.893	-100.895	-100.757	-100.856	-100.775	-100.595
8/19/2014	06:04:09 AM	-101.035	-100.883	-100.918	-100.796	-100.875	-100.628	-100.850	-100.770	-100.454
8/22/2014	06:04:13 AM	-100.998	-100.791	-100.869	-100.698	-100.856	-100.499	-100.843	-100.764	-100.313
8/25/2014	06:04:17 AM	-100.960	-100.699	-100.820	-100.601	-100.836	-100.370	-100.837	-100.759	-100.172
8/14/2014	06:04:31 AM	-101.148	-100.384	-100.496	-101.028	-101.796	-101.028	-102.112	-101.556	-100.232
8/17/2014	06:04:35 AM	-101.060	-100.944	-100.951	-100.861	-100.888	-100.714	-100.854	-100.773	-100.548
8/20/2014	06:04:39 AM	-101.023	-100.852	-100.902	-100.763	-100.869	-100.585	-100.848	-100.768	-100.407
8/23/2014	06:04:43 AM	-100.985	-100.760	-100.853	-100.666	-100.849	-100.456	-100.841	-100.762	-100.266
8/26/2014	06:04:47 AM	-100.948	-100.668	-100.804	-100.568	-100.830	-100.327	-100.835	-100.757	-100.125
8/12/2014	06:04:57 AM	-101.128	-101.224	-100.408	-101.780	-100.720	-101.372	-100.928	-99.892	-100.516
8/15/2014	06:05:01 AM	-101.085	-101.005	-100.983	-100.926	-100.901	-100.800	-100.858	-100.777	-100.642
8/18/2014	06:05:05 AM	-101.048	-100.913	-100.934	-100.828	-100.882	-100.671	-100.852	-100.771	-100.501
8/21/2014	06:05:09 AM	-101.010	-100.822	-100.885	-100.731	-100.862	-100.542	-100.845	-100.766	-100.360
8/24/2014	06:05:13 AM	-100.973	-100.730	-100.836	-100.633	-100.843	-100.413	-100.839	-100.761	-100.219
8/13/2014	06:05:27 AM	-101.660	-100.540	-101.404	-101.320	-99.892	-101.664	-101.148	-100.404	-101.568
8/16/2014	06:05:31 AM	-101.073	-100.975	-100.967	-100.893	-100.895	-100.757	-100.856	-100.775	-100.595
8/19/2014	06:05:35 AM	-101.035	-100.883	-100.918	-100.796	-100.875	-100.628	-100.850	-100.770	-100.454
8/22/2014	06:05:39 AM	-100.998	-100.791	-100.869	-100.698	-100.856	-100.499	-100.843	-100.764	-100.313
8/25/2014	06:05:43 AM	-100.960	-100.699	-100.820	-100.601	-100.836	-100.370	-100.837	-100.759	-100.172
8/14/2014	06:05:57 AM	-101.156	-101.536	-101.096	-101.192	-100.768	-101.628	-101.316	-99.056	-101.816
8/17/2014	06:06:01 AM	-101.060	-100.944	-100.951	-100.861	-100.888	-100.714	-100.854	-100.773	-100.548
8/20/2014	06:06:05 AM	-101.023	-100.852	-100.902	-100.763	-100.869	-100.585	-100.848	-100.768	-100.407

APPENDEX .40

Salalah - 12PM-6PM

Sample Radio Spectrum Traffic

		MHz								
Date	Time	670	675	680	685	690	695	700	705	710
		POWER IN dBm								
8/17/2014	12:00:03 PM	-100.436	-100.541	-100.605	-100.318	-100.482	-100.425	-100.210	-100.396	-100.345
8/20/2014	12:00:07 PM	-100.270	-100.455	-100.607	-100.157	-100.462	-100.382	-100.093	-100.418	-100.367
8/23/2014	12:00:11 PM	-100.105	-100.369	-100.609	-99.997	-100.442	-100.338	-99.976	-100.439	-100.389
8/12/2014	12:00:25 PM	-100.148	-99.900	-99.372	-100.992	-101.044	-100.412	-100.220	-99.472	-98.756
8/15/2014	12:00:29 PM	-100.547	-100.599	-100.604	-100.425	-100.496	-100.454	-100.288	-100.382	-100.331
8/18/2014	12:00:33 PM	-100.381	-100.512	-100.606	-100.264	-100.476	-100.411	-100.171	-100.403	-100.353
8/21/2014	12:00:37 PM	-100.215	-100.426	-100.607	-100.104	-100.456	-100.367	-100.054	-100.425	-100.375
8/24/2014	12:00:41 PM	-100.049	-100.340	-100.609	-99.944	-100.435	-100.324	-99.937	-100.447	-100.397
8/13/2014	12:00:55 PM	-99.636	-101.156	-100.384	-101.152	-100.404	-101.304	-101.264	-100.808	-100.712
8/16/2014	12:00:59 PM	-100.491	-100.570	-100.605	-100.371	-100.489	-100.440	-100.249	-100.389	-100.338
8/19/2014	12:01:03 PM	-100.326	-100.484	-100.606	-100.211	-100.469	-100.396	-100.132	-100.411	-100.360
8/22/2014	12:01:07 PM	-100.160	-100.397	-100.608	-100.051	-100.449	-100.353	-100.015	-100.432	-100.382
8/25/2014	12:01:11 PM	-99.994	-100.311	-100.610	-99.890	-100.429	-100.309	-99.898	-100.454	-100.404
8/11/2014	12:01:21 PM	-102.184	-102.472	-101.816	-101.768	-101.324	-99.944	-102.032	-101.692	-100.924
8/14/2014	12:01:25 PM	-101.604	-100.372	-100.636	-100.808	-98.500	-100.364	-98.872	-102.272	-100.856
8/17/2014	12:01:29 PM	-100.436	-100.541	-100.605	-100.318	-100.482	-100.425	-100.210	-100.396	-100.345
8/20/2014	12:01:33 PM	-100.270	-100.455	-100.607	-100.157	-100.462	-100.382	-100.093	-100.418	-100.367
8/23/2014	12:01:37 PM	-100.104	-100.369	-100.609	-99.997	-100.442	-100.338	-99.976	-100.439	-100.389
8/12/2014	12:01:51 PM	-101.328	-101.156	-101.460	-100.548	-101.116	-100.628	-101.180	-100.944	-100.212
8/15/2014	12:01:55 PM	-100.547	-100.599	-100.604	-100.424	-100.496	-100.454	-100.288	-100.382	-100.331
8/18/2014	12:01:59 PM	-100.381	-100.512	-100.606	-100.264	-100.476	-100.411	-100.171	-100.403	-100.353
8/21/2014	12:02:03 PM	-100.215	-100.426	-100.607	-100.104	-100.455	-100.367	-100.054	-100.425	-100.375
8/24/2014	12:02:07 PM	-100.049	-100.340	-100.609	-99.944	-100.435	-100.324	-99.937	-100.447	-100.397
8/13/2014	12:02:21 PM	-100.836	-102.196	-101.436	-99.220	-101.696	-100.296	-100.376	-99.492	-99.076
8/16/2014	12:02:25 PM	-100.491	-100.570	-100.605	-100.371	-100.489	-100.440	-100.249	-100.389	-100.338
8/19/2014	12:02:29 PM	-100.326	-100.484	-100.606	-100.211	-100.469	-100.396	-100.132	-100.411	-100.360
8/22/2014	12:02:33 PM	-100.160	-100.397	-100.608	-100.051	-100.449	-100.353	-100.015	-100.432	-100.382
8/25/2014	12:02:37 PM	-99.994	-100.311	-100.610	-99.890	-100.429	-100.309	-99.898	-100.454	-100.404
8/11/2014	12:02:47 PM	-101.128	-100.832	-102.136	-101.448	-100.220	-100.924	-100.396	-100.892	-99.924
8/14/2014	12:02:51 PM	-101.720	-100.316	-100.940	-101.500	-101.388	-99.524	-99.904	-100.752	-101.560
8/17/2014	12:02:55 PM	-100.436	-100.541	-100.605	-100.318	-100.482	-100.425	-100.210	-100.396	-100.345
8/20/2014	12:02:59 PM	-100.270	-100.455	-100.607	-100.157	-100.462	-100.382	-100.093	-100.418	-100.367
8/23/2014	12:03:03 PM	-100.104	-100.369	-100.609	-99.997	-100.442	-100.338	-99.976	-100.439	-100.389
8/12/2014	12:03:17 PM	-101.092	-101.400	-100.740	-100.316	-100.192	-101.764	-101.204	-100.528	-98.856
8/15/2014	12:03:21 PM	-100.547	-100.599	-100.604	-100.424	-100.496	-100.454	-100.288	-100.382	-100.331
8/18/2014	12:03:25 PM	-100.381	-100.512	-100.606	-100.264	-100.476	-100.411	-100.171	-100.403	-100.353
8/21/2014	12:03:29 PM	-100.215	-100.426	-100.607	-100.104	-100.455	-100.367	-100.054	-100.425	-100.375
8/24/2014	12:03:33 PM	-100.049	-100.340	-100.609	-99.944	-100.435	-100.324	-99.937	-100.447	-100.397
8/13/2014	12:03:47 PM	-101.204	-100.768	-101.108	-101.232	-100.844	-99.672	-100.032	-99.704	-99.572
8/16/2014	12:03:51 PM	-100.491	-100.570	-100.605	-100.371	-100.489	-100.440	-100.249	-100.389	-100.338
8/19/2014	12:03:55 PM	-100.325	-100.484	-100.606	-100.211	-100.469	-100.396	-100.132	-100.411	-100.360
8/22/2014	12:03:59 PM	-100.160	-100.397	-100.608	-100.051	-100.449	-100.353	-100.015	-100.432	-100.382
8/25/2014	12:04:03 PM	-99.994	-100.311	-100.610	-99.890	-100.429	-100.309	-99.898	-100.454	-100.404
8/11/2014	12:04:13 PM	-101.620	-101.820	-98.488	-100.464	-101.444	-100.532	-100.176	-101.176	-99.344
8/14/2014	12:04:17 PM	-100.652	-100.496	-99.880	-99.308	-100.424	-100.756	-100.824	-100.612	-100.152
8/17/2014	12:04:21 PM	-100.436	-100.541	-100.605	-100.318	-100.482	-100.425	-100.210	-100.396	-100.345
8/20/2014	12:04:25 PM	-100.270	-100.455	-100.607	-100.157	-100.462	-100.382	-100.093	-100.418	-100.367
8/23/2014	12:04:29 PM	-100.104	-100.369	-100.609	-99.997	-100.442	-100.338	-99.976	-100.439	-100.389
8/12/2014	12:04:43 PM	-99.496	-99.512	-100.324	-99.704	-99.896	-101.648	-100.488	-100.516	-99.728
8/15/2014	12:04:47 PM	-100.547	-100.599	-100.604	-100.424	-100.496	-100.454	-100.288	-100.382	-100.331
8/18/2014	12:04:51 PM	-100.381	-100.512	-100.606	-100.264	-100.476	-100.411	-100.171	-100.403	-100.353
8/21/2014	12:04:55 PM	-100.215	-100.426	-100.607	-100.104	-100.455	-100.367	-100.054	-100.425	-100.375
8/24/2014	12:04:59 PM	-100.049	-100.340	-100.609	-99.944	-100.435	-100.324	-99.937	-100.447	-100.397
8/13/2014	12:05:13 PM	-99.232	-101.424	-100.996	-101.072	-100.500	-99.924	-100.444	-100.404	-102.056
8/16/2014	12:05:17 PM	-100.491	-100.570	-100.605	-100.371	-100.489	-100.440	-100.249	-100.389	-100.338
8/19/2014	12:05:21 PM	-100.325	-100.484	-100.606	-100.211	-100.469	-100.396	-100.132	-100.411	-100.360
8/22/2014	12:05:25 PM	-100.160	-100.397	-100.608	-100.050	-100.449	-100.353	-100.015	-100.432	-100.382
8/25/2014	12:05:29 PM	-99.994	-100.311	-100.610	-99.890	-100.429	-100.309	-99.898	-100.454	-100.404
8/11/2014	12:05:39 PM	-101.444	-100.576	-100.672	-101.528	-99.904	-99.852	-100.876	-101.804	-100.232
8/14/2014	12:05:43 PM	-101.376	-98.736	-100.420	-99.804	-100.424	-99.572	-100.800	-100.372	-100.844
8/17/2014	12:05:47 PM	-100.436	-100.541	-100.605	-100.318	-100.482	-100.425	-100.210	-100.396	-100.345
8/20/2014	12:05:51 PM	-100.270	-100.455	-100.607	-100.157	-100.462	-100.382	-100.093	-100.418	-100.367
8/23/2014	12:05:55 PM	-100.104	-100.369	-100.609	-99.997	-100.442	-100.338	-99.976	-100.439	-100.389

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Salalah - 6PM-12AM

Sample Radio Spectrum Traffic

		MHz								
Date	Time	715	720	725	730	735	740	745	750	755
		POWER IN dBm								
8/12/2014	06:00:11 PM	-98.904	-99.992	-100.332	-100.472	-100.500	-100.512	-100.736	-99.976	-100.092
8/15/2014	06:00:15 PM	-100.181	-100.146	-100.068	-100.008	-99.995	-99.956	-99.913	-99.854	-99.863
8/18/2014	06:00:19 PM	-100.089	-100.070	-99.955	-99.880	-99.910	-99.849	-99.828	-99.686	-99.711
8/21/2014	06:00:23 PM	-99.997	-99.994	-99.843	-99.751	-99.824	-99.743	-99.744	-99.518	-99.559
8/24/2014	06:00:27 PM	-99.905	-99.918	-99.730	-99.623	-99.739	-99.636	-99.659	-99.351	-99.407
8/13/2014	06:00:41 PM	-100.896	-100.280	-100.140	-99.824	-99.112	-100.168	-99.172	-99.664	-99.428
8/16/2014	06:00:45 PM	-100.150	-100.121	-100.031	-99.965	-99.966	-99.920	-99.885	-99.798	-99.812
8/19/2014	06:00:49 PM	-100.058	-100.045	-99.918	-99.837	-99.881	-99.814	-99.800	-99.630	-99.660
8/22/2014	06:00:53 PM	-99.966	-99.969	-99.805	-99.709	-99.796	-99.707	-99.716	-99.462	-99.508
8/25/2014	06:00:57 PM	-99.874	-99.893	-99.692	-99.580	-99.711	-99.601	-99.631	-99.295	-99.356
8/11/2014	06:01:07 PM	-100.404	-100.664	-100.000	-98.644	-99.032	-97.412	-98.912	-101.488	-101.296
8/14/2014	06:01:11 PM	-100.211	-100.171	-100.106	-100.051	-100.023	-99.991	-99.941	-99.910	-99.914
8/17/2014	06:01:15 PM	-100.119	-100.095	-99.993	-99.922	-99.938	-99.885	-99.857	-99.742	-99.762
8/20/2014	06:01:19 PM	-100.028	-100.020	-99.880	-99.794	-99.853	-99.778	-99.772	-99.574	-99.610
8/23/2014	06:01:23 PM	-99.936	-99.944	-99.767	-99.666	-99.768	-99.672	-99.687	-99.406	-99.458
8/12/2014	06:01:37 PM	-99.988	-101.172	-99.740	-100.920	-100.848	-101.088	-99.872	-99.404	-100.608
8/15/2014	06:01:41 PM	-100.181	-100.146	-100.068	-100.008	-99.995	-99.956	-99.913	-99.854	-99.863
8/18/2014	06:01:45 PM	-100.089	-100.070	-99.955	-99.880	-99.910	-99.849	-99.828	-99.686	-99.711
8/21/2014	06:01:49 PM	-99.997	-99.994	-99.842	-99.751	-99.824	-99.743	-99.744	-99.518	-99.559
8/24/2014	06:01:53 PM	-99.905	-99.918	-99.730	-99.623	-99.739	-99.636	-99.659	-99.350	-99.407
8/13/2014	06:02:07 PM	-99.436	-100.740	-99.404	-99.144	-100.752	-101.104	-99.908	-99.208	-99.700
8/16/2014	06:02:11 PM	-100.150	-100.121	-100.031	-99.965	-99.966	-99.920	-99.885	-99.798	-99.812
8/19/2014	06:02:15 PM	-100.058	-100.045	-99.918	-99.837	-99.881	-99.814	-99.800	-99.630	-99.660
8/22/2014	06:02:19 PM	-99.966	-99.969	-99.805	-99.709	-99.796	-99.707	-99.716	-99.462	-99.508
8/25/2014	06:02:23 PM	-99.874	-99.893	-99.692	-99.580	-99.711	-99.601	-99.631	-99.295	-99.356
8/11/2014	06:02:33 PM	-99.336	-100.372	-99.524	-99.656	-100.624	-100.976	-99.540	-99.292	-100.808
8/14/2014	06:02:37 PM	-100.211	-100.171	-100.106	-100.051	-100.023	-99.991	-99.941	-99.910	-99.914
8/17/2014	06:02:41 PM	-100.119	-100.095	-99.993	-99.922	-99.938	-99.885	-99.857	-99.742	-99.762
8/20/2014	06:02:45 PM	-100.028	-100.020	-99.880	-99.794	-99.853	-99.778	-99.772	-99.574	-99.610
8/23/2014	06:02:49 PM	-99.936	-99.944	-99.767	-99.666	-99.768	-99.672	-99.687	-99.406	-99.457
8/12/2014	06:03:03 PM	-100.628	-98.152	-100.408	-100.196	-100.316	-101.180	-100.000	-99.904	-100.144
8/15/2014	06:03:07 PM	-100.181	-100.146	-100.068	-100.008	-99.995	-99.955	-99.913	-99.854	-99.863
8/18/2014	06:03:11 PM	-100.089	-100.070	-99.955	-99.880	-99.910	-99.849	-99.828	-99.686	-99.711
8/21/2014	06:03:15 PM	-99.997	-99.994	-99.842	-99.751	-99.824	-99.743	-99.744	-99.518	-99.559
8/24/2014	06:03:19 PM	-99.905	-99.918	-99.730	-99.623	-99.739	-99.636	-99.659	-99.350	-99.407
8/13/2014	06:03:33 PM	-99.084	-101.300	-101.024	-100.352	-98.628	-99.740	-100.828	-100.768	-98.892
8/16/2014	06:03:37 PM	-100.150	-100.121	-100.031	-99.965	-99.966	-99.920	-99.885	-99.798	-99.812
8/19/2014	06:03:41 PM	-100.058	-100.045	-99.918	-99.837	-99.881	-99.814	-99.800	-99.630	-99.660
8/22/2014	06:03:45 PM	-99.966	-99.969	-99.805	-99.709	-99.796	-99.707	-99.716	-99.462	-99.508
8/25/2014	06:03:49 PM	-99.874	-99.893	-99.692	-99.580	-99.711	-99.601	-99.631	-99.294	-99.356
8/11/2014	06:03:59 PM	-100.280	-99.624	-100.592	-99.588	-100.692	-100.936	-100.008	-100.108	-99.872
8/14/2014	06:04:03 PM	-100.211	-100.171	-100.106	-100.051	-100.023	-99.991	-99.941	-99.910	-99.914
8/17/2014	06:04:07 PM	-100.119	-100.095	-99.993	-99.922	-99.938	-99.885	-99.857	-99.742	-99.762
8/20/2014	06:04:11 PM	-100.028	-100.019	-99.880	-99.794	-99.853	-99.778	-99.772	-99.574	-99.609
8/23/2014	06:04:15 PM	-99.936	-99.944	-99.767	-99.666	-99.768	-99.672	-99.687	-99.406	-99.457
8/12/2014	06:04:29 PM	-99.556	-100.508	-99.560	-99.324	-100.028	-100.188	-99.640	-99.868	-99.264
8/15/2014	06:04:33 PM	-100.181	-100.146	-100.068	-100.008	-99.995	-99.955	-99.913	-99.854	-99.863
8/18/2014	06:04:37 PM	-100.089	-100.070	-99.955	-99.880	-99.910	-99.849	-99.828	-99.686	-99.711
8/21/2014	06:04:41 PM	-99.997	-99.994	-99.842	-99.751	-99.824	-99.743	-99.744	-99.518	-99.559
8/24/2014	06:04:45 PM	-99.905	-99.918	-99.730	-99.623	-99.739	-99.636	-99.659	-99.350	-99.407
8/13/2014	06:04:59 PM	-99.892	-100.476	-100.364	-99.760	-100.544	-99.432	-98.048	-100.388	-99.272
8/16/2014	06:05:03 PM	-100.150	-100.121	-100.031	-99.965	-99.966	-99.920	-99.885	-99.798	-99.812
8/19/2014	06:05:07 PM	-100.058	-100.045	-99.918	-99.837	-99.881	-99.814	-99.800	-99.630	-99.660
8/22/2014	06:05:11 PM	-99.966	-99.969	-99.805	-99.709	-99.796	-99.707	-99.716	-99.462	-99.508
8/25/2014	06:05:15 PM	-99.874	-99.893	-99.692	-99.580	-99.711	-99.601	-99.631	-99.294	-99.356
8/11/2014	06:05:25 PM	-101.088	-100.788	-99.480	-100.648	-100.240	-99.152	-98.380	-100.696	-99.804
8/14/2014	06:05:29 PM	-100.211	-100.171	-100.106	-100.051	-100.023	-99.991	-99.941	-99.910	-99.914
8/17/2014	06:05:33 PM	-100.119	-100.095	-99.993	-99.922	-99.938	-99.885	-99.857	-99.742	-99.761
8/20/2014	06:05:37 PM	-100.027	-100.019	-99.880	-99.794	-99.853	-99.778	-99.772	-99.574	-99.609
8/23/2014	06:05:41 PM	-99.936	-99.944	-99.767	-99.666	-99.768	-99.672	-99.687	-99.406	-99.457
8/12/2014	06:05:55 PM	-100.636	-98.988	-99.000	-100.096	-99.980	-99.896	-99.040	-98.552	-100.492
8/15/2014	06:05:59 PM	-100.181	-100.146	-100.068	-100.008	-99.995	-99.955	-99.913	-99.854	-99.863
8/18/2014	06:06:03 PM	-100.089	-100.070	-99.955	-99.880	-99.910	-99.849	-99.828	-99.686	-99.711

APPENDEX .42

Ibri - 12AM-6AM

Sample Radio Spectrum Traffic

		MHz								
Date	Time	760	765	770	775	780	785	790	795	800
		POWER IN dBm								
06/04/2014	12:00:01 AM	-79.996	-79.884	-81.356	-79.008	-78.680	-79.212	-79.868	-80.340	-80.960
09/04/2014	12:00:05 AM	-78.624	-80.568	-79.292	-80.184	-79.740	-80.936	-81.792	-79.584	-79.580
12/04/2014	12:00:09 AM	-80.872	-80.248	-81.208	-80.240	-78.920	-80.520	-78.356	-81.128	-82.076
15/04/2014	12:00:13 AM	-79.884	-80.924	-80.196	-81.728	-80.872	-80.964	-82.004	-80.620	-79.028
04/04/2014	12:00:27 AM	-80.344	-79.768	-79.752	-79.972	-78.968	-79.904	-80.180	-79.912	-80.288
07/04/2014	12:00:31 AM	-80.600	-78.948	-78.588	-79.308	-80.280	-80.768	-78.636	-78.564	-80.160
10/04/2014	12:00:35 AM	-78.840	-81.088	-81.176	-80.460	-81.008	-80.596	-80.852	-79.668	-81.120
13/04/2014	12:00:39 AM	-80.508	-79.092	-78.964	-78.932	-80.576	-79.556	-82.248	-79.004	-79.172
16/04/2014	12:00:43 AM	-81.644	-78.976	-80.048	-80.108	-79.228	-80.072	-80.060	-82.116	-82.288
02/04/2014	12:00:53 AM	-81.916	-79.716	-81.520	-79.888	-81.268	-81.848	-80.628	-77.752	-79.344
05/04/2014	12:00:57 AM	-80.264	-79.732	-79.544	-81.300	-80.656	-80.968	-78.920	-79.856	-80.632
08/04/2014	12:01:01 AM	-79.180	-80.216	-80.668	-79.664	-80.720	-81.432	-80.860	-81.032	-79.220
11/04/2014	12:01:05 AM	-79.104	-80.548	-80.124	-80.132	-81.044	-79.796	-79.936	-81.484	-80.348
14/04/2014	12:01:09 AM	-80.404	-80.664	-80.660	-80.072	-80.588	-80.060	-79.884	-80.400	-80.600
03/04/2014	12:01:23 AM	-79.412	-79.516	-80.248	-80.536	-80.464	-80.472	-79.220	-80.668	-78.932
06/04/2014	12:01:27 AM	-81.492	-82.132	-80.328	-81.648	-79.600	-80.024	-80.192	-80.872	-78.368
09/04/2014	12:01:31 AM	-80.780	-80.300	-78.760	-80.864	-79.924	-81.396	-78.424	-80.288	-80.624
12/04/2014	12:01:35 AM	-79.552	-79.532	-81.204	-79.516	-81.244	-79.368	-79.912	-79.776	-81.348
15/04/2014	12:01:39 AM	-80.164	-80.144	-80.412	-80.860	-79.616	-80.984	-80.268	-80.124	-79.524
04/04/2014	12:01:53 AM	-80.268	-80.068	-81.228	-79.524	-79.284	-80.296	-80.724	-80.516	-80.088
07/04/2014	12:01:57 AM	-78.444	-80.372	-79.520	-79.440	-80.400	-79.228	-79.760	-78.700	-80.852
10/04/2014	12:02:01 AM	-80.792	-79.256	-78.992	-80.152	-78.852	-79.908	-80.480	-80.588	-81.648
13/04/2014	12:02:05 AM	-79.784	-80.004	-80.732	-82.172	-79.632	-81.148	-81.452	-79.808	-80.296
16/04/2014	12:02:09 AM	-79.836	-78.708	-80.920	-82.004	-79.536	-78.428	-80.772	-79.628	-79.416
02/04/2014	12:02:19 AM	-78.256	-80.272	-80.492	-79.912	-81.584	-79.496	-79.116	-79.228	-81.524
05/04/2014	12:02:23 AM	-80.240	-78.972	-80.696	-79.672	-79.920	-80.756	-80.672	-79.820	-78.748
08/04/2014	12:02:27 AM	-80.572	-80.440	-80.236	-80.940	-81.448	-80.380	-80.572	-80.120	-80.224
11/04/2014	12:02:31 AM	-81.312	-78.840	-80.396	-80.032	-80.592	-80.388	-80.112	-79.932	-78.976
14/04/2014	12:02:35 AM	-79.984	-81.060	-81.272	-79.460	-79.208	-80.820	-80.176	-81.232	-79.752
03/04/2014	12:02:49 AM	-81.324	-79.348	-80.304	-81.328	-80.388	-80.236	-79.644	-79.480	-80.228
06/04/2014	12:02:53 AM	-80.160	-78.496	-80.916	-79.500	-79.140	-80.820	-79.340	-80.096	-79.932
09/04/2014	12:02:57 AM	-79.760	-81.748	-79.656	-79.024	-79.432	-80.512	-81.788	-80.096	-81.092
12/04/2014	12:03:01 AM	-80.276	-81.616	-81.956	-79.444	-81.856	-81.268	-82.136	-80.288	-80.168
15/04/2014	12:03:05 AM	-80.756	-79.504	-81.316	-80.108	-80.344	-80.724	-80.736	-80.060	-79.888
04/04/2014	12:03:19 AM	-79.812	-80.012	-79.408	-79.448	-78.008	-78.292	-78.220	-82.144	-79.844
07/04/2014	12:03:23 AM	-78.164	-79.476	-80.124	-80.192	-81.924	-79.296	-79.432	-79.628	-80.388
10/04/2014	12:03:27 AM	-80.680	-79.808	-80.472	-80.980	-79.964	-80.956	-80.688	-81.004	-80.304
13/04/2014	12:03:31 AM	-80.956	-81.008	-81.504	-80.380	-80.916	-80.584	-81.216	-82.700	-82.304
16/04/2014	12:03:35 AM	-81.488	-80.560	-79.892	-80.776	-80.816	-78.636	-80.168	-80.404	-80.992
02/04/2014	12:03:45 AM	-78.852	-79.352	-81.436	-79.076	-81.596	-80.124	-79.400	-77.988	-79.788
05/04/2014	12:03:49 AM	-79.412	-80.476	-80.288	-79.296	-81.316	-78.132	-80.216	-80.500	-81.492
08/04/2014	12:03:53 AM	-80.176	-80.780	-79.124	-79.676	-78.380	-79.884	-81.048	-79.520	-79.856
11/04/2014	12:03:57 AM	-79.900	-80.344	-81.660	-80.636	-81.512	-80.392	-80.496	-79.664	-82.048
14/04/2014	12:04:01 AM	-80.728	-80.440	-81.228	-81.428	-81.308	-81.512	-80.000	-79.820	-80.748
03/04/2014	12:04:15 AM	-80.020	-79.300	-81.840	-81.280	-80.416	-80.248	-80.164	-79.960	-79.728
06/04/2014	12:04:19 AM	-79.800	-79.708	-80.112	-80.784	-80.388	-80.828	-80.380	-80.540	-80.976
09/04/2014	12:04:23 AM	-79.560	-80.524	-81.196	-80.264	-80.312	-81.304	-80.304	-81.540	-81.076
12/04/2014	12:04:27 AM	-79.412	-80.132	-80.056	-79.860	-80.256	-81.324	-78.596	-79.860	-79.580
15/04/2014	12:04:31 AM	-80.728	-80.920	-81.496	-80.044	-80.156	-80.388	-81.340	-80.012	-80.420
04/04/2014	12:04:45 AM	-80.824	-78.144	-80.312	-78.564	-82.152	-78.652	-79.972	-79.064	-78.580
07/04/2014	12:04:49 AM	-81.128	-80.544	-79.444	-80.796	-81.596	-79.960	-79.300	-79.972	-80.132
10/04/2014	12:04:53 AM	-79.408	-79.420	-80.252	-79.708	-79.348	-79.868	-80.580	-79.936	-81.480
13/04/2014	12:04:57 AM	-78.752	-81.320	-79.488	-81.248	-79.736	-80.580	-80.512	-80.712	-80.284
16/04/2014	12:05:01 AM	-79.756	-80.768	-80.524	-81.036	-80.616	-80.600	-80.372	-79.864	-80.088
02/04/2014	12:05:11 AM	-79.072	-80.072	-79.456	-79.760	-79.400	-79.956	-79.340	-80.772	-80.704
05/04/2014	12:05:15 AM	-78.848	-78.432	-80.532	-77.564	-79.820	-80.548	-80.860	-80.684	-79.904
08/04/2014	12:05:19 AM	-80.712	-81.936	-80.436	-79.120	-78.800	-80.580	-79.880	-79.544	-79.812
11/04/2014	12:05:23 AM	-81.124	-80.964	-80.568	-81.284	-80.972	-81.140	-79.096	-80.912	-80.632
14/04/2014	12:05:27 AM	-81.036	-79.460	-79.964	-79.708	-80.380	-80.392	-79.296	-79.928	-79.692
03/04/2014	12:05:41 AM	-79.368	-77.348	-79.620	-79.432	-79.360	-81.448	-80.676	-78.880	-80.764
06/04/2014	12:05:45 AM	-80.968	-80.060	-80.308	-79.744	-78.580	-80.044	-79.872	-79.328	-78.680
09/04/2014	12:05:49 AM	-81.168	-79.972	-80.836	-79.692	-80.284	-80.372	-81.096	-80.944	-80.172
12/04/2014	12:05:53 AM	-79.388	-80.192	-81.892	-80.856	-79.752	-79.664	-80.092	-80.040	-80.256

APPENDEX .43

Ibri - 6AM-12PM

Sample Radio Spectrum Traffic

		MHz								
Date	Time	805	810	815	820	825	830	835	840	845
		POWER IN dBm								
04/04/2014	06:00:13 AM	-81.404	-80.280	-78.672	-78.860	-82.292	-81.396	-81.220	-80.368	-80.960
07/04/2014	06:00:17 AM	-79.892	-80.120	-79.636	-78.776	-79.136	-81.992	-80.520	-79.656	-79.716
10/04/2014	06:00:21 AM	-78.904	-82.664	-79.904	-80.656	-80.780	-79.744	-81.744	-82.796	-80.004
13/04/2014	06:00:25 AM	-80.044	-80.940	-81.320	-82.724	-82.492	-81.932	-83.400	-80.384	-80.292
16/04/2014	06:00:29 AM	-81.076	-80.404	-82.216	-81.792	-79.848	-81.364	-81.632	-81.864	-79.944
02/04/2014	06:00:39 AM	-79.800	-80.112	-79.792	-81.624	-81.140	-80.568	-79.276	-79.860	-79.552
05/04/2014	06:00:43 AM	-80.280	-81.264	-79.092	-80.868	-78.880	-80.304	-82.164	-79.932	-80.820
08/04/2014	06:00:47 AM	-80.696	-79.940	-81.852	-80.120	-82.212	-80.752	-82.052	-81.600	-81.736
11/04/2014	06:00:51 AM	-80.708	-80.640	-82.684	-81.776	-81.396	-81.180	-80.300	-81.576	-82.308
14/04/2014	06:00:55 AM	-79.964	-80.188	-81.300	-81.692	-80.680	-80.664	-80.900	-80.036	-81.464
03/04/2014	06:01:09 AM	-80.452	-78.700	-79.812	-81.308	-77.980	-80.644	-79.348	-80.796	-81.528
06/04/2014	06:01:13 AM	-78.852	-79.864	-80.708	-79.244	-80.864	-80.064	-80.188	-78.652	-79.084
09/04/2014	06:01:17 AM	-81.560	-80.728	-80.912	-80.688	-79.572	-80.844	-81.540	-81.548	-81.920
12/04/2014	06:01:21 AM	-78.788	-79.444	-80.424	-81.204	-80.968	-82.328	-82.760	-81.612	-82.576
15/04/2014	06:01:25 AM	-81.524	-80.392	-80.276	-81.360	-80.132	-81.392	-80.948	-82.728	-80.976
04/04/2014	06:01:39 AM	-79.808	-79.812	-80.920	-80.884	-79.312	-80.516	-81.636	-80.276	-80.120
07/04/2014	06:01:43 AM	-81.944	-80.092	-79.936	-80.076	-81.800	-81.172	-81.864	-80.516	-81.752
10/04/2014	06:01:47 AM	-79.516	-80.712	-79.556	-81.236	-80.316	-82.608	-81.928	-81.736	-82.080
13/04/2014	06:01:51 AM	-79.932	-79.044	-80.932	-80.096	-80.436	-81.328	-80.980	-82.016	-81.100
16/04/2014	06:01:55 AM	-80.568	-79.228	-81.128	-80.780	-78.724	-80.224	-81.604	-81.864	-81.160
02/04/2014	06:02:05 AM	-79.056	-81.356	-80.884	-79.500	-80.552	-80.980	-80.932	-80.912	-80.472
05/04/2014	06:02:09 AM	-80.944	-78.928	-80.552	-79.860	-79.832	-81.276	-80.232	-80.860	-82.076
08/04/2014	06:02:13 AM	-79.812	-80.152	-80.988	-80.452	-80.468	-80.960	-80.496	-80.956	-81.476
11/04/2014	06:02:17 AM	-79.744	-80.052	-80.880	-81.568	-80.176	-81.700	-81.868	-80.964	-81.604
14/04/2014	06:02:21 AM	-83.044	-80.644	-80.372	-80.476	-80.648	-80.764	-82.724	-81.704	-80.912
03/04/2014	06:02:35 AM	-80.120	-80.268	-79.568	-80.004	-80.176	-79.908	-80.180	-80.792	-79.800
06/04/2014	06:02:39 AM	-80.424	-80.496	-80.168	-80.924	-80.636	-81.620	-80.872	-81.060	-80.008
09/04/2014	06:02:43 AM	-81.600	-81.168	-82.516	-81.404	-81.800	-79.232	-81.296	-81.612	-80.440
12/04/2014	06:02:47 AM	-79.632	-79.348	-80.960	-81.748	-81.220	-81.560	-81.204	-80.804	-81.888
15/04/2014	06:02:51 AM	-80.428	-80.676	-79.992	-81.652	-80.956	-82.748	-81.372	-80.484	-81.664
04/04/2014	06:03:05 AM	-80.184	-80.216	-79.936	-81.604	-81.112	-82.100	-80.520	-80.344	-81.448
07/04/2014	06:03:09 AM	-80.728	-81.436	-80.500	-81.020	-80.164	-80.820	-81.240	-81.532	-82.536
10/04/2014	06:03:13 AM	-81.396	-82.152	-80.800	-82.620	-81.556	-80.580	-80.140	-81.332	-82.100
13/04/2014	06:03:17 AM	-81.364	-81.384	-80.080	-79.204	-79.952	-80.036	-81.288	-81.636	-80.832
16/04/2014	06:03:21 AM	-81.788	-81.040	-81.668	-81.440	-82.060	-79.776	-79.556	-80.208	-81.332
02/04/2014	06:03:31 AM	-80.028	-79.996	-80.572	-80.032	-81.716	-80.532	-80.840	-81.088	-82.656
05/04/2014	06:03:35 AM	-79.960	-79.368	-79.564	-79.396	-77.684	-81.728	-79.808	-79.968	-81.056
08/04/2014	06:03:39 AM	-79.356	-80.120	-81.952	-80.716	-80.764	-82.508	-80.316	-80.676	-81.660
11/04/2014	06:03:43 AM	-80.840	-79.880	-80.288	-80.488	-81.484	-80.676	-81.864	-80.824	-81.640
14/04/2014	06:03:47 AM	-79.632	-78.860	-80.084	-80.132	-80.420	-80.324	-80.980	-80.972	-82.164
03/04/2014	06:04:01 AM	-79.232	-80.436	-80.820	-80.796	-80.368	-82.188	-78.552	-79.436	-80.724
06/04/2014	06:04:05 AM	-81.196	-80.668	-78.972	-80.328	-81.292	-79.864	-81.604	-81.952	-80.248
09/04/2014	06:04:09 AM	-82.296	-80.000	-80.208	-80.720	-80.672	-81.612	-80.188	-82.500	-81.260
12/04/2014	06:04:13 AM	-81.580	-81.988	-79.316	-81.576	-81.396	-81.504	-80.424	-79.308	-80.964
15/04/2014	06:04:17 AM	-80.976	-77.876	-81.928	-81.712	-79.620	-81.052	-79.816	-80.584	-82.032
04/04/2014	06:04:31 AM	-81.044	-79.976	-79.800	-81.532	-81.696	-80.240	-81.656	-81.488	-81.192
07/04/2014	06:04:35 AM	-80.336	-81.068	-78.344	-80.304	-81.036	-82.160	-81.308	-81.384	-83.088
10/04/2014	06:04:39 AM	-81.404	-80.152	-81.568	-80.916	-81.380	-80.372	-81.668	-80.064	-81.708
13/04/2014	06:04:43 AM	-80.204	-78.712	-80.084	-80.656	-81.416	-80.648	-80.732	-80.696	-79.736
16/04/2014	06:04:47 AM	-80.532	-80.288	-79.908	-81.412	-80.980	-80.528	-81.296	-82.412	-80.956
02/04/2014	06:04:57 AM	-78.512	-79.432	-79.804	-81.424	-80.460	-80.788	-79.508	-78.676	-82.676
05/04/2014	06:05:01 AM	-79.972	-80.056	-80.512	-80.448	-80.716	-79.984	-81.012	-81.140	-80.268
08/04/2014	06:05:05 AM	-79.576	-80.588	-81.252	-80.928	-81.584	-81.344	-80.228	-80.692	-81.836
11/04/2014	06:05:09 AM	-78.040	-80.644	-82.916	-79.872	-80.000	-81.288	-82.388	-80.496	-81.368
14/04/2014	06:05:13 AM	-79.976	-80.924	-81.736	-80.188	-79.336	-78.864	-82.052	-82.176	-81.512
03/04/2014	06:05:27 AM	-81.624	-79.372	-79.740	-79.616	-79.436	-81.892	-81.336	-81.216	-80.176
06/04/2014	06:05:31 AM	-79.104	-80.608	-79.748	-80.816	-79.328	-83.188	-79.436	-81.624	-81.256
09/04/2014	06:05:35 AM	-79.144	-78.188	-81.764	-81.116	-80.164	-81.680	-82.368	-81.868	-80.768
12/04/2014	06:05:39 AM	-80.608	-81.100	-81.024	-80.376	-80.360	-81.472	-81.928	-81.508	-82.060
15/04/2014	06:05:43 AM	-81.448	-79.520	-79.136	-80.528	-80.724	-81.368	-81.948	-81.556	-80.884
04/04/2014	06:05:57 AM	-79.948	-79.380	-80.908	-81.100	-81.260	-80.720	-79.672	-81.156	-80.028
07/04/2014	06:06:01 AM	-80.936	-79.984	-82.320	-80.484	-80.112	-79.756	-82.192	-79.024	-81.648
10/04/2014	06:06:05 AM	-78.808	-81.212	-81.516	-81.376	-81.148	-81.208	-81.672	-80.604	-80.180

APPENDEX .44

Ibri - 12PM-6PM

Sample Radio Spectrum Traffic

		MHz								
Date	Time	850	855	860	865	870	875	880	885	890
		POWER IN dBm								
07/04/2014	12:00:03 PM	-83.264	-81.916	-81.876	-82.292	-66.648	-62.616	-61.744	-63.784	-58.044
10/04/2014	12:00:07 PM	-82.756	-80.156	-79.620	-80.968	-77.684	-62.340	-59.496	-64.388	-63.352
13/04/2014	12:00:11 PM	-82.184	-82.828	-81.084	-79.700	-78.912	-62.268	-64.740	-61.096	-58.588
02/04/2014	12:00:25 PM	-80.456	-80.112	-80.692	-83.228	-68.140	-62.512	-60.992	-60.816	-54.956
05/04/2014	12:00:29 PM	-82.088	-81.568	-80.284	-83.560	-62.440	-59.656	-61.220	-59.316	-61.660
08/04/2014	12:00:33 PM	-80.884	-82.352	-81.640	-82.036	-64.864	-59.520	-61.992	-65.572	-59.832
11/04/2014	12:00:37 PM	-82.704	-80.496	-82.672	-82.256	-76.564	-60.420	-64.800	-67.916	-62.020
14/04/2014	12:00:41 PM	-80.776	-82.116	-81.440	-82.536	-79.836	-62.588	-64.424	-65.128	-58.344
03/04/2014	12:00:55 PM	-78.660	-82.108	-81.312	-82.564	-66.304	-58.472	-60.836	-67.700	-59.048
06/04/2014	12:00:59 PM	-82.332	-80.524	-80.332	-82.272	-62.988	-56.628	-57.960	-59.024	-57.336
09/04/2014	12:01:03 PM	-80.164	-81.240	-83.904	-82.604	-63.604	-59.376	-58.964	-70.420	-64.212
12/04/2014	12:01:07 PM	-79.372	-81.460	-82.176	-81.320	-79.036	-63.420	-65.264	-67.952	-61.908
15/04/2014	12:01:11 PM	-81.728	-80.944	-81.028	-82.052	-71.116	-61.824	-63.056	-66.784	-60.792
04/04/2014	12:01:25 PM	-81.488	-81.472	-81.584	-79.120	-73.864	-57.524	-59.364	-60.532	-56.728
07/04/2014	12:01:29 PM	-81.560	-79.644	-81.136	-80.928	-78.556	-61.816	-63.640	-64.040	-65.968
10/04/2014	12:01:33 PM	-81.760	-79.700	-81.168	-81.416	-72.116	-58.196	-63.292	-69.164	-63.080
13/04/2014	12:01:37 PM	-83.160	-80.584	-81.372	-80.360	-62.540	-59.120	-64.284	-61.604	-59.028
02/04/2014	12:01:51 PM	-80.964	-81.452	-81.684	-80.812	-67.700	-61.108	-62.252	-59.700	-56.972
05/04/2014	12:01:55 PM	-81.280	-81.196	-83.180	-81.552	-78.468	-59.832	-61.028	-64.796	-61.836
08/04/2014	12:01:59 PM	-82.100	-80.708	-81.728	-81.808	-68.400	-62.040	-62.612	-63.016	-55.316
11/04/2014	12:02:03 PM	-81.048	-81.008	-80.388	-81.464	-77.864	-61.792	-62.172	-65.652	-61.040
14/04/2014	12:02:07 PM	-81.908	-81.392	-80.720	-83.412	-69.016	-62.916	-66.856	-59.196	-55.716
03/04/2014	12:02:21 PM	-80.400	-81.156	-82.096	-82.500	-66.820	-60.752	-59.748	-67.260	-61.324
06/04/2014	12:02:25 PM	-80.396	-80.928	-80.944	-81.912	-75.164	-59.792	-58.716	-58.300	-55.580
09/04/2014	12:02:29 PM	-81.540	-81.476	-82.272	-81.388	-62.660	-59.616	-62.376	-65.904	-57.228
12/04/2014	12:02:33 PM	-80.176	-82.404	-82.104	-81.856	-68.432	-63.180	-66.804	-66.732	-63.664
15/04/2014	12:02:37 PM	-82.068	-80.592	-80.200	-83.888	-61.000	-61.988	-63.480	-61.664	-60.760
04/04/2014	12:02:51 PM	-81.956	-80.256	-82.332	-82.028	-64.708	-59.256	-61.548	-63.408	-55.540
07/04/2014	12:02:55 PM	-80.692	-80.812	-82.272	-83.208	-77.944	-62.268	-62.556	-64.432	-60.772
10/04/2014	12:02:59 PM	-80.908	-80.812	-81.220	-80.552	-68.804	-58.872	-65.276	-63.668	-60.248
13/04/2014	12:03:03 PM	-81.576	-81.808	-80.968	-82.304	-65.104	-59.900	-63.776	-60.808	-58.932
02/04/2014	12:03:17 PM	-81.460	-80.332	-81.608	-80.680	-65.984	-61.240	-59.556	-60.052	-57.420
05/04/2014	12:03:21 PM	-80.848	-82.488	-80.292	-80.356	-66.300	-60.384	-60.988	-60.996	-57.204
08/04/2014	12:03:25 PM	-81.480	-83.368	-81.320	-83.108	-65.632	-57.512	-62.344	-67.148	-63.756
11/04/2014	12:03:29 PM	-80.328	-81.992	-82.200	-82.796	-75.720	-61.496	-61.944	-66.556	-66.892
14/04/2014	12:03:33 PM	-80.256	-81.432	-82.364	-79.692	-67.768	-62.428	-63.032	-70.460	-63.652
03/04/2014	12:03:47 PM	-80.812	-80.948	-82.900	-81.104	-68.904	-60.620	-61.644	-67.476	-61.540
06/04/2014	12:03:51 PM	-81.960	-80.068	-79.728	-82.124	-64.980	-58.260	-60.972	-57.984	-56.124
09/04/2014	12:03:55 PM	-80.888	-81.104	-81.244	-82.764	-61.580	-60.764	-61.348	-66.776	-58.132
12/04/2014	12:03:59 PM	-81.260	-81.428	-83.316	-81.308	-68.364	-62.824	-61.468	-66.900	-62.388
15/04/2014	12:04:03 PM	-80.040	-80.732	-82.708	-80.820	-73.880	-60.312	-63.992	-65.908	-57.268
04/04/2014	12:04:17 PM	-79.328	-79.272	-79.260	-81.188	-75.608	-60.808	-61.964	-68.396	-58.504
07/04/2014	12:04:21 PM	-81.124	-82.432	-81.416	-80.716	-79.628	-62.408	-61.736	-63.808	-61.064
10/04/2014	12:04:25 PM	-80.776	-81.488	-81.024	-81.104	-78.000	-60.284	-59.872	-62.568	-59.044
13/04/2014	12:04:29 PM	-81.260	-81.948	-81.420	-81.792	-67.508	-63.424	-61.076	-65.956	-58.704
02/04/2014	12:04:43 PM	-80.284	-79.704	-81.020	-81.304	-66.404	-59.892	-62.656	-64.732	-56.500
05/04/2014	12:04:47 PM	-81.564	-80.576	-81.204	-80.828	-66.684	-58.456	-59.448	-63.600	-57.604
08/04/2014	12:04:51 PM	-80.392	-80.900	-80.916	-82.088	-64.264	-60.396	-62.536	-63.860	-57.260
11/04/2014	12:04:55 PM	-81.076	-82.836	-82.908	-80.864	-67.756	-61.612	-61.988	-66.860	-65.476
14/04/2014	12:04:59 PM	-80.384	-81.448	-81.864	-82.636	-68.064	-62.088	-65.656	-60.072	-54.336
03/04/2014	12:05:13 PM	-80.800	-80.440	-80.524	-82.668	-78.144	-60.812	-60.728	-66.076	-57.116
06/04/2014	12:05:17 PM	-81.512	-81.228	-80.128	-80.536	-65.000	-56.120	-59.468	-58.396	-57.300
09/04/2014	12:05:21 PM	-81.088	-81.604	-81.876	-82.304	-60.628	-58.848	-61.244	-62.672	-60.824
12/04/2014	12:05:25 PM	-83.472	-82.088	-80.528	-82.440	-79.824	-62.280	-65.476	-64.448	-59.164
15/04/2014	12:05:29 PM	-81.484	-81.568	-80.848	-81.824	-76.956	-62.852	-64.848	-68.140	-58.452
01/04/2014	12:05:39 PM	-81.864	-80.768	-81.336	-78.684	-64.156	-57.804	-58.428	-61.752	-59.212
04/04/2014	12:05:43 PM	-82.224	-82.048	-82.316	-81.532	-76.804	-59.380	-61.528	-63.572	-59.204
07/04/2014	12:05:47 PM	-82.440	-81.280	-81.476	-81.432	-75.264	-59.672	-62.112	-61.004	-57.108
10/04/2014	12:05:51 PM	-80.916	-82.192	-82.800	-79.140	-65.128	-59.592	-61.060	-65.716	-63.444
13/04/2014	12:05:55 PM	-80.892	-81.048	-81.268	-81.592	-68.860	-62.768	-63.076	-63.588	-54.560
02/04/2014	12:06:09 PM	-80.860	-79.336	-78.828	-81.340	-80.572	-61.280	-61.640	-63.088	-55.392
05/04/2014	12:06:13 PM	-82.452	-81.188	-80.184	-82.112	-66.064	-56.252	-58.560	-58.692	-57.804
08/04/2014	12:06:17 PM	-81.644	-80.264	-80.492	-82.748	-63.260	-62.180	-62.012	-68.224	-57.672

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Ibri - 6PM-12AM

Sample Radio Spectrum Traffic

MHz										
Date	Time	40	45	50	55	60	65	70	75	80
		POWER IN dBm								
02/04/2014	06:00:11 PM	-60.552	-77.972	-81.892	-80.504	-83.032	-80.912	-81.760	-79.804	-80.672
05/04/2014	06:00:15 PM	-58.612	-80.784	-81.504	-82.348	-81.144	-82.792	-81.376	-81.572	-81.740
08/04/2014	06:00:19 PM	-69.632	-83.164	-84.044	-82.216	-80.960	-82.616	-82.848	-82.412	-82.500
11/04/2014	06:00:23 PM	-72.120	-82.068	-81.648	-82.064	-82.296	-82.792	-82.216	-83.480	-81.184
14/04/2014	06:00:27 PM	-56.108	-75.992	-81.872	-81.788	-82.164	-80.584	-81.820	-83.024	-81.736
03/04/2014	06:00:41 PM	-71.060	-82.536	-80.920	-82.268	-80.416	-80.660	-82.996	-80.884	-79.360
06/04/2014	06:00:45 PM	-69.472	-82.136	-81.084	-81.928	-82.560	-80.764	-82.420	-81.408	-80.928
09/04/2014	06:00:49 PM	-62.932	-82.352	-82.152	-81.816	-82.884	-82.676	-83.168	-82.524	-83.516
12/04/2014	06:00:53 PM	-76.976	-80.660	-82.384	-81.756	-81.132	-81.252	-81.660	-82.788	-82.296
15/04/2014	06:00:57 PM	-62.668	-82.412	-83.604	-82.896	-82.604	-82.452	-83.036	-82.384	-80.880
01/04/2014	06:01:07 PM	-60.544	-82.096	-80.812	-80.704	-81.564	-82.076	-81.852	-81.240	-81.272
04/04/2014	06:01:11 PM	-57.464	-82.148	-81.724	-81.088	-82.224	-81.848	-81.736	-81.240	-82.104
07/04/2014	06:01:15 PM	-60.604	-82.140	-80.768	-82.848	-81.792	-81.844	-82.012	-80.660	-81.688
10/04/2014	06:01:19 PM	-66.684	-81.448	-80.904	-80.736	-82.724	-82.864	-81.484	-80.796	-80.528
13/04/2014	06:01:23 PM	-56.936	-76.724	-81.532	-83.636	-81.352	-83.804	-81.048	-82.652	-82.764
02/04/2014	06:01:37 PM	-55.660	-79.704	-81.984	-82.004	-82.560	-81.368	-82.788	-82.432	-80.832
05/04/2014	06:01:41 PM	-60.144	-77.720	-80.820	-80.932	-83.380	-82.712	-82.268	-82.936	-80.476
08/04/2014	06:01:45 PM	-66.348	-81.816	-81.928	-83.208	-82.836	-80.840	-82.904	-81.132	-82.520
11/04/2014	06:01:49 PM	-76.436	-81.512	-81.704	-81.988	-81.556	-82.368	-81.452	-81.000	-80.312
14/04/2014	06:01:53 PM	-57.160	-75.836	-81.576	-80.816	-81.140	-82.600	-81.276	-81.368	-81.776
03/04/2014	06:02:07 PM	-66.172	-79.500	-82.004	-79.708	-81.012	-80.872	-82.204	-81.848	-79.600
06/04/2014	06:02:11 PM	-55.668	-82.252	-80.132	-82.900	-82.592	-82.100	-82.196	-81.840	-81.276
09/04/2014	06:02:15 PM	-54.412	-82.244	-81.732	-82.608	-81.304	-80.884	-82.332	-81.488	-81.648
12/04/2014	06:02:19 PM	-59.432	-81.544	-80.424	-81.308	-82.868	-81.640	-82.028	-81.868	-82.020
15/04/2014	06:02:23 PM	-64.872	-81.144	-82.040	-83.420	-80.636	-81.060	-82.284	-82.816	-81.780
01/04/2014	06:02:33 PM	-69.772	-81.948	-79.528	-81.084	-82.732	-82.720	-82.960	-82.164	-82.396
04/04/2014	06:02:37 PM	-55.340	-81.276	-80.388	-81.200	-81.932	-82.808	-81.996	-80.608	-81.356
07/04/2014	06:02:41 PM	-52.532	-75.632	-83.032	-82.036	-82.268	-82.720	-82.328	-82.516	-81.320
10/04/2014	06:02:45 PM	-69.556	-80.392	-81.704	-81.456	-82.288	-81.816	-82.888	-81.436	-80.552
13/04/2014	06:02:49 PM	-70.348	-81.312	-81.984	-81.036	-81.412	-82.304	-81.964	-80.656	-82.708
02/04/2014	06:03:03 PM	-72.868	-80.616	-82.284	-82.256	-81.684	-80.796	-82.260	-81.628	-82.152
05/04/2014	06:03:07 PM	-66.664	-82.660	-81.060	-81.580	-80.864	-82.068	-80.652	-81.732	-80.664
08/04/2014	06:03:11 PM	-67.284	-77.608	-82.120	-81.948	-81.148	-82.796	-81.364	-82.712	-80.956
11/04/2014	06:03:15 PM	-78.484	-81.900	-82.088	-82.632	-81.192	-81.544	-81.808	-82.364	-81.840
14/04/2014	06:03:19 PM	-60.040	-81.832	-81.612	-82.340	-83.656	-82.456	-82.172	-80.788	-83.600
03/04/2014	06:03:33 PM	-53.880	-81.536	-82.348	-80.876	-82.952	-81.748	-82.864	-82.480	-80.196
06/04/2014	06:03:37 PM	-55.192	-78.476	-81.968	-81.544	-81.112	-81.832	-80.808	-82.448	-79.704
09/04/2014	06:03:41 PM	-65.120	-80.948	-81.592	-82.200	-82.712	-82.384	-81.988	-81.172	-82.200
12/04/2014	06:03:45 PM	-79.328	-79.776	-81.268	-82.260	-82.900	-82.652	-80.428	-81.036	-82.404
15/04/2014	06:03:49 PM	-70.632	-83.164	-82.900	-80.988	-81.260	-81.496	-81.580	-82.696	-82.648
01/04/2014	06:03:59 PM	-59.060	-82.668	-80.468	-81.804	-81.448	-81.716	-81.272	-80.664	-81.996
04/04/2014	06:04:03 PM	-58.944	-83.168	-80.860	-80.276	-81.828	-82.000	-81.144	-81.952	-81.372
07/04/2014	06:04:07 PM	-66.008	-82.072	-84.516	-81.760	-82.592	-79.856	-83.224	-82.052	-82.828
10/04/2014	06:04:11 PM	-58.040	-78.344	-81.224	-82.068	-81.388	-81.856	-81.816	-83.344	-82.684
13/04/2014	06:04:15 PM	-70.480	-81.968	-81.560	-81.588	-81.468	-82.152	-80.316	-81.080	-80.812
02/04/2014	06:04:29 PM	-55.992	-81.528	-82.188	-82.808	-81.536	-81.880	-80.544	-81.156	-81.828
05/04/2014	06:04:33 PM	-59.376	-80.008	-81.480	-81.360	-81.500	-81.868	-80.664	-80.860	-82.068
08/04/2014	06:04:37 PM	-61.956	-82.880	-82.644	-81.348	-81.260	-81.236	-81.316	-82.748	-81.760
11/04/2014	06:04:41 PM	-76.588	-82.644	-81.768	-84.524	-81.116	-81.264	-82.684	-82.560	-83.084
14/04/2014	06:04:45 PM	-58.732	-80.172	-82.048	-81.512	-81.072	-82.240	-83.824	-81.548	-81.788
03/04/2014	06:04:59 PM	-56.020	-77.956	-82.956	-82.780	-81.684	-81.708	-81.456	-81.012	-81.056
06/04/2014	06:05:03 PM	-62.776	-80.372	-80.392	-81.276	-83.656	-81.980	-81.848	-81.372	-81.416
09/04/2014	06:05:07 PM	-56.028	-83.300	-82.172	-83.764	-83.104	-82.644	-80.992	-81.884	-80.640
12/04/2014	06:05:11 PM	-75.736	-81.824	-80.900	-81.384	-81.284	-82.752	-82.924	-80.856	-81.808
15/04/2014	06:05:15 PM	-76.684	-82.012	-83.124	-81.144	-82.400	-84.016	-83.040	-82.592	-81.664
01/04/2014	06:05:25 PM	-65.804	-81.072	-82.400	-82.548	-82.128	-81.580	-82.068	-82.704	-81.028
04/04/2014	06:05:29 PM	-55.224	-75.428	-82.576	-82.048	-81.780	-82.076	-81.984	-80.824	-80.764
07/04/2014	06:05:33 PM	-75.876	-82.020	-82.912	-83.012	-82.272	-82.760	-80.904	-84.828	-83.684
10/04/2014	06:05:37 PM	-74.468	-82.784	-83.028	-83.528	-81.808	-82.240	-82.148	-80.832	-83.348
13/04/2014	06:05:41 PM	-75.524	-80.300	-82.240	-83.124	-82.740	-81.004	-81.504	-81.340	-81.000
02/04/2014	06:05:55 PM	-54.948	-81.144	-82.372	-81.664	-82.096	-81.320	-81.200	-81.284	-83.328
05/04/2014	06:05:59 PM	-72.212	-81.484	-81.552	-81.676	-83.248	-81.136	-81.260	-79.960	-81.696
08/04/2014	06:06:03 PM	-56.188	-81.372	-81.616	-81.132	-82.268	-81.952	-82.212	-79.472	-79.772

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Sample of NDs' Database Before Parenting

Callsign	Add	Nom. power	Ant HT	Demanded DL Kbits	Dem UL	Tx FRQ	Rx FRQ	Tx Bw kHz	Rx Bw kHz	TLT °	AZM °	DL activity (pc)	UL activity (pc)	Clutter name
orphan	adr1	2	5	8192	4096	590	590	240	240	0	0	100	100	open
orphan	adr2	2	5	8192	4096	590	590	240	240	0	0	100	100	forest
orphan	adr3	2	5	8192	4096	590	590	240	240	0	0	100	100	forest
orphan	adr4	2	5	8192	4096	590	590	240	240	0	0	100	100	open
orphan	adr5	2	5	8192	4096	590	590	240	240	0	0	100	100	open
orphan	adr6	2	5	8192	4096	590	590	240	240	0	0	100	100	forest
orphan	adr7	2	5	8192	4096	590	590	240	240	0	0	100	100	forest
orphan	adr8	2	5	8192	4096	590	590	240	240	0	0	100	100	open
orphan	adr9	2	5	8192	4096	590	590	240	240	0	0	100	100	forest
orphan	adr10	2	5	8192	4096	590	590	240	240	0	0	100	100	open
orphan	adr11	2	5	8192	4096	590	590	240	240	0	0	100	100	forest
orphan	adr12	2	5	8192	4096	590	590	240	240	0	0	100	100	open
orphan	adr13	2	5	8192	4096	590	590	240	240	0	0	100	100	forest
orphan	adr14	2	5	8192	4096	590	590	240	240	0	0	100	100	forest
orphan	adr15	2	5	8192	4096	590	590	240	240	0	0	100	100	open
orphan	adr16	2	5	8192	4096	590	590	240	240	0	0	100	100	forest
orphan	adr17	2	5	8192	4096	590	590	240	240	0	0	100	100	forest
orphan	adr18	2	5	8192	4096	590	590	240	240	0	0	100	100	forest
orphan	adr19	2	5	8192	4096	590	590	240	240	0	0	100	100	open
orphan	adr20	2	5	8192	4096	590	590	240	240	0	0	100	100	forest
orphan	adr21	2	5	8192	4096	590	590	240	240	0	0	100	100	open
orphan	adr22	2	5	8192	4096	590	590	240	240	0	0	100	100	open
orphan	adr23	2	5	8192	4096	590	590	240	240	0	0	100	100	open
orphan	adr24	2	5	8192	4096	590	590	240	240	0	0	100	100	open
orphan	adr25	2	5	8192	4096	590	590	240	240	0	0	100	100	open
orphan	adr26	2	5	8192	4096	590	590	240	240	0	0	100	100	forest
orphan	adr27	2	5	8192	4096	590	590	240	240	0	0	100	100	open
orphan	adr28	2	5	8192	4096	590	590	240	240	0	0	100	100	forest
orphan	adr29	2	5	8192	4096	590	590	240	240	0	0	100	100	forest
orphan	adr30	2	5	8192	4096	590	590	240	240	0	0	100	100	open
orphan	adr31	2	5	8192	4096	590	590	240	240	0	0	100	100	forest
orphan	adr32	2	5	8192	4096	590	590	240	240	0	0	100	100	forest
orphan	adr33	2	5	8192	4096	590	590	240	240	0	0	100	100	open
orphan	adr34	2	5	8192	4096	590	590	240	240	0	0	100	100	open
orphan	adr35	2	5	8192	4096	590	590	240	240	0	0	100	100	open
orphan	adr36	2	5	8192	4096	590	590	240	240	0	0	100	100	open
orphan	adr37	2	5	8192	4096	590	590	240	240	0	0	100	100	open
orphan	adr38	2	5	8192	4096	590	590	240	240	0	0	100	100	forest
orphan	adr39	2	5	8192	4096	590	590	240	240	0	0	100	100	open
orphan	adr40	2	5	8192	4096	590	590	240	240	0	0	100	100	open

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Sample of NDs' Database After Parenting

Callsign	Add	Demanded DL Kbits	Obtained DL Kbits	Demanded DL Kbits	Obtained UL Kbits	Tilt °	Azimuth °	DL activity %	UL activity %	Clutter name
c0000005	adr1	8192	8192	4096	4096	-0.805	225.67	100	100	open
orphan	adr2	8192	8192	4096	4096	0	0	100	100	forest
c0000005	adr3	8192	8192	4096	4096	-0.723	231.22	100	100	forest
c0000005	adr4	8192	8192	4096	4096	-0.929	227.07	100	100	open
c0000005	adr5	8192	8192	4096	4096	-1.024	236.52	100	100	open
c0000009	adr6	8192	8192	4096	4096	-1.548	191.83	100	100	forest
c0000009	adr7	8192	8192	4096	4096	-1.473	192.12	100	100	forest
c0000005	adr8	8192	8192	4096	4096	-0.914	227.39	100	100	open
c0000005	adr9	8192	8192	4096	4096	-0.723	231.32	100	100	forest
c0000006	adr10	8192	8192	4096	4096	-0.888	233.62	100	100	open
c0000005	adr11	8192	8192	4096	4096	-0.649	235.42	100	100	forest
c0000005	adr12	8192	8192	4096	4096	-1.142	239.88	100	100	open
c0000009	adr13	8192	8192	4096	4096	-1.578	188.97	100	100	forest
orphan	adr14	8192	8192	4096	4096	0	0	100	100	forest
c0000009	adr15	8192	8192	4096	4096	-1.722	244.87	100	100	open
c0000005	adr16	8192	8192	4096	4096	-0.753	232.35	100	100	forest
c0000006	adr17	8192	8192	4096	4096	-0.639	235.41	100	100	forest
c0000006	adr18	8192	8192	4096	4096	-0.715	235.52	100	100	forest
c0000005	adr19	8192	8192	4096	4096	-1.139	240.32	100	100	open
orphan	adr20	8192	8192	4096	4096	0	0	100	100	forest
c0000009	adr21	8192	8192	4096	4096	-1.77	245.52	100	100	open
c0000009	adr22	8192	8192	4096	4096	-1.947	245.94	100	100	open
c0000001	adr23	8192	8192	4096	4096	-3.823	168.8	100	100	open
orphan	adr24	8192	8192	4096	4096	0	0	100	100	open
c0000005	adr25	8192	8192	4096	4096	-0.376	231.15	100	100	open
c0000006	adr26	8192	8192	4096	4096	-0.766	232.62	100	100	forest
c0000005	adr27	8192	8192	4096	4096	-0.827	234.24	100	100	open
c0000005	adr28	8192	8192	4096	4096	-0.628	235.62	100	100	forest
c0000005	adr29	8192	8192	4096	4096	-1.041	241.92	100	100	forest
orphan	adr30	8192	8192	4096	4096	0	0	100	100	open
orphan	adr31	8192	8192	4096	4096	0	0	100	100	forest
c0000009	adr32	8192	8192	4096	4096	-1.564	189.87	100	100	forest
orphan	adr33	8192	8192	4096	4096	0	0	100	100	open
c0000009	adr34	8192	8192	4096	4096	-1.735	245.57	100	100	open
orphan	adr35	8192	8192	4096	4096	0	0	100	100	open
c0000005	adr36	8192	8192	4096	4096	-0.843	236.34	100	100	open

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Sample of LTE-1800-NDs' Database

BS #	Distance (m)	Power (dBm)	SNR (dB)	DL Kbits/s	UL Kbits/s
1	2804.6	-41.1	55.9	8192	4096
1	2912	-41.7	55.27	8192	4096
1	2730.6	-41.7	55.26	8192	4096
1	2782.8	-77.3	19.65	8192	4096
1	2647.6	-39.4	57.62	8192	4096
1	2630.6	-39.4	57.55	8192	4096
1	2757.7	-40.4	56.56	8192	4096
1	2607.7	-40.6	56.36	8192	4096
1	2829	-66.6	30.38	8192	4096
1	2183.6	-62.5	34.52	8192	4096
1	2837.5	-75.6	21.39	8192	4096
1	2157.4	-63.4	33.55	8192	4096
1	2485.2	-66.6	30.45	8192	4096
1	2586.4	-53.7	43.27	8192	4096
1	2298.2	-70.1	26.87	8192	4096
1	2146.6	-57.1	39.89	8192	4096
1	1923.7	-69.6	27.4	8192	4096
1	1855.6	-74.4	22.64	8192	4096
1	1835.6	-37.3	59.66	8192	4096
1	2405.7	-48.3	48.7	8192	4096
1	2755.4	-76.8	20.21	8192	4096
1	2680.3	-48.4	48.64	8192	4096
1	1861.2	-41.6	55.39	8192	4096
1	2808.6	-80.4	16.59	8192	4096
1	1429.4	-65.9	31.13	8192	4096
1	1538.8	-42.3	54.69	8192	4096
1	2088.1	-41.4	55.61	8192	4096
1	2844.5	-49	48.03	8192	4096
1	1177.1	-33.3	63.7	8192	4096
1	2559.1	-45.1	51.91	8192	4096
1	1115.7	-32	64.96	8192	4096
1	2078.8	-62	34.99	8192	4096
1	1588	-38.5	58.49	8192	4096
1	2763.2	-48	48.97	8192	4096
1	2823	-50.1	46.94	8192	4096
1	1488.1	-38.2	58.78	8192	4096
1	1245.8	-64	33.01	8192	4096
1	2600	-47.1	49.92	8192	4096
1	1341.6	-54.5	42.51	8192	4096
1	2115.5	-59.3	37.7	8192	4096
1	2620.5	-47.5	49.52	8192	4096

1	2926.6	-82.1	14.88	8192	4096
1	2377.6	-48.1	48.94	8192	4096
1	1862.9	-59	38.04	8192	4096
1	933	-46.5	50.52	8192	4096
1	2282.8	-67	29.97	8192	4096
1	688.2	-39.9	57.14	8192	4096
1	1189.3	-57.2	39.78	8192	4096
1	368.8	-32.9	64.12	8192	4096
1	1835.6	-60.8	36.17	8192	4096
1	1388.5	-62.4	34.56	8192	4096
1	339.4	-55.9	41.12	8192	4096
1	2647.6	-49.4	47.59	8192	4096
1	1727.4	-63	34.02	8192	4096
1	506	-58.7	38.3	8192	4096
1	848.5	-37.8	59.17	8192	4096
1	2562.8	-49.5	47.47	8192	4096
1	481.7	-54.2	42.76	8192	4096
1	164.9	-34.8	62.2	8192	4096
1	2960.3	-56.9	40.07	8192	4096
1	1480.5	-72.7	24.29	8192	4096
1	2601.2	-69.8	27.17	8192	4096
1	843.8	-52.4	44.63	8192	4096
1	2243.2	-73.2	23.77	8192	4096
1	888.1	-41.9	55.14	8192	4096
1	651.2	-39.3	57.67	8192	4096
1	894.4	-42.6	54.42	8192	4096
1	1608	-65.9	31.07	8192	4096
1	2285.6	-70.7	26.26	8192	4096
1	863.5	-44	53.02	8192	4096
1	1572.8	-71.4	25.61	8192	4096
1	2014.3	-49.4	47.62	8192	4096
1	1815.9	-69.1	27.87	8192	4096
1	1050	-47.8	49.21	8192	4096
1	1319.4	-48.3	48.72	8192	4096
1	2942.1	-59.6	37.42	8192	4096
1	2361.4	-70.3	26.74	8192	4096
1	1467.5	-49.1	47.91	8192	4096
1	2565.3	-79.7	17.28	8192	4096
1	2573.1	-87	10	8192	4096
1	1162.8	-49.4	47.64	8192	4096
1	2115.5	-52	45.03	8192	4096
1	712.2	-68.8	28.24	8192	4096
1	850.4	-55.8	41.24	8192	4096
1	2347.8	-53.6	43.39	8192	4096
1	680	-50.5	46.49	8192	4096

1	2435.1	-54	43.04	8192	4096
1	1112.1	-57.7	39.34	8192	4096
1	769.4	-54.8	42.24	8192	4096
1	858.8	-53.5	43.51	8192	4096
1	1074.8	-75.9	21.07	8192	4096
1	1647.3	-69.8	27.23	8192	4096
1	1824.7	-74.1	22.85	8192	4096
1	2529.8	-55.5	41.53	8192	4096
1	1791.1	-74.3	22.67	8192	4096
1	941.5	-59.6	37.42	8192	4096
1	960.8	-58.8	38.2	8192	4096
1	1132.1	-63.8	33.2	8192	4096
1	1536.7	-82.6	14.42	8192	4096
1	1831.7	-79.4	17.61	8192	4096
1	1787.5	-77.2	19.84	8192	4096
1	2701.7	-82.5	14.52	8192	4096
1	1874.5	-81	16	8192	4096
1	2064.6	-77.5	19.49	8192	4096
1	1242.6	-62.7	34.34	8192	4096
1	1736.7	-62.7	34.32	8192	4096
1	1523.2	-66.1	30.92	8192	4096
1	2036.5	-73.2	23.78	8192	4096
1	1517.9	-66	31	8192	4096
1	2468.7	-81.3	15.71	8192	4096
1	1682.4	-68.2	28.8	8192	4096
1	1617.9	-65.4	31.6	8192	4096
1	2768.1	-78.8	18.21	8192	4096
1	1710.2	-68.5	28.48	8192	4096
1	1691.9	-67.2	29.8	8192	4096
1	1878.3	-67.6	29.42	8192	4096
1	1761.8	-67.2	29.84	8192	4096
1	2004.8	-68.2	28.82	8192	4096
1	2078.8	-76.9	20.09	8192	4096
1	1883	-69.8	27.17	8192	4096