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Ghana's Readiness to Pull the Plug on Analogue Transmission in 2016

Kwadwo Ntiamoah-Sarpong[1], Bernard Adjei-Frimpong[2], Kingsley Akom[3]

[1, 3]Kumasi Polytechnic, Department of Electrical Engineering, P.O. Box 854, Kumasi, Ghana

[2]Department of Electrical Engineering, Kumasi Polytechnic, P.O. Box 854 , Kumasi, Ghana

Abstract: ***Ghana under the Ministry of communications set March, 2016, as the new date for the complete migration from analogue to digital broadcasting. This is as a result of the inability of the country to meet the June 17, 2015 global target for Analogue Switch-off according to the GE06 plan. This paper provides a situational analysis of Ghana's preparedness to meet the March 2016 deadline. We discuss and analyze the actions taken by various stakeholders in the migration process, in support of this transition. Based on these analyses, we recommend some measures to further enhance the chances of Ghana to achieve its set deadline successfully. Ghana needs a comprehensive approach to the implementation of digital broadcasting to sustain the take up of digital terrestrial television (DTT) which encompasses a strategic orientation for switch over policy and concrete action plans. These include a strong leadership from Government, close cooperation between the regulator and market parties and adequate information and support to end users.***

Keywords: Digital Switch–On, Analog Switch-Off, Digital Switch Over, Digital broadcasting

1. Introduction

Analogue to Digital switch-off or Digital Switchover (DSO) is the process of launching the digital terrestrial television (DTT) platform and switching off analogue terrestrial television platform [4]. According to [1][2][3], digital transmission is an efficient technology that allows broadcast stations to offer improved picture and sound quality, as well as offer more programming options for consumers through multiple broadcast streams. Analogue broadcasting services being currently offered are transferred to digital based networks over a specific period.

A digital broadcasting plan, covering 116 countries (mainly in Africa and Europe), was agreed for the "frequency bands 174-230 MHz and 470-862 MHz" at the ITU RRC-06 in Geneva in June 2006. According to this plan, also known as GE-06, the analogue switch-off date was set globally to 17th June 2016[1][12].

According to ITU [1][2], the switchover to digital broadcasting is to create new distribution networks and expand the potential for wireless innovation and services. The digital dividend accruing from efficiencies in spectrum usage will lead to greater convergence of services, as more channels are carried over the airwaves. This paper address the main issues concerning switch over to digital television broadcasting in Ghana, although the migration process is applicable to both television and radio broadcasting services. According to NDBMTC [2], the primary delivery systems for television and radio broadcasting services in Ghana continue to be the terrestrial broadcasting network, in spite of existing satellite broadcast systems. Digital broadcasting systems, besides other potentials are meant to address the issue of scarce radio spectrum use. DTTB allows for the use of digital modulation and compression techniques to transmit video, audio and data signals to the consumer access devices by digital radio transmitters, broadcasting programs such as news, sports and music [2][14].

2. Background of the Study

Broadcasting services began in Ghana in 1935, with the first radio broadcasting system code-named Radio ZOY, a relay service of the BBC in Accra. Analogue television service was launched in Ghana in 1965 by the Ghana Broadcasting Cooperation (GBC). The GBC decree of 1968 mandates it to "broadcast programs in the field of culture, education, information and entertainment to reflect national progress and aspirations"[2] [4]. GBC held a broadcasting monopoly until 1994, when the NCA was established. GBC was then required to handover part of its control over the broadcast radio and television spectrum, although it retained control over other frequencies, which have been used later to assist the establishment of commercial broadcasting services. From 1997 to 2008, saw the emergence of Metro TV, TV3, TV Africa, Viasat, Net 2 TV, Skyy in Takoradi and Cable Gold (cable and MMDS Pay TV) established in Accra and Tema. DSTV (First Digital Satellite Pay TV) and Multi TV (First free to view Digital Satellite TV) were then established in Ghana. In 2008, GBC installed a pilot terrestrial video broadcasting system in Accra [2][12][19].

The National Digital Broadcasting Migration Technical Committee (NDBMTC) was established during the first quarter of 2010and in the second quarter of 2010, the GBC launched DVB-T transmissions in Accra and Kumasi [5].

Industry statistics indicate that since the liberalization of television broadcasting in Ghana, satellite TV covers the entire country, while Terrestrial TV covers approximately 85% of the population [2][6]. Ghana Television (GTV), operated by the GBC has the most extensive terrestrial TV coverage in Ghana. Terrestrial TV is the most dominant TV reception in Ghana followed by satellite. Analogue television broadcasting services in Ghana is offered in VHF and UHF frequency bands (174-230 MHz and 470 – 862 MHz respectively). Currently there is insufficient information available to estimate the number of TV sets available in

Ghana. However, data from the Ministry of Trade and Industry estimates that a little over three million sets were imported into the country from the first quarter of 2007 to the third quarter of 2010[2][6]. NCA [6] (2011), however expects over six (6) million set-top boxes will be required to convert analogue TV receiver sets to receive digital signals.

There has been considerable discussion of the benefits of changing use of UHF spectrum for mobile industry (i.e. the Digital Dividend) [13]. However according to Beutler, the available spectrum making up the digital dividend is currently fragmented into relatively narrow bands, scattered over many frequencies, and intertwined with digital broadcasting channels [7]. This is a consequence of spectrum planning options adopted by various countries based on traditional use of broadcasting spectrum. The Ge-06 provided flexibility to open up the spectrum for other uses. However, this flexibility is limited under the existing technical conditions and in practice; the current system is not conducive to the allocation of this spectrum to more efficient alternative use. Hence, the switch-over from analogue to digital broadcasting by mid-2015 as the GE06 agreement stipulates, is to free up significant amount of spectrum since techniques used in digital broadcasting require less spectra for the transmission of a television signal of higher quality.

Digital migration offers a unique opportunity to meet the fast growing demand for wireless communication services by utilizing freed up spectrum to ensure that other important social and economic uses, such as broadband applications have access to spectrum [8] (Jared, 2009). It is also important to note that the ITU has extended the digital broadcast migration deadline for a number of developing countries, including Ghana in the VHF band, with a 5 year extension to 17 June, 2020 [11][12][13][14]. The failure to meet the June 2015 deadline has been attributed to challenges involving investment in the necessary infrastructure, the technology, standards, and licensing. As many as 30 African countries including Ghana have failed to meet the deadline. Given the very important gains in spectrum efficiency which may result from this transition, there has been growing interest in the last decade on how these gains might be distributed [2][10] . ITU defines the digital dividend as the amount of spectrum made available by the transition of terrestrial television from analogue to digital [1][2][13]. The gains made, may be used by broadcasting services such as the provision of more program content, standard and high definition, 3G or mobile television[2][13][14]. It may also be shared by other services, such as mobile service, in a frequency band which could be shared with broadcasting short range devices, e.g. for short range mobile devices, such as wireless microphones used in theatres or during public events, or fixed access points, without disrupting broadcasting services. It may also be used in a distinct, harmonized frequency band to enable ubiquitous service provision, universally compatible equipment and international roaming e.g. for International Mobile Telecommunications (IMT).

2.1 Reasons for Ghana's Digital Migration

The deadline for all countries to migrate from the analogue to digital terrestrial broadcasting in the UHF band according to GE06 is June 17, 2015, and according to ITU [1]and (ITU, 2012) with an extension to 17 June 2020 for a number of developing countries in the VHF band [14][1].

The reasons for this, is first and foremost is "to comply with and adopt tenets of the GE06 agreement" and to rapidly adopt spectrum efficient methods in the management of the available spectrum to widen its utility in the interest of stakeholders [2].

Enhance the quality of video and audio in television broadcasting, by improvements in terrestrial transmission and reception. Other factors included as necessary and urgent for the migration is to promote environmental sanity, through co-location of broadcast transmission infrastructure and last but not the least to prevent dumping of obsolete analogue transmission equipment into the country to protect the environment, and consumers (NCA, 2009; [2].

Some of the spectrum has also been auctioned to companies that will provide consumers with advanced wireless services, such as mobile broadband access and high speed mobile data access. Many countries over the world have completed the migration to digital broadcasting while with others the process is still on-going, as shown in figure.

2.2 Benefits of Digital Broadcasting

While the migration from analogue to digital terrestrial television can be considered a national evolution for the broadcasting industry, the adoption of digital broadcasting has been led by satellite, cable and to some extent IPTV, however it's the terrestrial broadcast platform that arguably brings the most benefit to society []. Migrating to DTT involves considerable costs especially for broadcasters. However, these are outweighed by the significant advantages digital broadcasting delivers for all the players and actors across the value chain. The broadcasting value chain is shown in figure.

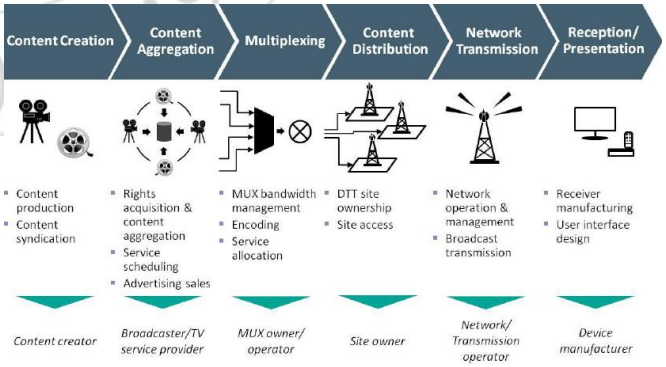


Figure 1: Digital broadcasting value chain [9][10]

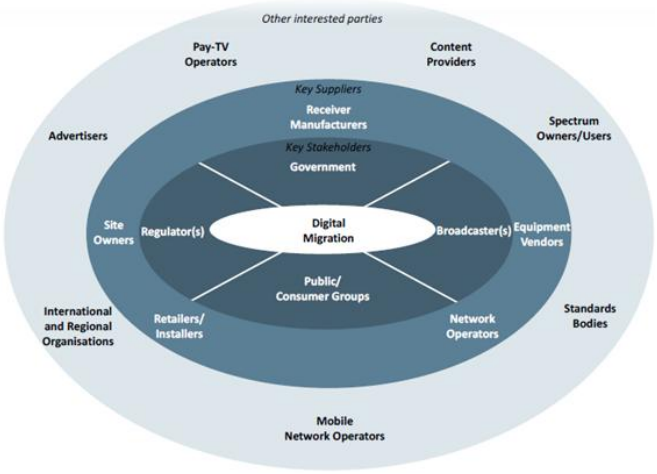


Figure 2: Digital migration Key Stakeholders, suppliers and other interested parties[10]

1) **Increased coverage area:** In most African countries including Ghana, television is largely and urban phenomenon, because most private broadcasters focus their coverage on urban areas because they mostly contain the target group for their advertisement. The public broadcaster often has the mandate to extend coverage to a wider range of communities. Introducing digital TV increases the potential to use digital broadcasting to narrow the digital divide, reach unserved areas and to provide e-government and other digital services. Regulators and governments can make access to television a universal access goal, setting a policy for signal carriage.
2) **Consumer Benefits:** Digital Television Broadcasting offers consumers a wider choice of high quality TV and radio programs and access to different services, including additional channels, data services, and HD offerings. It also offers a wide choice of digital equipment having various levels of functionality and different transmission platforms (satellite, cable, terrestrial. For instance GTV, now provides many more channels on their own, such as GTV Govern, GTV Sports+, GTV Life, and GBC 24 all as dedicated channels.
3) **Lower Barrier to Entry:** DTT reduces barriers to entry for service providers (the delivery cost of provision of a TV service within a multiplex will be lower on a per unit basis than that of providing a single analogue TV channel). The lower barrier to entry enables DTT the ability to provide more opportunities to deliver niche, regional and community content.
4) **Enhanced competition: In** a competitive multi-channel, multi-platform, DTT will increase market competition and innovation, attracts new entrants at different levels of the value –chain.
5) **Efficient use of spectrum:** An increase in the capacity of broadcast transmission networks by improving the spectrum efficiency (i.e. more data can be transmitted per unit bandwidth)

3. Status of Digital Switchover

Digital terrestrial television has been introduced in many countries all over the world and several countries have completed switching off analogue TV Services as shown in figure 3. Notably are the Netherlands (2006); Sweden (2007); Finland (2007); Germany (2008); Switzerland (2008); USA (2009); South Africa

Figure 3: World map indicating countries with completed and ongoing DTT migration (ITU, 2016)

3.1 Overview of Analogue and Digital Transmission in Ghana

In the Regional Radio Communications Conferences (RRC) of 2004 (RRC-04) and 2006 (RRC-06), ITU developed a digital terrestrial plan. The government of Ghana recognizing the importance of the GE06 digital migration plan, established through the Ministry of communication the National Digital Broadcasting Technical committee (NDBMTC), inaugurated by the Minister of communication to tackle the digital migration initiative in 2010.

The mandate of the 26 member committee chaired by the NCA is to ensure among others, a coordinated and cost effective migration. According to NDBMTC [2], their terms of reference include, the determination of the spectrum and strategies to be made available for digital broadcasting services in Ghana, and to identify technical issues to be addressed to ensure harmonious spectrum usage with respect to our immediate neighboring countries and to make appropriate recommendations on standards and pricing for digital broadcasting services, with respect to free to air, free access and subscription digital broadcasting systems.

The implementation time table by the committee includes among others, the completion of the switchover date targeted during December 2014, which has already elapsed by more than a year [2]. The NDBMTC finished its work and submitted its final report to the ministry of communication in august 2010. Ghana is currently in the dual illumination or simulcast stage of the digital broadcasting migration, with concurrent transmission of analogue and digital television. In the NDBMTC report to the ministry of communications, and from the bidding document for the procurement of Digital Terrestrial Television (DTT) network solutions, the Digital Video Broadcasting (DVB-T2) system has been adopted for digital television transmission in Ghana. The DVB standard allows the transmission of high quality images and sound, allowing the use of the format 16:9 instead of the traditional 4:3 aspect ratio (the ratio of the relative width to height of the dimensions of an image displayed on a TV screen), ensuring TV viewing is possible with very large screens without any degradation of image definition, and also limiting the number

of programs in one channel images with high definition (HD) can be transmitted.

3.2 Digital Transmission

Digital television broadcasting is not an entirely new technology in Ghana. The first digital TV transmission in Ghana was implemented by Multi-choice Ghana in 1993 with the DVB-S standard in the Ku-band. The company operates a pay TV service, DSTV (Digital satellite television) which is nationwide. It is a DTH (direct-to-home) satellite service. Subscribers receive the service with a KU-Band satellite receiver [2]. The main push factor for network operators migrating to digital is the efficiency of bandwidth and its associated increase service provision and quality.
The digital television standard, when fully realized in Ghana, will provide the following advantages over analogue transmission:

- Considerable enhancement of the television programs as quantity. This is because; with the digital television broadcasting different programs with more information and interactive utility can be transmitted in place of one analogue program. It is possible to transmit up to 8 different programs.
- Considerable enhancement of the television programs like quality, allowing the use of the format 16:9 with very large screens without any degradation of image definition.
- For the same service area, lower transmit power amplifiers are used since extra protection against interference and noise is guaranteed.
- Creation of national networks on Multiple Network (MFN) or single Frequency Network (SFN); provision of several additional interactive services [2][11]. Through the use of the latest generation of TVs, one can treat and store the information and, through connection to the telephone line or mobile phone, one will have access to internet services such as MHP (Multimedia Home Platform) for multimedia services.

According to the NCA [6], licenses shall be acquired to implement following standards as announced by the Ministry of Communications;

1) Transmission standard- **ETSI EN 302 755 popularly called DVB-T2**
2) Compression technology- **Advanced Video Coding (AVC)/ MPEG4 (Part 10) and High Efficiency Advanced Audio Coding (HE-AAC)**
3) Application programming interface (API) for additional and interactive services- **MPEG-5**

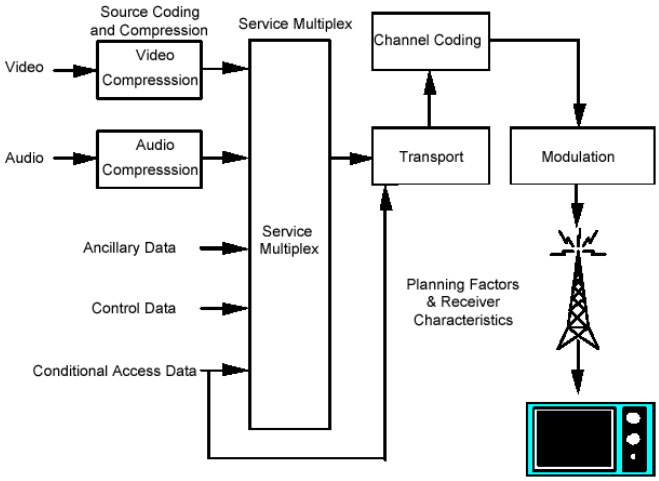


Figure 4: ITU-R Model for Digital Terrestrial Television Broadcasting [2][16]

3.3 Operation of a Digital Set Top Box

The Digital Video Broadcast (DVB) project group has established a family of interrelated international criteria for digital television broadcasting through 3 key media. These are "DVB-T for digital terrestrial transmission, DVB-S for digital satellite transmission, and DVB-C for digital Cable". Essential features of these standards, is that they all have identical source coding/compression and service multiplexing/transport segments. These two segments are based on the Mpeg-2 international standard. However channel coding/modulation part of the three is optimized for the respective transmission media. While terrestrial transmission uses a multicarrier modulation scheme called Orthogonal Frequency Division Multiplexing (OFDM), satellite and cable transmission are based on single carrier modulation schemes of Quadrature Phase Shift Key (QPSK) and Quadrature Amplitude Modulation (QAM). Digital set top boxes will be utilized in the home for the reception of all three signals until integrated digital television (IDTV) sets become cheaper,. Therefore the availability and accessibility of set top boxes at affordable prices is an important factor to ensure a quick take up of digital television broadcasting in Ghana.

Another important feature which will also lead to a cost reduction of STBs is to make the STB, to the large extent possible, to be based on an 'open architecture' and make it 'interoperable' across different networks. Architecture can be considered to be 'open' "if and only if the functionality of each and every module in that architecture is available in the public domain in the form of published international standards or defacto industry standards"[14].

An STB is said to be interoperable if it can receive any service from any network. The diagram in figure 5 gives a simplified overview of the major components of a typical STB.

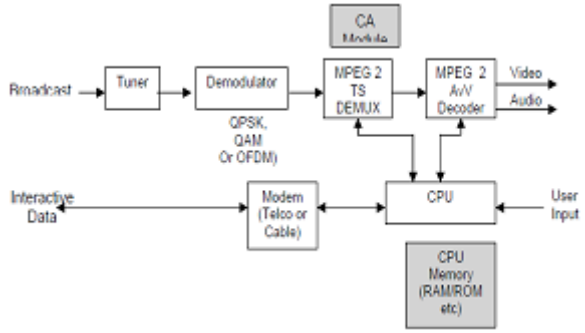


Figure 5: Block diagram of a STB Architecture [14]

The STB selects the appropriate broadcast TV information by tuning to one of many input channels. The signal is digitally modulated using QPSK for satellite applications, QAM for cable and OFDM for terrestrial. The information in the selected RF channel is then processed by the demodulator to produce an MPEG-2 Transport Stream (TS) containing the audio, video and other information that relates to the selected TV program. The STB generally also contains some form of modem to allow it to send and receive interactive data. Conventional telecommunication modems are typically used in satellite and terrestrial STBs while cables STBs generally have a cable modem. In general, digital television information in the MPEG-2 TS may be encrypted to prevent customers who have not paid for a particular service from being able to view it. The MPEG demultiplexer selects and decrypts the compressed audio and video for the particular program that the viewer wishes to watch, using decryption keys supplied by the conditional access sub system (CASS). The MPEG decoder then compresses the audio and video information for the selected program. The central processing unit (CPU) controls the whole operation and performs specific data manipulation function. It generally uses Real-Time-Operating-System (RTOS) on top of hardware abstraction layer for the management of the resources and processes of the STB directed by the higher layer software. From Figure it can be seen that the front-end of the diagram, which contains the tuner and the demodulator, will be different for the 3 transmission media. Hence if an STB is to be made interoperable across all the 3 transmission media, it should be fitted with switchable front ends.

4. General Approach to Digital Migration

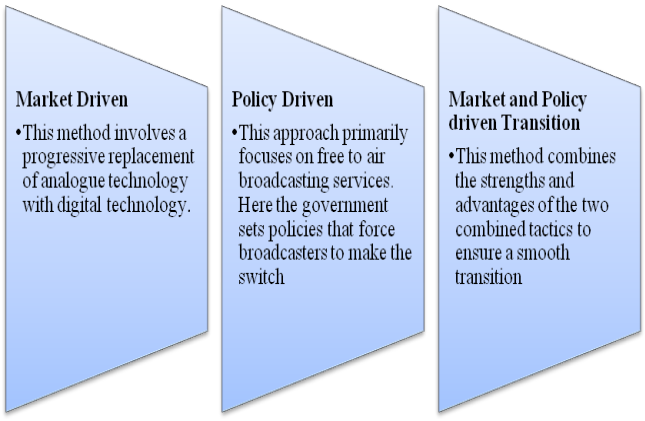


Figure 6: Approaches to Digital Migration

Some countries including the South African government adopted this approach to ensure a smooth transition without noticeable government intervention driving competition among the broadcasters. Ghana has adopted both the market and policy driven technology transition with a determined switch off date set to end of December 2016.

4.1Situational Analysis of Ghana's Digital Migration

There has been a massive increase in the number of television and radio stations in the last few years. As at the end of December2015;Ghana had licensed a total of 412 radio stations with 313 operational and 99 off-air. According to the NCA as at the fourth quarter of 2015, the total number of authorized TV stations stood at 63. Of these the total number broadcasting on air as at the end of 2015 were 30 [23].

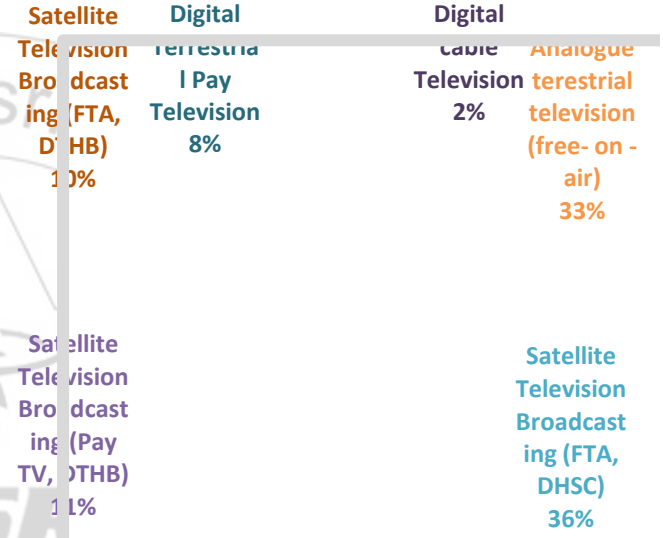


Figure 7: Distribution of Types of TV Stations in Ghana as at end of 2015

The switch to digital terrestrial television (DTTV) preliminary project has been cooperation between Sweden-based Next generation Broadcasting (NGB) and the GBC, in collaboration with Ghana's 4 major channels- GTV, TV3, TV Africa and Net2 Television. GBC is the national broadcaster and has been assigned by the government in carrying out the project.

GBC already has some infrastructure and also can acquire more infrastructures relatively easily. NGB is a private firm that has been accepted in Ghana for trail purposes, and since the period it has been in Ghana, has a strong basis of digital broadcasting [2][6].By end of March, 2016, the analogue signals were to be switched off. Failure to migrate can lead to the isolation of the country in respect of digital broadcasting. According to APC [5][15], due to the magnitude of the migration task and the sensitivity of some of the issues, the migration committee has been working in a manner in order to meet the deadlines with minimal issues.

4.2 Ghana's readiness for digital migration

This section outlines the steps Ghana has taken towards completing its digital migration successfully.

An advisory board has been set up known as the National Digital Broadcasting Technical Migration Committee (NDBMTC) which is tasked to offer advisory services to NGB and GTV. This body is also to help Ghana resolve seemingly deeper issues that could still affect the digital transition. This includes harmonizing of policy and choice of formal digital broadcasting standard. Ghana needs a comprehensive approach to the introduction of digital broadcasting to sustain the take up of DTT which encompasses a strategic orientation for switch over policy and concrete action plans.

4.3 Challenges facing Digital Migration in Ghana

The major challenge is the funding for the digital network infrastructure roll-out. The cancellation of the contract between the ministry of communications and star communications Network Technology in April2012, has contributed immensely to Ghana missing the ITU's June 2015 analogue switch-off deadline. This was followed by a 2 year litigation period at the courts which finally ended in 2014. The contract was to deploy a reliable, efficient and cost effective DTT system for Ghana. The abrogation of the contract boarded on the company's inability in securing funding for the project.

The government of Ghana has signed a new contract in July 2015 with K-Net to complete the roll-out in one year. In its quest to ensure a smooth and speedy roll-out, the government inaugurated an 8 member DTT management board in October 2015. Its mandate is to ensure that the DTT infrastructure is managed effectively and efficiently with availability, affordability and accessibility of service. The board has also been mandated to work with statutory bodies to address the issues of authorization, contributions, transmission and spectrum management and to act as an arbiter in disputes between all users of the platform as well as make input into policies.

5. Digital Terrestrial Transmission

The contribution feed will be microwave links provided by the supplier on a band dedicated for the transportation of feed to the head-end by broadcasters to ensure maximum efficiency. The transmission power will support both HD and SD formats. The transmission power for each site is 5Kw; however this will also depend on the topology of the coverage area. Encoding and multiplexing will be carried out at the head-end. The deployment is expected to be completed by the end of March 2016, for both the Greater Accra and Ashanti regions, comprising of one head-end and 6 transmitter sites. In all a total of 42 sites will be deployed nationwide. The other site locations in the other regions is to be determined by the GBC, however its highly likely to follow the existing site locations for analogue being used by the GBC all over the country. Existing GBC sites for FM and TV transmitters is shown in figure 8. Roll-out of the project will be executed in 3 phases as illustrated in figure 8.

Figure 8: Phases of roll-out and locations for Digital Transmitter Sites in Ghana

Reduced cost of infrastructure due to enhanced sharing, in monetary terms, the cost shall be shared and still the owner of the base infrastructure shall be paid by private broadcasters using the infrastructure.

It is a fact that digital television migration does affect all aspects of the broadcasting chain from content production through broadcasting and reception, all these require technical upgrading to support digital broadcasts [24].

It may even span as far as retraining or replacing support personal. It will also give a proper base for the emergence of local pay TV stations. Technically a digital system has a conditional access component and subscriber authorization subsystem that can be used for billing and managing subscribed users or viewers. Digital technology shall be important in eliminating the impairment caused by multi-path propagation that eventually fades the signal as it propagates the air interface. Signals propagation can be impaired by low signal levels and noise as the receiver moves further away from the transmitter. Very effective error correction in the receiver is able to mask the impact and continue to produce perfect pictures and sound up to the point where the error correction can no longer work and the picture will fail completely. This therefore needs adequate digital transmission power levels

6. Digital Terrestrial Television Broadcasting (DTTB) Network

A block diagram of a typical DTTB network is shown on figure 9. A Digital terrestrial network consist of essentially of one or more head ends, a distribution network and transmitter sites.

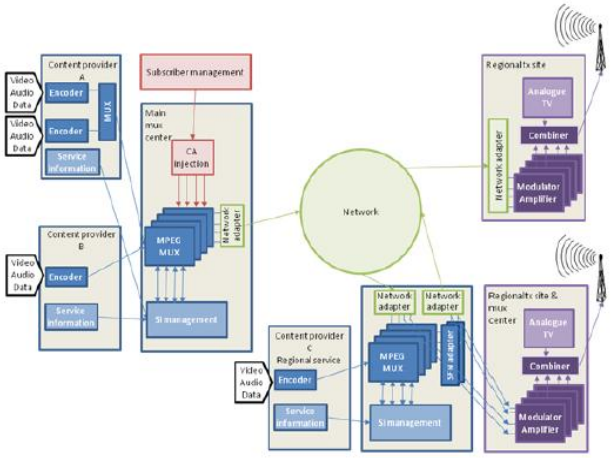


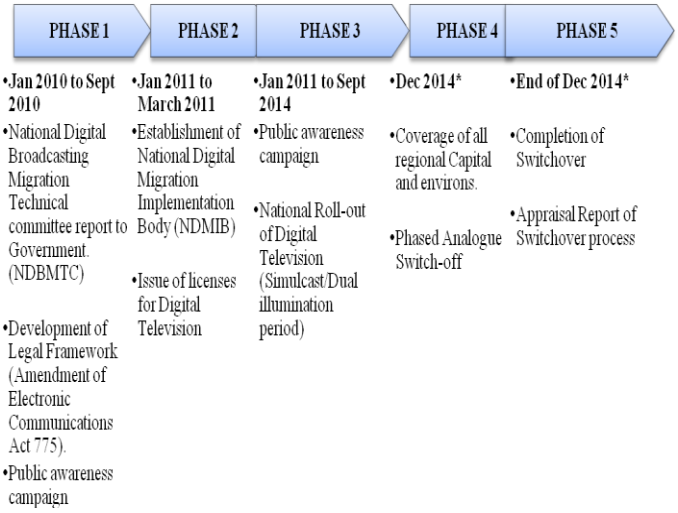
Figure 9: A Typical Digital Terrestrial Television Broadcasting Network Layout [16]

The head-end is the part of the network where the incoming video and audio signals from the studio are compressed. The compressed signals (MPEG 2/MPEG), together with the associated data signals, are multiplexed into a MPEG Transport stream (TS).The multiplexer will integrate several single program transport stream (SPTS) into multiple program transport stream (MPTS), in whichSPTS is the output signal from the encoder.The MPEG TS is distributed to the transmitting sites through the distribution network.
Electronic program guide (EPG), is also fed into the multiplexers as special program data, with which the subscribers can see the program guide information on TV. The scrambler is embedded in the multiplexer and each output stream is with scrambling.

Remote monitoring and control is used to monitor the equipment operation status and to send the control instruction from control center to the controlled devices while monitoring subsystems monitors operations of the head-end and transmission stations.

At the transmitting site, each MPEG TS is modulated in a transmitter to provide an OFDM signal with an appropriate system variant and converted to the required transmission channel. The RF signals of all or a number of, transmitters at a site are combined into one antenna. In case of services with diverse coverage requirements, then more than one antenna, each having a different radiation pattern, is used. It may be necessary to operate DTTB services with restricted power or to use temporary frequencies, in order to protect analogue TV services during the migration period.

7. Proposed Timetable for Digital Migration in Ghana[2]



**As at time of writing, only phases 1 to 3 has been realised, Phase has only been partially achieved and it is still an ongoing process. Phase 5 has now been set to December 2016, as a result of the delays in its implementation due to litigation issues, which has now be resolved.*

8. Action taken by Private Broadcasters in response to the transition Plan

As a directive by the government and also the need, broadcasters are required to migrate from analogue to digital technology in the studio. Broadcasters have installed digital studio equipment;the content recorded from the field is digitized through the digital system. Studio owners and producers are purchasing digital recording equipment; this is to allow on-air studios to play digital content without need for translation.

9. Action taken by Consumers

Most consumers are buying STBs to be able to view digital stations on their analogue TV sets. Others who can afford are purchasing Digital Television with either terrestrial or satellite receiving capabilities or both. However due to the value proposition of the platform, some consumers are still buying DVB-T2 or DVB-S STB.

10. Recommendations on Implementation

The recommendations are to all stakeholders in the migration process.

- Government should ensure that citizens are well informed of the roll-out phases of migration and should publish appropriate policy statement and timelinesof the process.
- Equipment for converting digital signals to for viewing on existing analogue TV receiversshould be made easily available, affordable and accessible. New digital TVs that conform to the technical standard and can receive DVB-T2 signals directly are priced at Gh₵1000 (approx. US$250). A large portion of the population cannot throw away their analogue TV and purchase another at that price.
- Government should assist broadcasters during the migration period and afterwards by way of policy

interventions to help mitigate against the impacts of the migration

- Through the NCA and NMC, promote fairness, unbiased access and a conducive atmosphere for growth and profitability in the broadcasting industry.
- The Government should institute measure to ensure availability of STBs and digital transmissions country wide at the time of the switch over date. This will protect end users against instant crash of service leaving them with no option at the end of the migration process.
- Consumers should be given adequate and timely information on migration implementation timeframe to enable them prepare for change. The Digital Migration Board should respond to public concerns even beyond the switchover date as all concerns may not be anticipated in time.
- Consumer education should involve all broadcasters, retailers and other players in the broadcasting industry in order to yield the expected benefits.
- There should be a zero tax on importation of set top boxes for digital broadcasting so as to reduce their cost to the final consumer (user).
- The government should take immediate steps to ban the importation of analogue television sets in support for the digital migration.
- Adequate measures have to be put in place by the government to ensure that all old analogue TV sets are disposed of with minimum damage to the environment after the implementation of the analogue switch-off
- It is obvious that digital migration is being a challenge to Africa as a continent; it is therefore realistic for Ghana to take the best practices from developed countries that have successfully migrated and are broadcasting in digital.

11. Conclusion

In this paper we have discussed the current status of digital migration in Ghana, highlighting on the policy, economic and technology choices being made and their potential impact on the transition to digital terrestrial television broadcasting in Ghana. We have also analyzed the actions being taken by the various stakeholders as well as the prevailing challenges. Based on this analysis, we have made some recommendations to various stakeholders that will assist in keeping Ghana on track for a smooth roll-over to meet its migration deadline. The GBC has thirty (30) transmitters operating in VHF Band III, and 9 repeater stations operating in UHF Bands IV and V and The private broadcasting stations still operating in analogue in Band III are TV3, Metro TV and TV Africa. Net2 TV, Via-Sat, e-TV Ghana, Crystal TV and Coastal TV operate on UHF transmitters. The prospective for future development will enhance increase revenue national development. Experience from other countries indicates that it is essential to meet a number of conditions to achieve a successful transition to digital terrestrial television broadcasting. These include a strong leadership from Government, close cooperation between the regulator and market parties and adequate information and support to end users.

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