

PERFORMANCE EVALUATION OF DVB-T2 BROADCASTING NETWORK: A CASE STUDY OF DAR ES SALAAM, TANZANIA

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Abstract

DVB-T2 is the second generation of the digital terrestrial television broadcasting system which transmits composite (compressed digital audio and video) signal and other data in an MPEG-4 transport stream, using coded orthogonal frequency-division multiplexing (COFDM or OFDM) modulation. DVB-T2 uses multiple MPEG-4 transport streams and have enhanced FEC and higher QAM (256-QAM) constellations. Tanzania switched from analogue to Digital Video Broadcasting Terrestrial second generation (DVB-T2) in 2013, since the official switching there has been complaints from the DVB-T2 users on the coverage and quality of service provided. In this paper we evaluated the DVB-T2 performance and make the recommendations on the ways to optimize the performance. Through measurements it has been observed that, the quality of coverage in some areas (locations) is poor, so to improve the received signal strength coverage and quality we recommend the use of enhanced Yagi-Uda antenna gain which is going to be designed.

Keywords: DVB-T2, Received Signal Strength Indicator (RSSI), Bit Error Rate (BER), Carrier to Noise Ratio (CNR), Modulation Error Rate (MER), Polarization, Yagi-Uda antenna.

1. INTRODUCTION

Performance is a multi-faceted concept and it is conceptualized in many ways. Since networks stand at the heart of the TV broadcast systems, then network performance can be perceived in business context in three perspectives: customer perspective, technical perspective and system complexity perspective. It means performance as interpreted by customers and network engineers and technicians; and in terms of network components and complexity.

Analogue video broadcasting technology is being replaced by the digital video broadcasting ones. The common problems found in analog video broadcasting are ghost images due to multipath distortion in the radio channel and noise signals which degrades the quality of the analog video signal and sound which are all efficiently solved by a digital television. The transition of analog to digital by the roll out of the Digital Video Broadcasting-Terrestrial (DVB-T)[1] standards provides advantages in the exploitation of bandwidths, more robustness in front to the noise and another series of advantages that are translated in a clear improvement of the image and the sound, besides adding new applications for users like teletext services, email services in which the user is capable to communicate with service provider from his television through the decoder.

The benefits of digital coding and transmission techniques allow perfect signal recovery in all the serviced areas avoiding the effects of the wireless channel and noise. Considering the physical level of the communications, the digital data sequences, which contain MPEG video, audio and other information streams, are transmitted using Coded Orthogonal Frequency Division Multiplexing (COFDM) modulation. The information bits are coded, interleaved, mapped to a Quadrature Amplitude Modulation (QAM) constellation and grouped into blocks. All the symbols in a block are transmitted simultaneously at different frequency subcarriers using an Inverse Fast Fourier Transform (IFFT) operation. The number of IFFT points, which can be either 2048 (2K) or 8192 (8K), determines the transmission mode and the number of the available subcarriers in the transmission bandwidth. Some of these subcarriers are not used to allow for guard frequency bands whereas others are reserved for pilot symbols, which are necessary to acquire the channel information required for signal recovery.[2]

DVB-T2 is a 2^{nd} generation terrestrial broadcast transmission system developed by DVB project since 2006. The main purpose is to increase capacity, ruggedness and flexibility to the DVB-T system. The emergence of DVB-T2 is motivated by the higher spectral efficiency going along with DVB-T2 – be it for a transition from analogue TV to DVB-T2, be it for a transition from DVB-T to DVB-T2. Higher spectral efficiency means that with the same amount of spectrum, a larger number of programmes can be broadcast or the same number of programmes

broadcast with a higher audio/video quality or coverage quality. In addition improved source coding (MPEG-4) is employed, the gain in broadcast transmission remarkable.[3]
The new technologies, like compression standard Moving Picture Experts Group 4 (MPEG-4) part 10, or H.264/AVC (hereinafter called MPEG-4)[4] and the second generation of digital terrestrial broadcasting standard (DVB-T2)[5], provide increased capacity and ruggedness in the terrestrial transmission environment. As indicated in previous research [6], when considering the whole picture, it is evident that the latest technologies besides technical benefits, increased capacity for new services and higher quality of service, bring also a higher system cost. DVB-T2, second generation of terrestrial digital video broadcasting standard, promises performance gains because of improved coding, modulation and multiple antenna technologies.[7]
The radio frequency spectrum is a limited natural resource that can be used to increase the efficiency and productivity of a nation's workforce consequently enhance the quality of life. Spectrum is used to provide a wide variety of radio-communication services including; broad casting TV and sound, radio navigation, aeronautical, maritime radio, satellite, radio location and amateur radio. In addition, the spectrum-based services have become important inputs to a range of socio-economic activities such as security, education, health, defense, transportation etc.
The number of Television and Radio broadcasting services are increasing tremendously and this cause some problems in terms of quality of service provided to customers, for example in 2010 there were 10% of Tanzania's population complaining about the quality of service provided by broadcasting network. [8]
Since the official switching from analogue video broadcasting to DVB-T2 transmission, there has been an increasing number of complaints from customers (End users) on the bad or scrambled reception of the TV signals or sometimes lack of received signal at all. The source of complaints may be due to settings of the transmission towers of the DVB-T2 operators, settings of the reception antennas, or geographical layout of the region. Some important services like teletexting, email and subtitling have been missing since the launch of this services.
The DVB-T2 transmitting antenna used in Tanzania by different multiplexers have the following specifications:

Frequency range	470-697MHz
VSWR	<1.12
Gain (reference to $\lambda/2$)	11dB at midband
Impedance	50ohms
Maximum transmit power	3kW for vertical polarization antenna
Polarization	Vertical polarization but they may be also used for horizontal polarization like Star Media Limited they have set horizontal polarization in Arusha and Moshi with maximum transmit power in those regions being 0.8kW

Note: The vertical polarization covers the large area compared with the horizontal polarization that's why for small coverage region the horizontal polarization is better than vertical polarization
The figure below shows the customer complaints as per TCRA annual report

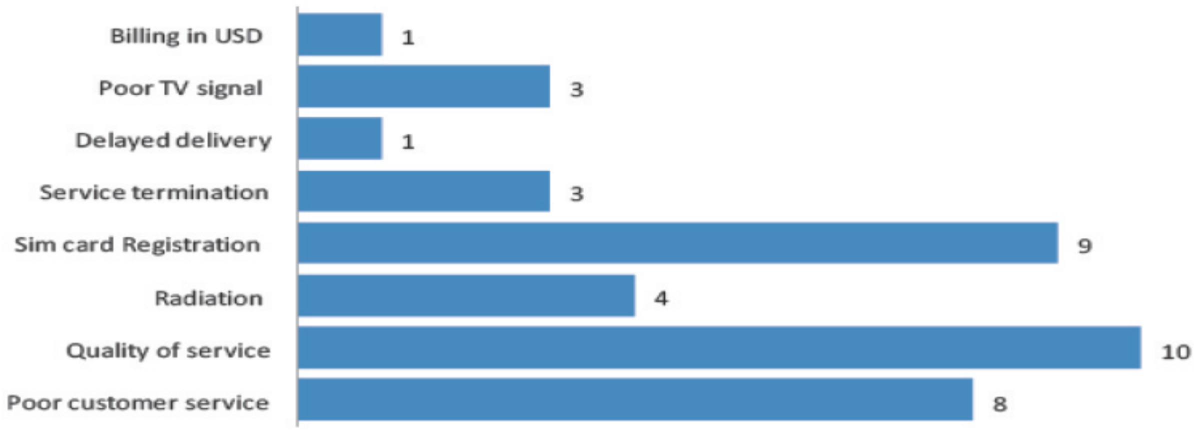

Figure 1: Customer complaints [9]

Due to the nature of buildings and poor planning of the Dar es salaam city there are places where the signal coverage are poor as stated before and the signals from transmitting towers at Kisarawe Hill and Makongo Juu (for Star Media), Mikocheni (for BTL) and Tangibovu (for AAL) struggle to reach the houses or buildings in some areas causing poor signal quality.

Figure 2: Diagram showing some tall buildings in Dar es Salaam as viewed from Posta PPF house

Figure 3: Diagram showing some rising buildings and forests in Mikocheni areas.

Another observations from survey shows that many outdoor directional antennas (Yagi-Uda antenna) are used and which are placed on the roof approximately 4m from the ground, this may cause poor reception of signals once heavy wind blows as the antenna direction may be twisted. But other buildings near by the transmitting sites uses indoor monopole antennas but there are no any obstruction of signals from those towers. The receiving antenna type used mostly are MISO (Multiple input single output)

Figure 4: Yagi-Uda antenna placed on the roof.

Also the presence of mountainous terrain in some areas like Changanyikeni (University of Dar es salaam), Kimara Bonyokwa and other places causes some poor signal reception to the areas behind those terrain even though taking Star Times as a case have erected their towers 132m high for Kisarawe transmission base and 83m for Makongo Juu transmission base(At first it was constructed as a gap filler or a repeater in technical term but now it is transmission base) but still the signals struggle to reach the receiving antennas in the mentioned areas above.

2. PERFORMANCE PARAMETERS CONCEPTS AND THEORY

i.) CARRIER TO NOISE RATIO (C/N)

In communications, the carrier-to-noise ratio, often written CNR or C/N, is a measure of the received carrier strength relative to the strength of the received noise or C/N is the ratio of the relative power level to the noise level in the bandwidth of a system. High C/N ratios provide better quality of reception, and generally higher communications accuracy and reliability, than low C/N ratios.

The C/N characterizes the robustness of transmission systems with regard to noise and interference. As such it is used to determine the signal level required to receive a viable signal in noise and interference limited channels. Subsequently, the determination of the C/N is of fundamental importance for network planning as it allows to analyze if a carrier can still be recognized as such, or if it is obliterated by ambient and system noise. C/N provides a value for the quality of a communication channel.[3]

The carrier-to-noise ratio (CNR) can be calculated through the following link budget formula:

$$\frac{C}{N} = \frac{P_{received}}{P_{noise}} = \frac{P_{received}}{F * k * T_o * B} \quad ----------- (1)$$

Where: $P_{noise} = Received\ noise\ input\ power$

$F = Receiver\ noise\ Figure$

$P_{received} = Minimum\ Receiver\ input\ power$

B= Receiver noise bandwidth (MHz)

$k = Boltzman\ constant$

$T_o = Absolute\ temperature\ (290K)$

$\frac{C}{N} = Carrier\ to\ Noise\ ratio$

$$P_{received}(dB) = \frac{C}{N}(dB) + F(dB) + 10log_{10}B(MHz) - 114 \quad ---- (2)$$

Table 3: Threshold data for CNR in different environment for three bands, for DVB-T2 only band IV and V applies.[10]

Threshold C/N [dB]			
Environment	**Band III**	**Band IV**	**Band V**
Rural	**20**	**20**	**20**
Suburban	**22**	**22**	**22**
Urban	**24**	**24**	**24**

The quality of the system is usually determined through BER plots against C/N.

Increased system robustness will also have a large impact upon SFN performance since a lower required *C/N* will reduce the susceptibility for SFN self-interference. DVB-T2 will give the possibility to provide much higher data rates than current DVB-T networks designed for portable or mobile reception.[3]

ii.) SIGNAL TO NOISE RATIO (SNR)

SNR is the ratio of the received signal strength over the noise strength in the frequency range of the operation. Noise strength, in general, can include the noise in the environment and other unwanted signals (interference). BER is inversely related to SNR, that is high BER causes low SNR. High BER causes increases packet loss, increase in delay and decreases throughput. The exact relation between the SNR and the BER is not easy to determine in the multi-channel environment. Signal to noise ratio (SNR) is an indicator commonly used to evaluate the quality of a communication link and measured in decibels.

SNR is calculated as the ratio of average symbol power to noise power. Noise power includes anything that causes the symbol to deviate from the ideal state position, including additive noise, distortion, and ISI (inter-symbol-interference).[11]

$$SNR = 10\log\left[\frac{sum\ N(IQ\ reference\ vector\ at\ symbols)^2}{sum\ N(error\ vector\ at\ symbols)^2}\right] ------(3)$$

Where: sum N is the summation of 1 to N and N is the result length in symbols. This indicates that the SNR and the MER are closely related to each other.

$$SNR = 10\log\left(\frac{Signal\ power}{Noise\ power}\right) -----------(4)$$

CNR measurements can be converted to SNR by using the relation[12]:

$SNR = CNR - 10\log_{10}(m)$

Where $m = \log_2 M$ for M-QAM in which for the case of DVB-T2 M= 64 or 256

iii.) BIT ERROR RATE (BER)

The BER, or quality of the digital link, is calculated from the number of bits received in error divided by the number of bits transmitted.

In digital transmission, the number of bit errors is the number of received bits of a data stream over a communication channel that has been altered due to noise, interference, distortion or bit synchronization errors. The BER is the number of bit errors divided by the total number of transferred bits during a particular time interval. BER is a unit less performance measure, often expressed as a percentage.

$$BER = \frac{Bits\ with\ errors}{Total\ number\ of\ bits\ received} -------------- (5)$$

Noise affects the BER performance. Quantization errors also reduce BER performance, through incorrect or ambiguous reconstruction of the digital waveform. The accuracy of the analog modulation process and the effects of the filtering on signal and noise bandwidth also effect quantization errors.

The following expression gives the relationship between BER and the SNR for M-QAM in which for the case of DVB-T2, M=64 or 256 which are square in nature;

Then the expression for BER is:

$$BER = \left(\frac{\sqrt{M}-1}{M\log_2\sqrt{M}}\right) erfc\left[\sqrt{\frac{2^{\sqrt{N}}-1}{2^{\sqrt{N-1}}}\frac{3\log_2 M}{2(M-1)}SNR}\right] ---------- (6)$$

Where *erfc* stands for complementary error function and N stands for carrier mode i.e in the case of DVB-T2 in Tanzania it is 8k.

iv.) MODULATION ERROR RATIO (MER)

The Modulation Error Ratio (MER) is a measure of the signal-to-noise ratio (SNR) in digital modulation applications. This is used to determine system performance in communications applications. For example, determining if an EDGE system conforms to 3GPP radio transmission standards requires accurate MER, Minimum MER, and 95th percentile for the MER measurements.

For each received symbol, a decision is made as to which symbol was transmitted. The error vector is defined as the distance from the ideal position of the chosen symbol (the center of the decision box) to the actual position of the received symbol.[1]

This distance can be expressed as a vector $(\delta I_j, \delta Q_j)$

The sum of the squares of the magnitudes of the ideal symbol vectors is divided by the sum of the squares of the magnitudes of the symbol error vectors. The result, expressed as a power ratio in dB, is defined as the MER.

MER is a measure of the SNR in a modulated signal calculated in dB and it is given by the following formula:

$$MER = 10\log_{10}\left\{\frac{\sum_{j=1}^{N}\left(I_j^2+Q_j^2\right)}{\sum_{j=1}^{N}\left(\delta I_j^2+\delta Q_j^2\right)}\right\}dB \quad ------------ (7)$$

Where: I = In-phase measurement and Q = Quadrature phase measurements.
It should be reconsidered that MER is just one way of computing a "figure of merit" for a vector modulated signal. Another "figure of merit" calculation is Error Vector Magnitude (EVM). MER and EVM are closely related and one can generally be computed from the other .Also there is relationship between SNR and the EVM as shown below:

$EVM = \frac{1}{SNR^{1/2}}$ In which there is inverse square law relationship existing between the two parameters.

v.) RECEIVER INPUT SIGNAL LEVELS (RSSI)

In telecommunications, **received signal strength indicator** (**RSSI**) is a measurement of the power present in a received radio signal.[13]
RSSI (Received Signal Strength Indicator) is a common name for the signal strength in a wireless network environment. It is a measure of the power level that a RF client device is receiving from an access point. The closer the figure is to zero, the better. For example, RSSI of -65dBm is better than -85dBm. As a general example, a good signal would be -50dBm, a reasonable would be -75dBm, and a bad one would be -90dBm, while -100dBm would provide no service at all. [14]
The received signal levels is related to the CNR by the following relations:

$$\frac{C}{N} = \frac{P_{received}}{P_{noise}} = \frac{P_{received}}{F * k * T_o * B}$$

$$P_{received} = \frac{C}{N} \times P_{noise}$$

$$P_{noise} = F * k * T_o * B$$

In dB, $P_{noise} = F + 10log(k * T_o * B)$
Where $F =$ Receiver noise figure $= 6$dB for DVB-T2 in Tanzania as a case.
$B =$ Receiver noise bandwidth $= 7.71$(MHz) For carrier mode of 8k for 8MHz channels.

vi.) MODULATION TECHNIQUES

The DVB-T2 specification allows for time slicing, which is a well-known DVB-H feature. Time slicing reduces the energy consumption of the receiving device. This is achieved by transmitting the services of a multiplex in time blocks which allows the receiver to demodulate the signal only for a certain fraction of time in order to receive a particular service. For the rest of the time the receiver may remain idle, it may use the remaining time for the check of other frequency blocks or channels.[3]
64-QAM and 256-QAM are the modulations used in DVB-T2 technology and in Tanzania only 64-QAM technique is used, delivering a gross data rate of 6 bits per symbol per carrier (i.e. 6 bits per OFDM cell) even though there is a room for 256-QAM which increases this to 8 bits per OFDM cell.

3. MATERIALS AND METHODOLOGIES

Drive test measurements was conducted in different points and different places by considering the distance from the tower in terms of coverage and considering the terrain nature(environment) and finally considering the presence of tall buildings in the city which causes the non-line of sight to appear due to their penetration loss caused by them. The measured parameters were Power received (RSSI), BER, MER and CNR. These parameters were recorded after setting the upper limit parameter levels to gauge the relative strength of different areas against the best values (E.g. the CNR were required to be measured up to 70dB, MER from 18dB, RSSI up to 116 dBμV and BER up to 10^-8). Also the measurement were taken under the following fixed condition:

- ✓ STB signal input sensitivity of 25-100 dBμV
- ✓ Antenna height 4m above the ground
- ✓ Fixed transmitted power from the multiplexers

The measurements were taken in areas where people live and as said above the terrain level, vegetations and the buildings(high rise buildings like Kariakoo, Posta, Upanga or low rise buildings like Kiwalani, Yombo kwa Limboa, Tegeta, Kigamboni etc) were considered during the collections of the mentioned data. The areas visited for the data collections includes: Bunju, Kilungule, Boko, Bahari beach, Kunduchi, Mbezi Beach, Tangibovu, Jogoo, Rafia Bags, Salasala, Tegeta Kibaoni, Wazo Kiwandani, Tegeta Nyuki, Whie Sands, Makongo Juu, Goba, External, Buguruni, Tazara, Kipawa, Karakata, Banana, Ukongo Magereza, Mombasa, Gongo la Mboto, Pugu secondary, Kinyerezi, Tabata Bima, Tabata Segerea, Mbezi mwisho, Kimara Suka, Baruti, Corner, Ubungo Msewe, Kurasini Bandarini, Mtoni kwa Azizi ally, Mtoni kichangani, Tandika Mwisho, Kiwalani Bombom, Kiwalani Minazi mirefu, Jet Ally Mboa, Buza, Yombo, Yombo vituka, Duce, Bamaga Kijitonyama, Victoria, Mwenge, Osterbay(CCBRT), Coco beach,Sarenda Bridge, Feri, Posta ya zamani, Kigamboni, Vijibweni,

Gezaulole, Mnazi Mmoja, Posta Mpya, Kariakoo sokoni, Kariakoo Mtaa wa Congo, Kariakoo Jangwani, Muhimbili, Manzese Darajani,Shekilango, Sinza Uzuri, Sinza makaburini, Mbagala, Kibamba, Mbezi Msakuzi, Mbezi makabe, Mpiji Majoe.
In those locations above the parameters were recorded for three multiplexers which are currently operating in Tanzania and those includes Basic Transmission Limited(BTL) which formally were serving the Digitek and Continental decoders, Agape associates Limited(AAL) which supplies the Ting decoders and Star Media Limited which supplies the Star Times decoders.
The figure below shows the coverage map of Dar es Salaam city for three multiplexers.

Figure 5: The coverage map of DVB-T2 for Dar es Salaam city for both multiplexers where green indicates the portable outdoor reception.

The analysis was done through MATLAB but the data were entered first in the Microsoft Exell and then imported to MATLAB through commands.

4. RESULTS AND OBSERVATIONS

The analysis and evaluation of the performance was conducted using the relationships between parameters like RSSI vs CNR relation, BER vs CNR relation for different multiplexers (BTL, AAL and Star Media).
It has been observed that high CNR ratios provide better quality of reception, and generally higher communications accuracy and reliability, than low CNR ratios. So in the data obtained from the field measurements, the presence of higher CNR indicates that the quality of signal is high. Also the low values of BER indicates that the signal quality is good relative to the CNR. The following graphs indicates the relation between RSSI with CNR and BER with CNR for BTL, AAL and Star Media.

i) RSSI against CNR

The following figure indicates the relationship between the Received Signal Strength Indicator and the Carrier to Noise Ratio for BTL (Basic Transmission Limited which comprises of Digitek and Continental decoders), AAL and Star Media.

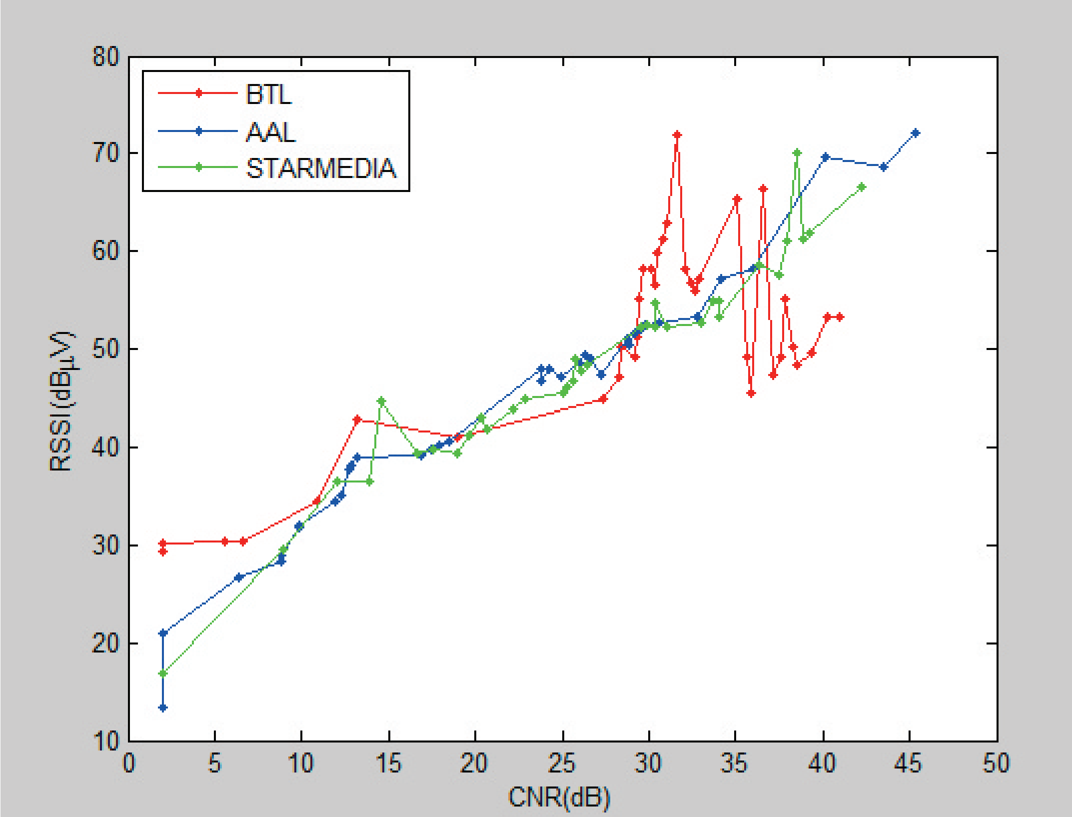

Figure 6: A graph of RSSI vs CNR for BTL, AAL and Star Media

From the graph above the relationship between the RSSI and CNR is directly proportional relationship in some locations because the increase in CNR goes with the increase in the RSSI but in other locations there is variation between the two parameters in the sense that instead of RSSI values going high for high CNR values it fluctuates meaning that it goes down or sometimes high e.g. for CNR of 35.1dBμV the RSSI value was found to be 65.3dBμV while for CNR value of 35.9dBμV the RSSI value was found to be 45.5dBμV which shows that there is a drop of 19.8dBμV, so the high CNR values are having relatively low RSSI values i.e signal received in some areas are low for high CNR values which means that the quality of signal is still high in some areas which are not well served by digital transmitter. In distributed non high rise buildings like Kiwalani, Mbagala, Gongo la Mboto and the like, there is very good reception of signal levels because there is no reflections as there is good LOS between the receiver and the digital transmitter. In the areas with low rise buildings like Mwenge, Mbezi beach, Mbezi mwisho, Kimara and the like, there is good reception of signals with high quality signals observed at Mwenge and Mbezi beach areas as the RSSI and the CNR are observed to be very high in the mentioned areas and this is because the digital transmitter antenna is close to those areas as the transmitting antenna of BTL as a case is located at Mikocheni near Mwenge with the direct LOS with very low noise or interference of signals. In general the areas are well served by the digital transmitter, although some areas tend to get degraded signals from high rise buildings in the neighborhood for example Kariakoo and Posta Mpya, those buildings which are not tall buildings receive very low signals and sometimes receives nothing which means there is no coverage at all due to blockage of signals caused by high rise buildings and this occurs for all multiplexers as it shown in the figure 6 above. In some areas like Ubungo Msewe there is degraded signals due to adjacent terrain and low altitude on which they lay so inorder to compensate for the degraded signals residents are advised to use high gain aerials. Low lying areas and areas near the national stadium may require signal boosting because the signal strength degrades due to propagation path loss caused by the distance from the transmitter to the receiver.

ii) BER against CNR

The following figure indicates the relationship between the Bit Error Rate (BER) and the Carrier to Noise ratio (CNR) for BTL, AAL and the Star Media for the points taken at different locations in Dar es salaam.

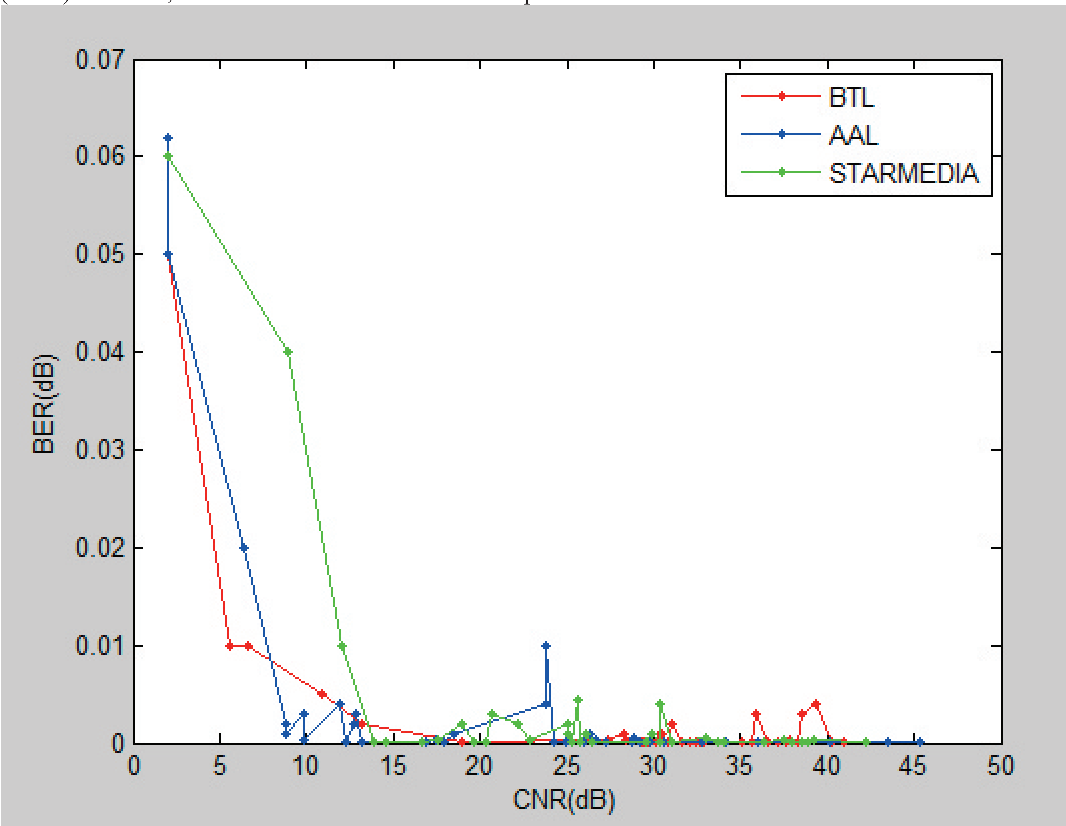

Figure 7: A graph of BER vs CNR for multiplexers BTL, AAL and Star Media.

From the graph, it can be observed that there is variation between BER and CNR at different location for different multiplexers, where in some areas or in the same location the values of BER differs for both multiplexers where one multiplexer can have a very good signal quality in terms of BER then the other multiplexer, for example at a CNR of approximately 23.5dBμV the value of BER for AAL is high compared to the values of BER for the other multiplexers(BTL and Star Media) which means that the signal quality of AAL at a 23.5dBμV is very poor as the high values of BER indicates that the signal is having more bits with errors even though the CNR values are high. In general for the signal to have an excellent quality, the values of BER must very low almost negligible for high values of CNR, example a signal at CNR of 34.8dBμV is very good in terms of quality for all multiplexers because the BER is very low compared to the signal quality at 38.5dBμV where the value of CNR is high but the BER value is also high for BTL as shown in figure 7 above.

iii) MER against CNR

The following figure indicates the relationship between the Bit Error Rate (BER) and the Carrier to Noise ratio (CNR) for BTL, AAL and the Star Media for the points taken at different loactions in Dar es Salaam.

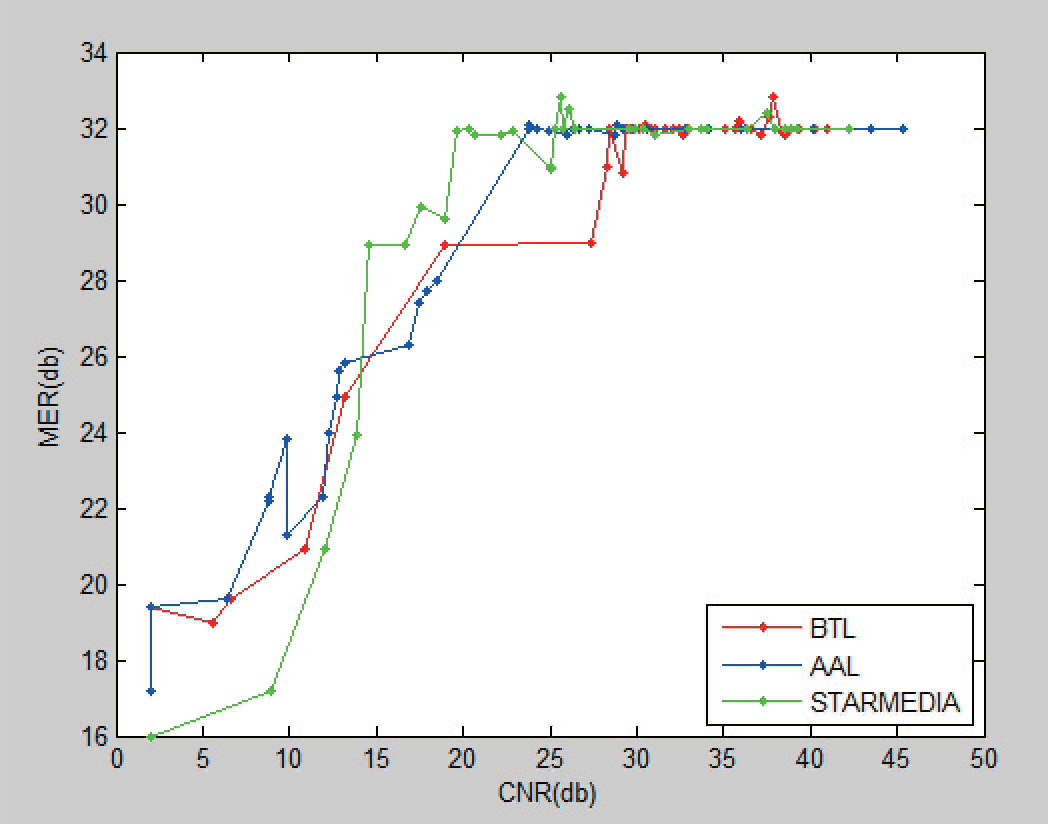

Figure 7: A graph of BER vs CNR for multiplexers BTL, AAL and Star Media.

From the graph it can be observed that, the MER and the CNR are directly proportional to each other in the sense that when one parameter increases also the other increases which correlates with the theory, but in some locations the value of MER was seen to be constant with the increased values of CNR which indicates that the performance is the same in some areas despite the RSSI values for example when MER was 32dB, the values of CNR went from 25dB up to approximately 43dB with MER being 32dB for all multiplexers(BTL, AAL and Star Media). So in general in most locations the performance was observed to be good.

5. CONCLUSION

From the analysis above for DVB-T2 broadcasting network involving three multiplexers, most of the areas within the primary service areas had good reliable signal (coverage and quality) apart from trouble spots that have been in the location where digital transmitters do not cover them. High rise buildings in Dar es salaam were observed to be causing signal obstructions to others for example areas like Mnazi Mmoja receives very low signal due to its location because it is at the center of high buildings. It would be prudent if the use of shared amplified resources hard wired to all high rise units would be incorporated in the building code. With favorable terrain (Relatively flat) the strongest reliable signal was picked in those areas with non-rise buildings like Mwenge areas, Kiwalani areas and others which are alike. Another observations from the

6. RECOMMENDATIONS AND FUTURE WORK

All high rise buildings (which tends to block the signals from the transmitting antenna to reach other resident buildings) should be encouraged to adopt the shared resources of the all channels amplified TV signal wired to all units in a block. Residents living in low altitude like Goba, Kimara Baruti are advised to use high gain aerials to compensate for degraded signal due to low altitude.

Most of the aerials or receiving antenna are Yagi-Uda antenna which are directional (with high gain) in the sense that they are positioned to receive signal in the direction of transmitting antenna so in some areas the signal from transmitter reaches the receiver with very low values so an antenna with high gain will be capable to pick those signals due to increased directivity and radiation pattern.

To solve this problem the design of the Yagi Uda antenna with an improved gain must take place or the use of the quadrifilar helical antenna may serve the purpose because they are of very high gain and hence improve the quality of the received signal.

Another recommendations is to use gap fillers (Repeaters or boosters) in places where the signals fade away before reaching the receiving antenna. The areas like Bunju will be covered only when repeaters are placed.

Also the additional of transmitting power from 1.6kW will also help in improving the quality of coverage for those relatively flat areas like Bunju and the like.

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REFERENCES
[1] E. TR101, "290 V1. 2. 1. Digital video broadcasting (DVB)," *Measurement guidelines for DVB systems,* vol. 8, 2001.
[2] M. Mendicute, I. Sobrón, L. Martínez, and P. Ochandiano, "DVB-T2: new signal processing algorithms for a challenging digital video broadcasting standard," *Digital Video (In-Tech, 2010),* pp. 185-206, 2010.
[3] B. Series, "Frequency and network planning aspects of DVB-T2," 2012.
[4] H. ITU-T RECOMMENDATION, "264 “Advanced Video Coding for Generic Audiovisual Services”," *ISO/IEC,* vol. 14496, 2003.
[5] E. ETSI, "302 755 V1. 1.1,“," *Digital Video Broadcasting (DVB),* pp. 1-167, 2008.
[6] A. Sugaris and I. Reljin, "DVB-T2 technology improvements challenge current strategic planning of ubiquitous media networks," *EURASIP Journal on Wireless Communications and Networking,* vol. 2012, pp. 1-14, 2012.
[7] M. Tormos, C. Tanougast, A. Dandache, D. Masse, and P. Kasser, "Evaluation performance analysis of DVB-T2 in a SFN network," in *I/V Communications and Mobile Network (ISVC), 2010 5th International Symposium on*, 2010, pp. 1-4.
[8] T. REPORT, 2010.
[9] TCRA, "Annual report," *Tanzania Tellecommunication Regulatory Authority,* 2012.
[10] A. B. Authority, "Digital terrestrial television broadcasting planning handbook," ed: Camberra, 2005.
[11] http://wireless.agilent.com/wireless/helpfiles/89600B/WebHelp/subsystems/digdemod/content/digdemod_symtblerrdata_snr.htm, 2014.
[12] T. ETSI, "101 290 Digital Video Broadcasting (DVB)," *Measurement guidelines for DVB systems,* vol. 1, pp. 1987-1993, 2001.
[13] http://en.wikipedia.org/wiki/Received_signal_strength_indication, 2014.
[14] http://www.speedguide.net/faq_in_q.php?qid=418, 2014.