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A Qualitative Study of Signal Strength Coverage of Digital Terrestrial Television in Ibadan South Western Nigeria

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Abstract
This work investigated the quality of signal strength coverage of the existing Digital Terrestrial Television (DTTV) operator in Nigeria using Startimes Ibadan as a case study. Signal strength and altitude data at different locations within a 40km radius of the Startimes transmitting station were measured to determine the quality of signal strength reception of Startime's digital television in Ibadan metropolis. A signal analyzer, a 10-meter cable, Yaggi external antenna and Global Positioning System (GPS) were used for the measurements at various locations in Ibadan within 40km radius distance of Startimes based station at Agodi in Ibadan. The city was grouped into six different zones for proper signal testing and efficient data0 collation. Parameters such as signal strength, distance, altitude, signal to noise ratio, modulation error rate, pre-bit error rate and post bit-error rate were measured and recorded. The effects of distance and altitude were analyzed. It was observed from the result that there is a direct relationship between power level and altitude. In addition, there is an inverse relationship between power level and distance.

Keywords: DTTV, Signal Strength, Altitude, Distance, DVB-T

Introduction

Digital Video Broadcasting Television (DVB-T) came up as the first system based on Orthogonal Frequency Division Multiplexing (OFDM) modulation for digitalization of television when considering terrestrial propagation in the early 90's (Satitsamitpong and Mitomo, 2013). DVB-T is an improvement to the analogue system, the robustness of its modulation eliminates the limitation and shortcoming encountered in the analogue system, and the technology was proposed by the DVB Consortium and standardized by the European Telecommunication Standard Institute (ETSI) (Dhok and Dhanvijay, 2015; Gyamfi, 2015). A digital terrestrial television (DTTV) is a terrestrial implementation of Digital Television (DTV) technology that uses an aerial to broadcast to a television antenna or aerial instead of satellite dish or cable television technology (Seamus, 2000; Adda and Ottaviani, 2005). DTTV is usually transmitted on radio frequencies through terrestrial space in the same way a standard analogue television is transmitted (Ajibola, 2015). However, it uses the multiplex transmitter to allow reception of multiple channels on a single frequency range known as a sub-channel. This enables television stations to provide clearer pictures and better sound quality (Telecom Regulatory Authority of India, 2017).

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DTTV transmits information such as picture and sound as "data bits" like a computer. It also enables a television station to deliver a high quality television services for consumers with high definition (HD) television sets and offer such essential data services such as: closed-captioning, electronic program guides, additional languages (spoken or subtitled), and allow other advanced services such as live broadcasting and interactivity functionality (Collins, 2001; Balarabe, 2013; BT.2140-7, 2014).

Terrestrial Television services brought many advantages and benefits to viewers compared to conventional analogue. Although many countries around the world introduced DTTV with the attendant benefits, it provides in mind (Simon, 2000; Plum, 2014). The rates of DTTV adoption have been slow, and many a time some countries have to postpone the analogue switch-off date, including Nigeria (Idachaba, 2018).

Digital Terrestrial Television (DTTV) migration have a great deal of complexity, which bound up with many issues such as technical, social and economic. For any change in technology, there has to be a considerable challenges attached to it. Identifying, monitoring and mitigating these challenges are therefore, necessary (Mbatha and Lesame, 2014; Nkaka and Mukumbwa, 2016).

In compliance with the International Telecommunications Union, ITU directive to migrate from analogue to digital television transmission, the National Broadcasting Commission which is the body responsible for broadcasting regulation in Nigeria, recognizes, digitization as an important global movement and believed that the transition to digital terrestrial broadcasting will affect all segments along the broadcasting value chain positively (Idoko, 2010; NBC, 2018)

Nigeria and the rest of the world have experienced a dramatic rise in the use of television (TV) sets and has even become essential part of everyday life of their citizens. The introduction of many operators and competitive technologies has driven the price of DTTV downwards, thereby compelling more users across the social divide and age to subscribe to the services. (Idachaba, 2018)

In December 2007, the National Broadcasting Commission (NBC) set June 17, 2012, for the complete switchover from analogue TV to digital television. This date was shifted to June 2015 and later to June 17, 2017, due to unforeseen challenges that hinder the implementation (NBC, 2016)

According to Davis, (2009); Satitsamitpong and Mitomo (2013), there are needs to examine and understand the factors affecting the quality of signal reception of DTTV so that the intention of switching over from analogue to digital television will not be defeated. As Nigeria is switching from analogue transmission to digital transmission, there is the need to study the quality of the signal strength coverage of the existing DTTV operator in the country and determine if they are in line with the standards set by the ITU for the DTTV services.

In this work, we investigated the signal coverage quality within a 40km radius of transmitting site of Startimes. The effect of distance and altitude on the signal power strength were analyzed and determine if the transmitter parameters such as bit error rate, Modulation error rates of Startimes are within the specified standards.

Materials and Method

The material used for the collation of data include, a DS2400T DVB-T2 Signal analyzer meter, a Global Positioning System (GPS), 10 meter high external yaggi antenna connected with the signal analyzer and mounted as shown in Figure 1, and a car for transportation from one location to the other. The Startimes transmitting base is located inside the national television authority (NTA) premises at Agodi gate in Ibadan city on latitude 7°23'45.738" N and Longitude 3°55'2.742" E. The station is at altitude 252.40 meter above the sea level. Figure 2 presents the map of the study area.

Figure 1. Yagi receiving antenna set up

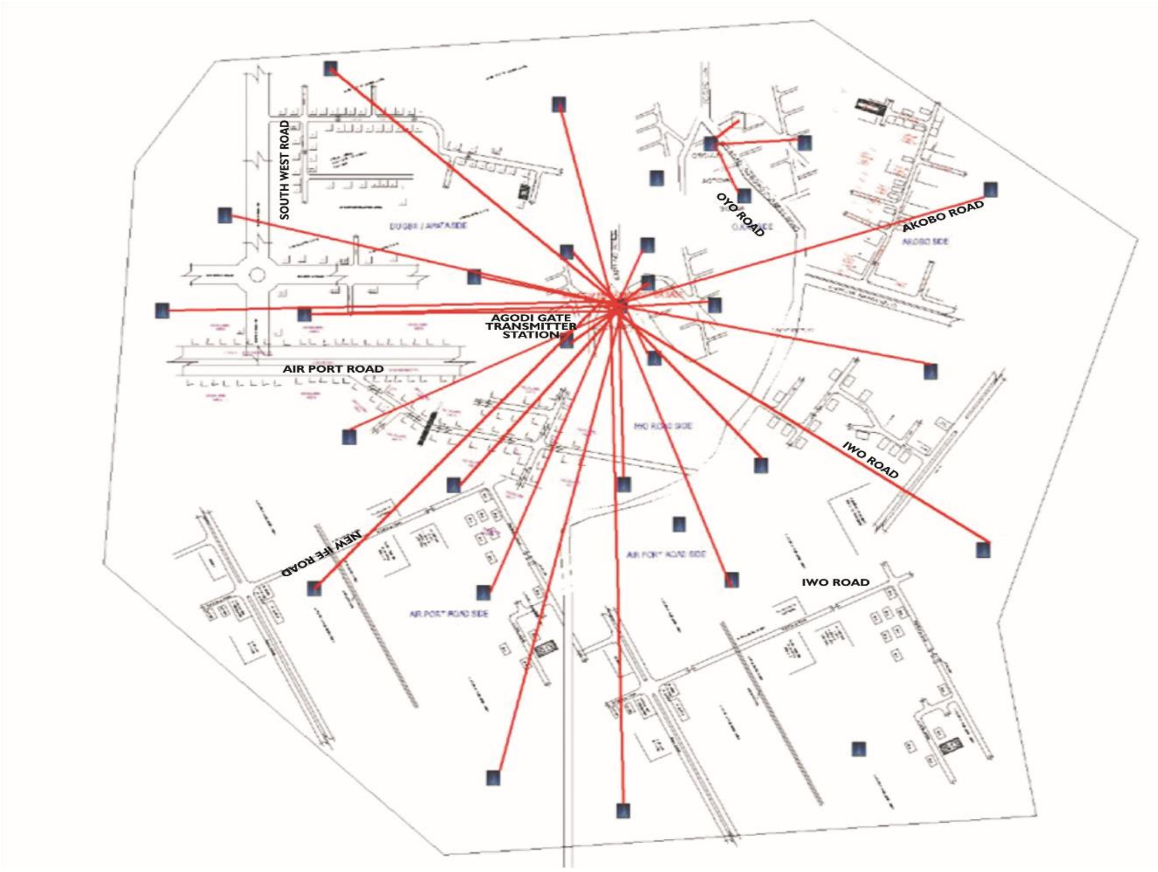


Figure 2. Ibadan city map indicating various zone of signal testing location and data collation

Signals from two transmitting antennas radiating at frequencies of 738Hz and 762Hz with a transmitted power of 2.5 kW were monitored from Oyo Road, Akobo Road, Iwo Road, New Ife Road, Southwest Road, and Airport Road in Ibadan. The radiating antennas were mounted on a transmitting mast height at 250ft at the Startimes transmitting base in Agodi. Several readings such as signal strength (SS), altitude, signal to noise ratio (SNR), modulation error rate (MER), before correction bit-error rate (Pre BER) and after correction bit-error rates (Post BER) were measured and recorded at twenty (20) different locations in each zone ranging between 1km to 40km radius distance from transmitting antenna using GPS, Yaggi receiving external antenna set at a fixed height of 10m and connected with the signal analyzer.

Results and Discussion

Table 1 to 6 present the results from the signal strength (SS), altitude, signal to noise ratio (SNR), modulation error rate (MER), before correction bit-error rate (preBER) and after correction bit-error rate (postBER) for the two transmitting frequencies (728 and 762 MHz) measured along the six route at different distance location up to 40km distance from the Startimes television transmission site.

From the tables, the pre BER ranging from 10^{-2} to 10^{-4} obtained for the two frequencies is good enough to produce post BER correction of 10^{-8}. The obtained BER is in agreement with the ITU recommendation (ITU_R.BT.1306, 2011) which state that the post BER correction must be at least 10^{-6}. This implies that the post BER of Startimes is above the minimum required for a quality delivery of DTTV at the users end. The signal to noise ratio (SNR) which was between 28 to 32db obtained in the tables for the two frequencies falls within the ITU recommendation for a stable signal which was stated in (ITU_R.F.339-8, 2013). The modulation error rate (MER) of between 25 to 32db obtained in the tables falls within the ETSI recommendation for a

Table 1. Signal data for the frequencies 738Hz and 762Hz along Oyo road, Ibadan

Test point	GPS Coordinate		Distance from transmitting station (km)	Altitude (Ft)	Power level (dBµV)		SNR (dBµV/m)		MER (dB)		bBER		aBER	
	Longitude	Latitude			738	762	738	762	738	762	738	762	738	762
1	3°54'36"E	7°25'25"N	3.2	737	77.0	75.4	30	30	31.1	30.6	1x10^{-4}	2x10^{-4}	$<10^{-8}$	$<10^{-8}$
2	3°54'30"E	7°25'53"N	4.2	730	74.7	72.5	30	31	30	30	1x10^{-4}	1x10^{-4}	$<10^{-8}$	$<10^{-8}$
3	3°54'25"E	7°26'45"N	5.7	689	66.9	65.2	31	31	32	31.6	1x10^{-4}	1x10^{-4}	$<10^{-8}$	$<10^{-8}$
4	3°54'45"E	7°26'58"N	6.5	700	70.3	70.1	31	31	32	32	1x10^{-4}	1x10^{-4}	$<10^{-8}$	$<10^{-8}$
5	3°54'49"E	7°27'40"N	7.7	725	68.1	68.3	31	31	32	32	1x10^{-4}	1x10^{-4}	$<10^{-8}$	$<10^{-8}$
6	3°54'51"E	7°28'34"N	8.9	746	65.3	65.0	31	31	29	31.5	6x10^{-4}	1x10^{-4}	$<10^{-8}$	$<10^{-8}$
7	3°54'55"E	7°28'45"N	9.8	750	63.1	63.4	31	31	29	29	1x10^{-4}	1x10^{-4}	$<10^{-8}$	$<10^{-8}$
8	3°54'58"E	7°29'52"N	11.3	763	65.5	64.1	31	31	32	32	1x10^{-4}	1x10^{-4}	$<10^{-8}$	$<10^{-8}$
9	3°55'06"E	7°31'04"N	13.6	829	69.6	67.9	31	32	32	32	2x10^{-4}	1x10^{-4}	$<10^{-8}$	$<10^{-8}$
10	3°54'57"E	7°32'26"N	16.1	786	59.4	58.2	31	31	32	32	1x10^{-4}	1x10^{-4}	$<10-^{8}$	$<10^{-8}$
11	3°54'55"E	7°35'33"N	21.8	862	51.9	50.2	30	28	30.9	28.8	2x10^{-4}	4x10^{-4}	$<10^{-8}$	$<10^{-8}$
12	3°55'06"E	7°36'42"N	24	916	48.3	47.5	25	24	25.5	24.6	2x10^{-3}	2x10^{-3}	$<10^{-8}$	$<10^{-8}$
13	3°55'15"E	7°37'42"N	25.9	927	55.4	53.1	31	24.5	32	32	2x10^{-4}	2x10^{-4}	$<10^{-8}$	$<10^{-8}$
14	3°55'12"E	7°39'17'N	27.3	923	51.0	51.0	26	26	32	31	9x10^{-4}	1x10^{-3}	$<10^{-8}$	$<10^{-8}$
15	3°54'59"E	7°42'21"N	28.1	1054	50.5	50.1	26	25	31	31	2x10^{-4}	2x10^{-4}	$<10^{-8}$	$<10^{-8}$
16	3°54'58"E	7°42'31"N	30.5	1067	47.1	47.0	26	26	31	31	1X10^{-2}	1x10^{-2}	$<10^{-8}$	$<10^{-8}$
17	3°55'08"E	7°45'41"N	33.1	962	45.0	44.2	28	28	31	31	2x10^{-4}	1x10^{-2}	$<10^{-8}$	$<10^{-8}$
18	3°54'57"E	7°48'43"N	35.3	1014	43.7	43.1	28	28	31	31	1x10^{-2}	1x10^{-2}	$<10^{-8}$	$<10^{-8}$
19	3°55'10"E	7°49'08"N	37.5	1008	40.0	39.3	28	28	31	31	1x10^{-2}	1x10^{-2}	$<10^{-8}$	$<10^{-8}$
20	3°55'34"E	7°49'56"N	40.5	965	37.9	37.5	28	28	31	31	1x10^{-2}	1x10^{-2}	$<10^{-8}$	$<10^{-8}$

Table 2. Signal data for the frequencies 738Hz and 762Hz along Akobo road, Ibadan

Test point	GPS Coordinate		Distance from transmitting station (km)	Altitude (Ft)	Power level (dBµV)		SNR(dBµV/m)		MER (dB)		bBER		aBER	
	Longitude	Latitude			738	762	738	762	738	762	738	762	738	762
1	3°54'54"E	7°25'15"N	3.4	725	74.2	71.9	31	32	31.1	30.6	1x10^{-4}	2x10^{-4}	$<10^{-8}$	$<10^{-8}$
2	3°54'30"E	7°25'20"N	4.3	720	72.3	71.8	31	32	30	30	1x10^{-4}	1x10^{-4}	$<10^{-8}$	$<10^{-8}$
3	3°54'14"E	7°25'25"N	5.7	707	66.2	65.2	32	32	32	31.6	1x10^{-4}	1x10^{-4}	$<10^{-8}$	$<10^{-8}$
4	3°55'59"E	7°25'34"N	6.7	801	75.0	72.0	32	31	32	32	1x10^{-4}	1x10^{-4}	$<10^{-8}$	$<10^{-8}$
5	3°56'22"E	7°25'44"N	7.7	794	71.0	70.0	31	30	32	32	1x10^{-4}	1x10^{-4}	$<10^{-8}$	$<10^{-8}$
6	3°56'35"E	7°25'58"N	9	805	69.3	69.5	31	31	29	31.5	6x10^{-4}	1x10^{-4}	$<10^{-8}$	$<10^{-8}$
7	3°56'51"E	7°26'14"N	9.9	813	77.6	76.5	31	31	29	29	1x10^{-4}	1x10^{-4}	$<10^{-8}$	$<10^{-8}$
8	3°56'57"E	7°26'50"N	11.3	823	72.5	72.1	31	31	32	32	1x10^{-4}	1x10^{-4}	$<10^{-8}$	$<10^{-8}$
9	3°57'10"E	7°27'30"N	13.5	816	71.8	70.2	32	32	32	32	2x10^{-4}	1x10^{-4}	$<10^{-8}$	$<10^{-8}$
10	3°57'20"E	7°27'55"N	16	828	68.1	67.3	31	31	32	32	1x10^{-4}	1x10^{-4}	$<10^{-8}$	$<10^{-8}$
11	3°57'28"E	7°28'23"N	21.5	837	65.1	64.8	31	31	30.9	28.8	2x10^{-4}	4x10^{-4}	$<10^{-8}$	$<10^{-8}$
12	3°57'55"E	7°28'37"N	24.3	830	63.0	62.5	31	31	25.5	24.6	2x10^{-3}	2x10^{-3}	$<10^{-8}$	$<10^{-8}$
13	3°58'14"E	7°28'55"N	26	795	60.5	60.0	32	32	32	32	2x10^{-4}	2x10^{-4}	$<10^{-8}$	$<10^{-8}$
14	3°58'40"E	7°28'05"N	27.2	900	58.4	58.2	31	31	32	31	9x10^{-4}	1x10^{-3}	$<10^{-8}$	$<10^{-8}$
15	3°59'21"E	7°29'24"N	28.3	736	55.5	54.5	31	30	31	31	2x10^{-4}	2x10^{-4}	$<10^{-8}$	$<10^{-8}$
16	3°59'52"E	7°29'55"N	30.3	855	54.1	53.2	31	31	31	31	1X10^{-2}	1x10^{-2}	$<10^{-8}$	$<10^{-8}$
17	4°00'08"E	7°30'04"N	33	714	48.1	47.5	32	31	31	31	2x10^{-4}	1x10^{-2}	$<10^{-8}$	$<10^{-8}$
18	4°00'55"E	7°30'25"N	35.5	820	45.1	44.3	31	31	31	31	1x10^{-2}	1x10^{-2}	$<10^{-8}$	$<10^{-8}$
19	4°01'10"E	7°30'51"N	37	915	40.3	40.1	31	31	31	31	1x10^{-2}	1x10^{-2}	$<10^{-8}$	$<10^{-8}$
20	4°01'50"E	7°31'05"N	40	960	37.8	37.5	31	31	31	31	1x10^{-2}	1x10^{-2}	$<10^{-8}$	$<10^{-8}$

Table 3. Signal data for the frequencies 738Hz and 762Hz along Iwo road, Ibadan

Test point	GPS Coordinate		Distance from transmitting station (km)	Altitude (Ft)	Power level (dBμV)		SNR(dBμV/m)		MER (dB)		bBER		aBER	
	Longitude	Latitude			738	762	738	762	738	762	738	762	738	762
1	3°56'30"E	7°24'15"N	3,2	821	76,1	76,7	32	32	32	32	1×10^{-4}	1×10^{-4}	$<10^{-8}$	$<10^{-8}$
2	3°56'58"E	7°24'51"N	4,5	835	74,3	74,1	31	31	32	32	1×10^{-4}	1×10^{-4}	$<10^{-8}$	$<10^{-8}$
3	3°57'24"E	7°25'00"N	5,5	740	64,1	63,9	30	30	32	32	2×10^{-3}	2×10^{-3}	$<10^{-8}$	$<10^{-8}$
4	3°57'50"E	7°25'00"N	6,5	755	64,0	63,6	30	30	31	31	1×10^{-4}	1×10^{-4}	$<10^{-8}$	$<10^{-8}$
5	3°58'25"E	7°25'13"N	7,5	790	60,8	60,5	30	30	31	31	1×10^{-4}	1×10^{-4}	$<10^{-8}$	$<10^{-8}$
6	3°59'09"E	7°25'27"N	8,1	644	58,3	58,1	29	29	32	32	1×10^{-3}	4×10^{-8}	$<10^{-8}$	$<10^{-8}$
7	3°59'45"E	7°25'35"N	9,2	700	61,3	60,8	30	30	31	31	1×10^{-4}	1×10^{-4}	$<10^{-8}$	$<10^{-8}$
8	4°00'14"E	7°25'50"N	10,3	657	66,4	66,4	32	31	32	32	1×10^{-4}	1×10^{-4}	$<10^{-8}$	$<10^{-8}$
9	4°00'52"E	7°26'05"N	11,2	690	62,5	62,0	31	31	32	32	1×10^{-4}	1×10^{-4}	$<10^{-8}$	$<10^{-8}$
10	4°01'00"E	7°26'40"N	12,2	615	58,4	58,0	32	32	32	32	1×10^{-4}	1×10^{-4}	$<10^{-8}$	$<10^{-8}$
11	4°02'09"E	7°27'05"N	14,4	705	71,5	71,4	32	32	32	32	1×10^{-4}	1×10^{-4}	$<10^{-8}$	$<10^{-8}$
12	4°03'39"E	7°27'30"N	17,2	705	51,9	52,0	30	30	30	31	1×10^{-4}	1×10^{-4}	$<10^{-8}$	$<10^{-8}$
13	4°04'25"E	7°28'15"N	19,1	655	50,1	50,0	30	30	31	31	1×10^{-4}	1×10^{-4}	$<10^{-8}$	$<10^{-8}$
14	4°04'53"E	7°29'58"N	21,4	640	48,3	48,1	30	30	31	32	1×10^{-4}	1×10^{-4}	$<10^{-8}$	$<10^{-8}$
15	4°05'38"E	7°32'12"N	25	671	46,7	46,5	30	30	31	31	1×10^{-4}	1×10^{-4}	$<10^{-8}$	$<10^{-8}$
16	4°06'03"E	7°33'25"N	27	667	45,8	45,0	30	30	31	31	1×10^{-4}	1×10^{-4}	$<10^{-8}$	$<10^{-8}$
17	4°06'43"E	7°33'51"N	29,1	730	43,5	43,1	30	30	31	31	1×10^{-4}	1×10^{-4}	$<10^{-8}$	$<10^{-8}$
18	4°07'01"E	7°33'09"N	31,5	750	40,7	40,2	30	30	31	31	1×10^{-4}	1×10^{-4}	$<10^{-8}$	$<10^{-8}$
19	4°07'25"E	7°33'34"N	35,1	780	38,9	38,3	30	30	31	31	1×10^{-4}	1×10^{-4}	$<10^{-8}$	$<10^{-8}$

Table 4. Signal data for the frequencies 738Hz and 762Hz along Ife road, Ibadan

Test point	GPS Coordinate		Distance from transmitting station (km)	Altitude (Ft)	Power level (dBμV)		SNR(dBμV/m)		MER (dB)		bBER		aBER	
	Longitude	Latitude			738	762	738	762	738	762	738	762	738	762
1	3°06'55"E	7°23'57"N	3,5	782	75,1	74,3	31	32	31	32	9×10^{-4}	1×10^{-4}	$<10^{-8}$	$<10^{-8}$
2	3°57'05"E	7°23'41"N	4,5	780	73,5	73,1	31	31	32	32	1×10^{-4}	1×10^{-4}	$<10^{-8}$	$<10^{-8}$
3	3°57'57"E	7°23'37"N	5,3	791	71,3	71,3	31	30	32	32	2×10^{-4}	2×10^{-3}	$<10^{-8}$	$<10^{-8}$
4	3°58'10"E	7°23'19"N	7	800	70,5	70,3	31	30	32	31	1×10^{-4}	1×10^{-4}	$<10^{-8}$	$<10^{-8}$
5	3°58'55"E	7°23'02"N	8,5	805	68,3	68,5	31	30	32	31	1×10^{-4}	1×10^{-4}	$<10^{-8}$	$<10^{-8}$
6	4°00'50"E	7°22'57"N	10,7	542	58,5	55,0	31	29	31	32	1×10^{-4}	4×10^{-8}	$<10^{-8}$	$<10^{-8}$
7	4°01'56"E	7°22'35"N	12,8	613	61,7	64,2	31	30	31	31	1×10^{-4}	1×10^{-4}	$<10^{-8}$	$<10^{-8}$
8	4°04'29"E	7°22'22"N	17,6	644	62,5	66,5	31	31	32	32	6×10^{-4}	1×10^{-4}	$<10^{-8}$	$<10^{-8}$
9	4°04'52"E	7°22'09"N	18,8	750	67,8	67,3	31	31	32	32	1×10^{-4}	1×10^{-4}	$<10^{-8}$	$<10^{-8}$
10	4°05'54"E	7°22'01"N	20,1	755	57,4	56,7	32	32	32	32	1×10^{-4}	1×10^{-4}	$<10^{-8}$	$<10^{-8}$
11	4°07'27"E	7°21'35"N	23,2	801	55,3	55,0	31	32	32	32	1×10^{-2}	1×10^{-4}	$<10^{-8}$	$<10^{-8}$
12	4°08'31"E	7°21'15"N	25,2	785	52,8	52,5	31	30	32	31	9×10^{-3}	1×10^{-3}	$<10^{-8}$	$<10^{-8}$
13	4°09'40"E	7°21'46"N	27,2	825	50,5	50,0	31	30	32	31	1×10^{-2}	1×10^{-4}	$<10^{-8}$	$<10^{-8}$
14	4°10'41"E	7°21'35"N	28,8	830	52,0	51,5	31	30	32	32	1×10^{-4}	1×10^{-4}	$<10^{-8}$	$<10^{-8}$
15	4°10'53"E	7°21'23"N	30,1	700	49,5	49,2	31	30	32	31	1×10^{-4}	1×10^{-4}	$<10^{-8}$	$<10^{-8}$
16	4°11'07"E	7°21'04"N	32,5	713	48,8	48,5	31	30	32	31	1×10^{-4}	1×10^{-4}	$<10^{-8}$	$<10^{-8}$
17	4°11'41"E	7°20'53"N	35	900	46,9	46,3	31	30	32	31	1×10^{-4}	1×10^{-4}	$<10^{-8}$	$<10^{-8}$
18	4°11'58"E	7°20'40"N	37,5	905	43,5	42,5	31	30	32	31	1×10^{-4}	1×10^{-4}	$<10^{-8}$	$<10^{-8}$
19	4°12'10"E	7°20'31"N	38,9	950	40,1	40,0	31	30	32	31	1×10^{-4}	1×10^{-4}	$<10^{-8}$	$<10^{-8}$
20	4°12'38"E	7°20'14"N	40,1	961	40,0	38,5	31	30	32	31	1×10^{-4}	1×10^{-4}	$<10^{-8}$	$<10^{-8}$

Table 5. Signal data for the frequencies 738Hz and 762Hz along Airport road, Ibadan

Test point	GPS Coordinate		Distance from transmitting station (km)	Altitude (Ft)	Power level (dBµV)		SNR(dBµV/m)		MER (dB)		bBER		aBER	
	Longitude	Latitude			738	762	738	762	738	762	738	762	738	762
1	3°53'56"E	7°22'47"N	2.7	813	73.1	71.2	32	32	32	32	$1x10^{-4}$	$1x10^{-4}$	$<10^{-8}$	$<10^{-8}$
2	3°53'30"E	7°22'38"N	3.5	720	62.0	62.0	31	31	32	32	$1x10^{-4}$	$1x10^{-4}$	$<10^{-8}$	$<10^{-8}$
3	3°53'31"E	7°21'43"N	4.7	728	65.9	64.5	30	30	32	32	$2x10^{-3}$	$2x10^{-3}$	$<10^{-8}$	$<10^{-8}$
4	3°52'44"E	7°20'56"N	6.8	624	58.7	60.5	30	30	31	31	$1x10^{-4}$	$1x10^{-4}$	$<10^{-8}$	$<10^{-8}$
5	3°52'20"E	7°20'31"N	7.8	794	80.7	80.2	30	30	31	31	$1x10^{-4}$	$1x10^{-4}$	$<10^{-8}$	$<10^{-8}$
6	3°52'04"E	7°19'44"N	9.3	750	67.4	64.4	29	29	32	32	$1x10^{-3}$	$4x10^{-8}$	$<10^{-8}$	$<10^{-8}$
7	3°52'10"E	7°20'23"N	10.5	813	70.0	70.3	30	30	31	31	$1x10^{-4}$	$1x10^{-4}$	$<10^{-8}$	$<10^{-8}$
8	3°50'56"E	7°20'10"N	11.7	823	78.5	78.6	32	31	32	32	$1x10^{-4}$	$1x10^{-4}$	$<10^{-8}$	$<10^{-8}$
9	3°49'43"E	7°19'58"N	13.8	816	61.2	60.3	31	31	32	32	$1x10^{-4}$	$1x10^{-4}$	$<10^{-8}$	$<10^{-8}$
10	3°50'24"E	7°21'03"N	14.5	828	74.6	73.1	32	32	32	32	$1x10^{-4}$	$1x10^{-4}$	$<10^{-8}$	$<10^{-8}$
11	3°48'53"E	7°21'56"N	15.6	837	74.4	72.0	32	32	32	32	$1x10^{-3}$	$1x10^{-3}$	$<10^{-8}$	$<10^{-8}$
12	3°49'00"E	7°22'34"N	16.5	790	66.3	66.3	30	30	30	31	$1x10^{-4}$	$1x10^{-4}$	$<10^{-8}$	$<10^{-8}$
13	3°49'25"E	7°23'12"N	18	795	60.5	60.0	30	30	31	31	$1x10^{-4}$	$1x10^{-4}$	$<10^{-8}$	$<10^{-8}$
14	3°48'02"E	7°23'54"N	20.3	750	58.7	58.0	30	30	31	32	$1x10^{-4}$	$1x10^{-4}$	$<10^{-8}$	$<10^{-8}$
15	3°47'07"E	7°23'45"N	22.5	736	50.2	49.0	30	30	31	31	$1x10^{-4}$	$1x10^{-4}$	$<10^{-8}$	$<10^{-8}$
16	3°23'58"E	7°46'02"N	25.3	730	48.5	48.0	30	30	31	31	$1x10^{-4}$	$1x10^{-4}$	$<10^{-8}$	$<10^{-8}$
17	3°23'36"E	7°45'01"N	30.5	733	46.0	46.1	30	30	31	31	$1x10^{-4}$	$1x10^{-4}$	$<10^{-8}$	$<10^{-8}$
18	3°44'46"E	7°23'20"N	33.1	700	45.8	45.3	30	30	31	31	$1x10^{-4}$	$1x10^{-4}$	$<10^{-8}$	$<10^{-8}$
19	3°43'18"E	7°23'12"N	37.3	715	41.0	40.5	30	30	31	31	$1x10^{-4}$	$1x10^{-4}$	$<10^{-8}$	$<10^{-8}$
20	3°42'02"E	7°23'43"N	40.3	703	37.1	36.9	30	30	31	31	$1x10^{-4}$	$1x10^{-4}$	$<10^{-8}$	$<10^{-8}$

Table 6. Signal data for the frequencies 738Hz and 762Hz along Southwest road, Ibadan

Test point	GPS Coordinate		Distance from transmitting station (km)	Altitude (Ft)	Power level (dBµV)		SNR(dBµV/m)		MER (dB)		bBER		aBER	
	Longitude	Latitude			738	762	738	762	738	762	738	762	738	762
1	3°56'56"E	7°20'53"N	3.5	821	80.0	79.1	31	31	31	32	$9x10^{-4}$	$1x10^{-4}$	$<10^{-8}$	$<10^{-8}$
2	3°57'10"E	7°20'40"N	5.5	835	75.1	74.1	31	31	32	32	$1x10^{-4}$	$1x10^{-4}$	$<10^{-8}$	$<10^{-8}$
3	3o57'24"E	7°20'34"N	6.8	740	73.3	73.2	31	30	32	32	$2x10^{-4}$	$1x10^{-4}$	$<10^{-8}$	$<10^{-8}$
4	3°57'55"E	7°20'15"N	8.5	755	70.3	69.8	31	31	32	32	$1x10^{-4}$	$1x10^{-4}$	$<10^{-8}$	$<10^{-8}$
5	3°58'21"E	7°20'02"N	9.2	790	72.3	72.0	31	31	32	32	$1x10^{-4}$	$1x10^{-4}$	$<10^{-8}$	$<10^{-8}$
6	3°59'28"E	7°19'15"N	11.6	644	70.6	70.0	31	32	31	32	$1x10^{-4}$	$1x10^{-4}$	$<10^{-8}$	$<10^{-8}$
7	4°00'41"E	7°18'30"N	14.2	700	69.0	70.6	31	30.1	31	30.8	$1x10^{-4}$	$1x10^{-4}$	$<10^{-8}$	$<10^{-8}$
8	4°00'35"E	7°18'50"N	16	657	68.1	67.3	31	30	32	31.6	$6x10^{-4}$	$1x10^{-4}$	$<10^{-8}$	$<10^{-8}$
9	4°01'30"E	7°17'05"N	17.1	690	65.8	62.3	31	27	32	32	$1x10^{-4}$	$1x10^{-4}$	$<10^{-8}$	$<10^{-8}$
10	4°01'34"E	7°16'30"N	19	615	62.6	59.3	32	31	32	32	$1x10^{-4}$	$1x10^{-2}$	$<10^{-8}$	$<10^{-8}$
11	4°01'43"E	7°15,02"N	20.3	705	60.1	57.3	31	31	32	32	$1x10^{-2}$	$1x10^{-2}$	$<10^{-8}$	$<10^{-8}$
12	4°01'36"E	7°13'43"N	22.2	705	57.0	54.1	31	31	32	32	$9x10^{-3}$	$6x10^{-3}$	$<10^{-8}$	$<10^{-8}$
13	4°01'45"E	7°12'01"N	25.2	655	54.5	52.4	31	31	32	32	$1x10^{-2}$	$1x10^{-4}$	$<10^{-8}$	$<10^{-8}$
14	4°01'59"E	7°11'25"N	26.5	640	52.8	50.1	31	31	32	32	$1x10^{-4}$	$3x10^{-4}$	$<10^{-8}$	$<10^{-8}$
15	4°02'02"E	7°10'24"N	27.9	671	50.5	48.3	31	31	32	32	$1x10^{-4}$	$1x10^{-4}$	$<10^{-8}$	$<10^{-8}$
16	4o02'50"E	7°09'30"N	29.1	667	48.1	45.0	31	31	32	32	$1x10^{-4}$	$2x10^{-4}$	$<10^{-8}$	$<10^{-8}$
17	4°01'44"E	7°07'45"N	31.1	730	45.7	42.5	31	31	32	32	$1x10^{-4}$	$1x10^{-4}$	$<10^{-8}$	$<10^{-8}$
18	4°01'51"E	7°06'50"N	33.5	750	42.0	40.5	31	31	32	32	$1x10^{-4}$	$1x10^{-4}$	$<10^{-8}$	$<10^{-8}$
19	4°01'57"E	7°05'55"N	36.3	780	40.7	38.1	31	31	32	32	$1x10^{-4}$	$1x10^{-4}$	$<10^{-8}$	$<10^{-8}$
20	4°02'20"E	7°05'10"N	40	801	38.0	37.0	31	31	32	32	$1x10^{-4}$	$1x10^{-4}$	$<10^{-8}$	$<10^{-8}$

Quadrature Phase Shift keying (QPSK) modulation techniques employed by Startimes. This specification as stated in (ETSI TR 101 290, 2001) recommended a minimum acceptable operational value of 18dB. Both the SNR and MER are quantities measured at the baseband. The SNR is measured before modulation and this value have a significant effect on the MER, which is a measure of the quality of digitally modulated signal and it provides the figure of merit analysis of the signal in the assessment of the performance of a DVB-T system (Fortin, 2008). With the MER of Startimes above the minimum, this implies the performance of Startimes DVB-T system is good enough to deliver a High definition image.

The plot of the signal strength against distance presented in Figures 3 and 4 show some spikes in signal strength as it decrease with distance, these spikes are attributed to the effect of the altitude on the signal strength. This relationship can be vividly seen on the 3-D graph plotted in Figures 5 and 6 for the two frequencies. This finding is also correlated with the statistical analysis carried out using SPSS IBM presented in Tables 7 and 8, which reveals the effect of altitude on the signal strength. From the correlation analysis in Table 7, there exists a positive relationship between the power level and altitude for the two transmitting frequencies. The correlation coefficients for the 728MHz and 738 MHz are given to be r = 0.618 and r = 0.510 respectively. This relationship is insignificant considering their p-values of 0.057 and 0.132 respectively as compared to the test p-value of 0.05. A negative relationship between the power level and distance was established with and r-value of 0.873 and r-value of 0.790 respectively. This relationship is significant at 0.001 and 0.007 respectively compared to the P-value of 0.05.

A Paired T-test presented in Table 8 was further used to determine the effect of power level on the altitude and distance. The result showed that altitude affects the power level since

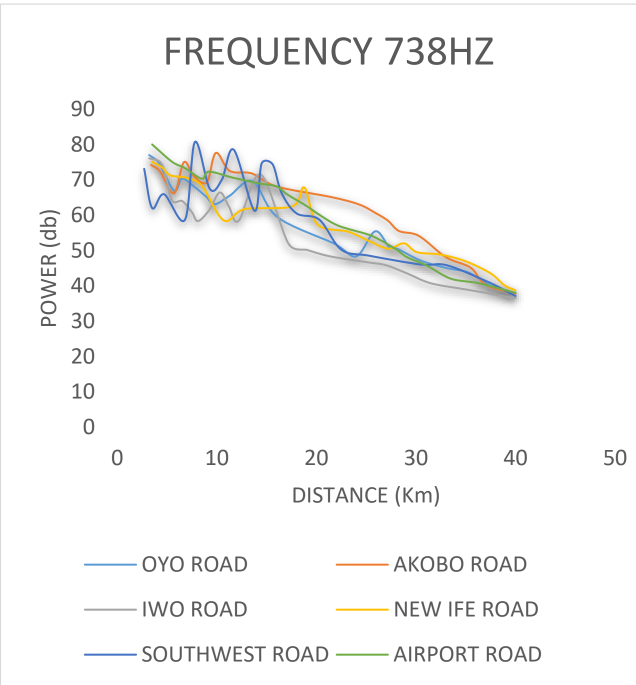


Figure 3. Plot of measured power against distance for frequency 738Hz

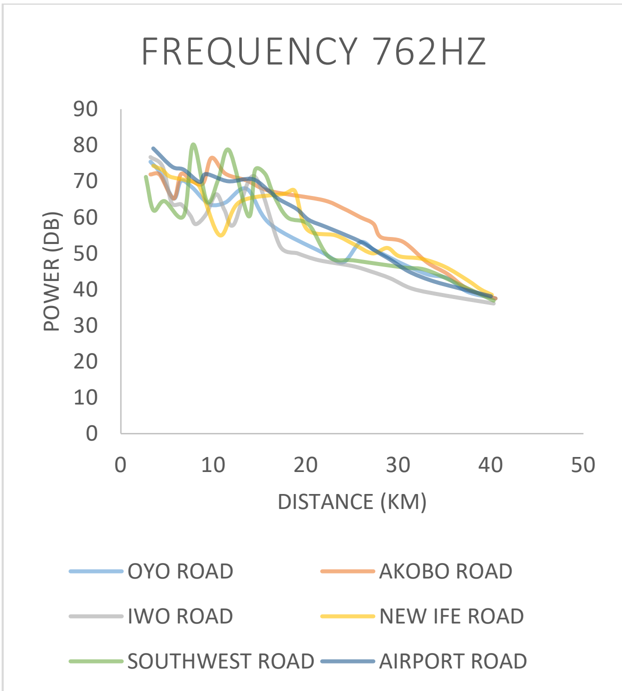


Figure 4. Plot of measured power against distance for frequency 762Hz

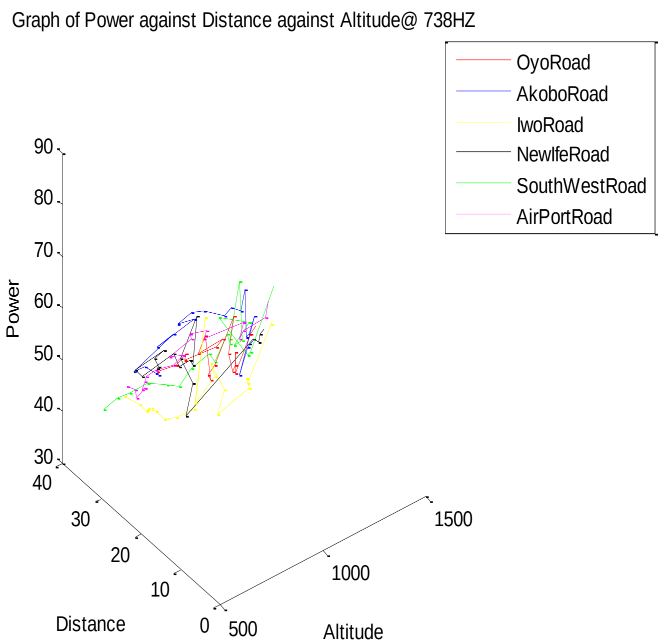


Figure 5. 3-D Plot showing the effect of altitude on the measured signal strength in respect to distance for the 738Hz frequency using MATLAB

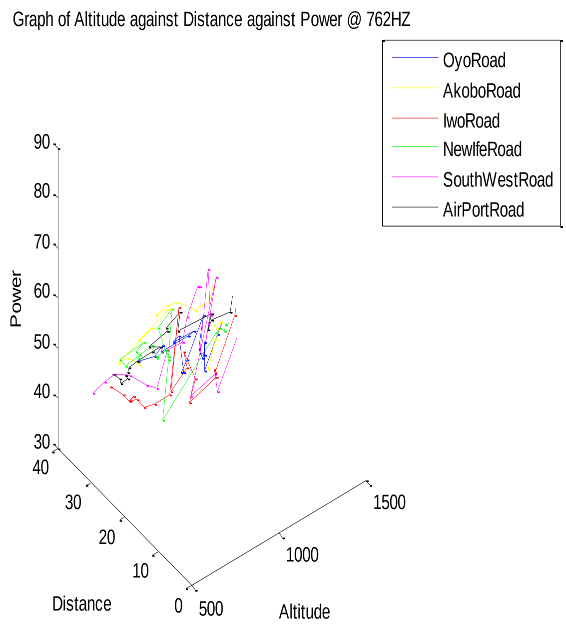


Figure 6. 3-D Plot showing the effect of altitude on the measured signal strength in respect to distance for the 762Hz frequency using MATLAB p-value=0.000 <0.05 and also the distance from

Table 7. The power level, altitude, and distance for transmission Station

	N	Correlation coefficient(r)	P value
Power Level and Altitude(Ft)	20	.618	.057
Power Level and Altitude(Ft)	20	.510	.132
Power Level and Distance from Transmission Station(km)	20	-.873	.001
Power Level and Distance from Transmission Station((km)	20	-.790	.007

Table 8: The effect of power level on the altitude and distance.

Parameters	Std. Deviation	Std. Error Mean	t-value	Df	P-value
PowerLevel/Altitude(Ft)	80.49019	25.45323	2.747	19	0.000
Power Level/ Altitude(Ft)	80.44766	25.43978	22.841	19	0.000
Power Level/Distance for Transmission Station(km)	18.55281	5.86691	6.148	19	0.000
Power Level/Distance for Transmission Station(km)	21.03821	6.65287	5.108	19	0.001

transmission station have effects on the power level as p value=0.000<0.05. Figures 7 to 12 compare the relationship between the signal strength of the two frequencies which reveal how both signal strength reduces progressively as the distance from the transmitter increases. No significant difference was observed for the two frequencies. This show that the transmitting frequencies does not affect the quality of the power of the transmitted signals since the two frequencies are very close in the UHF band.

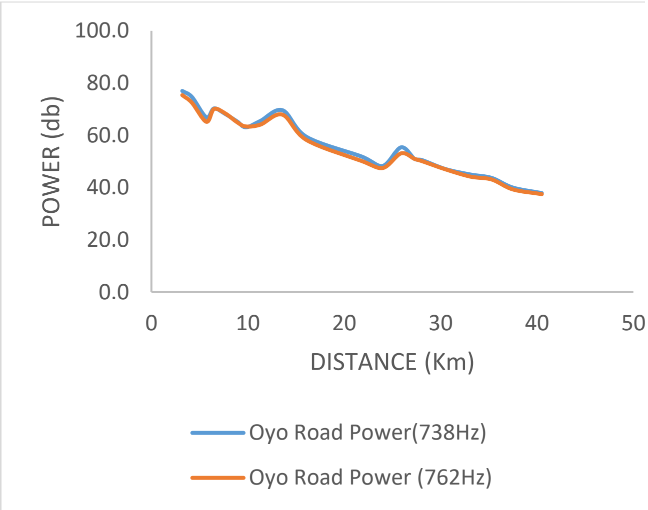


Figure 7. Comparison plot of power level against signal strength along Oyo road for the frequencies 738 and 762MHz.

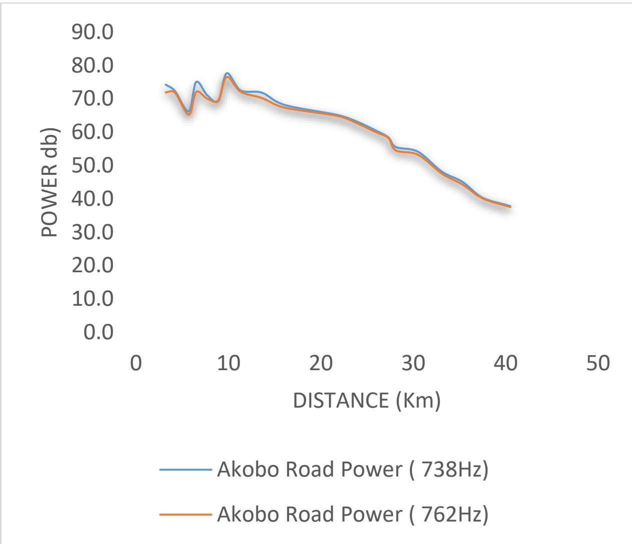


Figure 8. Comparison plot of power level against signal strength along Akobo road for the frequencies 738 and 762MHz

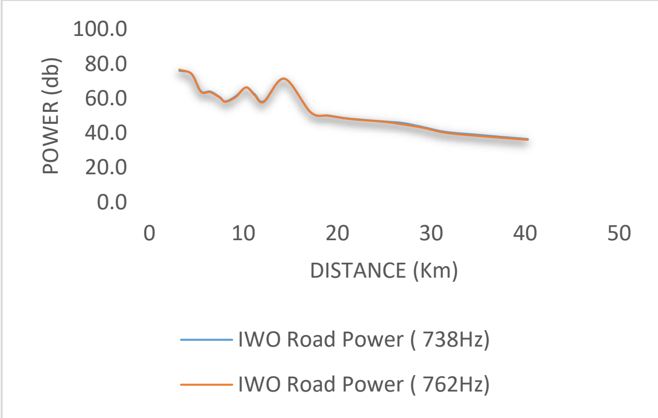


Figure 9. Comparison plot of power level against signal strength along Iwo road for the frequencies 738 and 762 MHz.

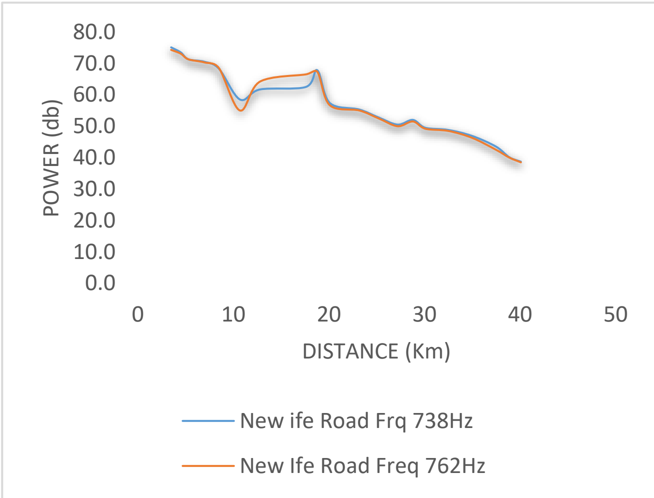


Figure 10. Comparison plot of power level against signal strength along New Ife road for the frequencies 738 and 762 MHz.

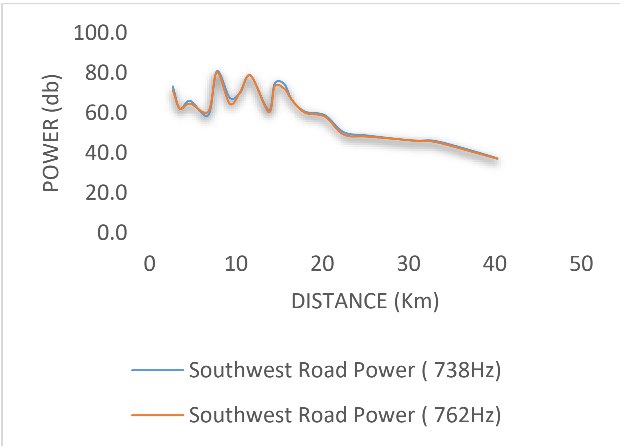
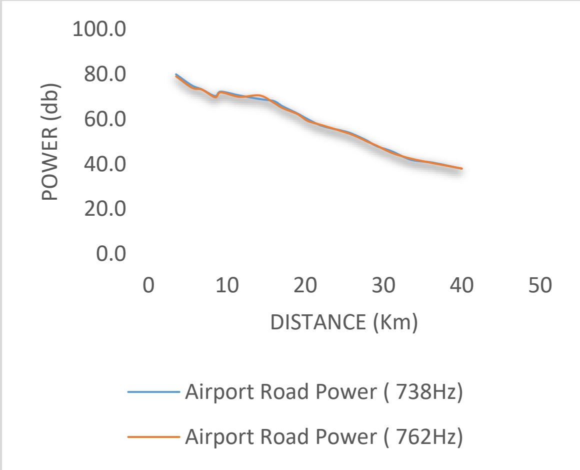


Figure 11. Comparison plot of power level against signal strength along Southwest road for the frequencies 738 and 762 MHz.



.Figure 12. Comparison plot of power level against signal strength along Airport road for the frequencies 738 and 762 MHz

Conclusion

The results obtained showed that the Startimes transmission parameters are in agreement with the International Telecommunication Union (ITU) standards. It was also observed that there exist an inverse relationship between the distance and signal strength monitored from the transmission station, i.e. the higher the distance, the lower the transmitted power received. It also reveals that there is a direct relationship between the altitudes and the signal strength. The higher the altitude, the higher the received power. The SNR, MER, and BER of the Startimes signal within the 40km radius in Ibadan were in agreement with the ITU recommendation for stable signal.

With this finding it could be said that a complete switch over from analogue to digital transmission should not pose serious challenges in Nigeria as the existing DTTV operators operating parameters are well in line with the ITU and ETSI Standards.

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