# ASSESSMENT OF C-BAND USAGE IN AFRICAN COUNTRIES

**BY EUROCONSULT**

FINAL REPORT

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# Table of Contents

# BACKGROUND, SCOPE OF WORK AND METHODOLOGY

# Background and scope of work

In May 2014, we were appointed by the European Space Agency (ESA) to perform this assessment of the effective utilization of C-band, as defined herein, for satellite services in Africa.

The purpose of this study is to inform ESA, in advance of the World Radiocommunications Conference scheduled by the International Telecommunication Union on November 2-27, 2015, and of the latter's consideration of proposals to reassign all or parts of C-band from satellite to terrestrial services. To this end, and as per our terms of reference, the study assesses the number and characteristics of user antennas operating in C-band in Africa, and more specifically in Nigeria, Democratic Republic of Congo and Angola (the study's three "focus countries"), as well as the economic value and socio-economic benefits that accrue from the services these antennas are used to provide.

This final report delivered on September 22, 2014 provides the complete results from our research.

# Methodology and technical information

## GENERAL METHODOLOGY

To prepare this report, we reviewed publicly available information on market trends, including third-party publications and our own past research, including interviews with end users, satellite service providers and equipment manufacturers.

In addition, we performed interviews or received written data from 35 organizations, with the list and distribution presented below. We questioned these officials on the current use of C-band by their customers or themselves, on their views of the broader market and on the feasibility of alternatives to C-band.

**LIST OF ORGANIZATIONS THAT PROVIDED INFORMATION THROUGH THE INTERVIEW PROCESS**

**International**

| | |
|---|---|
| Air Traffic Navigation Services Ltd, South Africa | Air traffic management service provider |
| Amos | Satellite operator |
| Arabsat | Satellite operator |
| Bentley Walker | VSAT service provider |
| CETel, Germany | VSAT/Teleport Service provider |
| Comtech | VSAT manufacturer |
| EMC | VSAT service provider |
| Globecast Africa | Television content provider |
| Globecast France | Television content provider |
| Hughes Communications | VSAT manufacturer/service provider |
| Intersat Africa, Kenya | VSAT service provider |
| iSAT Africa, Kenya | VSAT service provider |
| Liquid Telecom, South Africa | VSAT service provider, Telecom carrier |
| Newsat | Satellite operator/VSAT service provider |
| North Telecom, UAE | VSAT service provider |

| | |
|---|---|
| Onlime group (Former CET teleport), Germany | VSAT/Teleport service provider |
| Orange | Cellular carrier |
| PCCW | Telecom carrier and VSAT service provider |
| Q-kon, South Africa | VSAT service provider |
| SAT-ADSL, Belgium | VSAT/Internet service provider |
| International Bank | Bank |

**Angola**

| | |
|---|---|
| Infrasat | VSAT service provider |
| MSTelcom | VSAT service provider |
| STARTEL | VSAT service provider |
| INATEL | VSAT service provider |

**Nigeria**

| | |
|---|---|
| Nigerian Television Authority | Television broadcaster |
| MTN Nigeria | Cellular carrier and VSAT service provider |
| Globacom Limited | Cellular carrier and VSAT service provider |
| Nigerian National Petroleum Corporation | Oil and Natural gas producer |
| Discoverytel | VSAT service provider |
| Coollink | VSAT installer |

**Democratic Republic of Congo**

| | |
|---|---|
| Microcom | ISP and VSAT service provider |
| Téléconsult | Broadcast infrastructure operation |
| Trust Merchant Bank | Bank |
| Global Broadband Solutions | ISP and VSAT service provider |

Specific sources used to perform the analysis are referenced in the report

## LIMITATIONS

Our analysis relies in part on public information that cannot always be corroborated as well as on interviews with third parties made independently of this study on the condition that such parties not be identified, made without their explicit consent to be identified or made subject to non-disclosure agreements. The report also examines questions on which we find prior research or available statistics to be extremely limited or non-existent; the specific uncertainties that result are detailed in this report.

As such, Euroconsult disclaims liability for any harm that may result from use of this report. However, we believe that the information at our disposal was sufficient to support our analysis within our normal standards of accuracy and for the purpose of our engagement.

## CONTRIBUTORS

This report was managed by Pacome Revillon, Euroconsult CEO. The analysis was principally researched and written by Pacome Revillon, Marc Welinski, Deputy Director – Broadcast and Broadband, Deepu Krishnan, Senior Consultant and Dimitri Buchs, Consultant.

## TECHNICAL TERMS AND ACRONYMS

ACM: Adaptive Code Modulation

ADS-B: Automatic Dependent Surveillance-Broadcast

ARPU: Average Revenue Per Unit

ATM: Automatic Teller Machine

bn: Billion

C-band: Radio frequencies at approximately 4-7 GHz

d.b.a.: Doing business as

dB: Decibel

DTH: Direct To Home (television)

FM: Frequency Modulation

GDP: Gross Domestic Product

GHz: Gigahertz

HD: High definition (television)

ITU: International Telecommunication Union

Ka-band: Radio frequencies at approximately 17-40 GHz

Ku-band: Radio frequencies at approximately 11.45-14.5 GHz

LNB: Low Noise Blockconverter

m: Million

Mbps: Megabit per second

MCPC: Multiple Channel Per Carrier

MHz: Megahertz

RF: Radio Frequency

SD: Standard definition (television)

SLA: Service Level Agreement

TVRO: Television Receive Only (antenna)

UHF: Ultra High Frequencies; radio frequencies at approximately 0.3-3 GHz

VHF: Very High Frequencies; radio frequencies at approximately 30-300 MHz

VSAT: Very Small Aperture Terminal

YE: Year end (unless noted, 31 Dec.)

# EXECUTIVE SUMMARY

## Overview

For this study, we assessed the usage of C-band in three focus countries in Africa, namely Nigeria, Democratic Republic of Congo and Angola. Those three countries differ significantly in terms of size, geography and organization.

In the three countries, we found that C-band is extensively used for communication networks, with a large impact for the country's economy, social development and the efficiency of government actions. Users include a large number of public and private organizations, and networks have been identified in both urban and rural areas, with C-band often being used to connect multiple locations spread around the country, as well as to provide direct or backup international connectivity.

Most identified networks present stringent requirements for reliable and uninterrupted communications, which could not be met with higher frequency bands with greater susceptibility to rain fade. C-band communication services themselves constitute a high technology industry, supported in each of the three countries by a robust local ecosystem of organizations and highly qualified personnel:

- In Nigeria, a national satellite operator already has a first satellite in service, with development plans for additional satellites. In DRC and Angola, the first national systems are currently under procurement and should be launched in the coming year. As the case in other countries with national satellite operators such as India and Indonesia, C-band capacity will be provided in large part by one or more national satellite operators, in addition to foreign operators.
- In each focus country, at least 10 specialized service providers manage the C-band links and networks of end users, with a significantly larger number of service suppliers in Nigeria.
- A number of organizations internalize technical competencies for the procurement and management of C-band communication links. These can typically include mobile network operators and operators of broadcast infrastructures and services, as well as certain banks.
- A number of installers and distributors complete the ecosystem and cooperate with either local or international companies.

## Public services and contribution to policy objectives

The governments of Nigeria, DRC and Angola all have invested in various C-band networks to optimize the efficiency of their operations and to support key development policies. In total, we identified close to 1,600 VSATs already installed as part of government networks in the three focus countries, along with a number of additional development projects.

These include in particular networks for:

- **Education and health**: Programs to connect schools, universities and offices of the Ministry of Education are in service in at least Nigeria and DRC. In addition, we identified networks supporting health activities, including one pan-African network connected with India and providing telemedicine capabilities.

- **Better access and efficiency of education and medicine**: There are multiple programmes currently deployed to help e-education and e-medicine in Africa using C-band for rural connectivity. As an example, the pan African e-project (by ISRO) has as of January 2014 connected more than 11,500 university students, provided more than 4,500 medical sessions and more than 500 medical consultations in 53 countries in Africa over C-band.
- **Water access and agriculture:** We identified networks in DRC and Nigeria supporting either agriculture (Nigeria) or water supply (DRC).
- **Air navigation, safety and security**: Airports and air traffic control centers in all three countries are interconnected by C-band networks, representing networks of 6 to 30 terminals. In addition, we identified, at least in DRC, some VSAT networks supporting the action of police forces and customs, with larger deployments planned for the coming years.
- **e-Government:** We identified large networks in each of the three countries, including for the driver's license scheme in Nigeria, for elections and fiscal administration in DRC and for the ID card project and security in Angola.
- **Other networks:** Our research and interviews we completed suggest the use of at least 650 additional terminals for government offices, for uses that we could not directly identify.

In addition, international government organizations and NGOs are large users of C-band VSAT networks and tend to complete the action of the national government in support of the population. Offices of the United Nations likely have the largest networks on a combined basis, with close to 100 terminals installed in the three countries, with the largest presence being in DRC. The United States, the European Commission and other governments also support local networks, with the third component corresponding to networks of NGOs. Available information suggests that these networks support several million individuals on a daily basis, with satellite C-band connectivity being key to coordinate and optimize local operations.

# Impact on economic sectors

The availability of C-band satellite links is of clear, direct and often considerable importance to a variety of economic sectors in all three focus countries.

C-band contribution feeds directly underpin the television industries of Nigeria, DRC and Angola. C-band transmission is a key component for the distribution of free-to-air (analog and digital) and pay-DTT services. The access of millions of viewers to TV content is consequently dependent on the availability of high-quality C-band transmissions.

Another key segment is the oil and gas and mining industries. We identified the use of more than 200 C-band VSAT terminals in each of three countries for a combined total of more than 1,000 units. Connectivity is key in both exploration and daily production activities, and any impact on C-band networks would have a direct impact on the productivity of the industry, directly impacting the country's economy and government budgets.

A third key segment is the banking sector. In each country, C-band VSAT networks are widely used to connect bank branches to headquarters, supporting banking services to millions of citizens on a daily basis. In total, banks currently use a total of around 1,900 VSAT networks in the three countries. The availability of C-band connectivity is an important tool to support the expansion of banking networks. In DRC, for example, it is a key tool to allow the payment of civil servants through bank accounts on a national basis.

The fourth key economic sector supported by C-band connectivity corresponds to the telecom sector, including mobile networks and ISPs. Mobile operators, in particular, are dependent on C-band to connect part of their mobile base stations. C-band is and will remain for a number of years the only option to expand the coverage of mobile networks on a national basis.

# OVERVIEW OF C-BAND CAPACITY USAGE IN AFRICA

# 1. Overview and rationale for C-band usage

The C-band corresponds to frequencies of 5.8-6.4GHz for transmission and 3.6-4.2GHz for reception. In addition, satellite systems can also make use of the "extended-C-band" (transmission 6.4-6.7GHz, reception 3.4-3.6GHz).

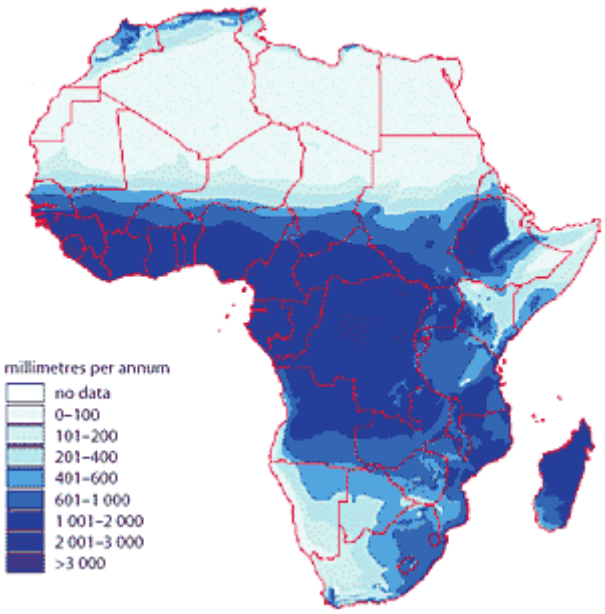
C-band has historically been the first frequency band used by FSS satellite systems on a large scale. FSS systems are currently using primarily C-band and Ku-band with an increasing use of Ka-band. When compared to other types of spectrum used by satellite communication systems, C-band benefits from two principal physical characteristics that are particularly well suited to part of Africa's environment, which explain why the C-band continues to be selected in key satellite applications in a large part of the region.

**Resistance to rain fade**

Service levels and reliability of above 99% are often a prerequisite for professional users, including for the oil and gas and banking industries as well as for GSM backhaul. For such users, service interruptions and poor network quality can cause huge revenue losses.

During rainy periods, the signal attenuation for Ku-band links can range from 6 to 10 dB (or even go up to 14-16 dB), while for C-band it falls in the range of 0.4-1dB (max)[1]. The high rain fade attenuation makes Ku-band less preferred for the above applications in many African countries.

**Exh. 1: MAP OF RAINFALL IN AFRICA**




Source: United Nations Environment Programme - UNEP[2]

The three countries we assessed for this study are all subject to high rainfall during at least part of the year (i.e., the rainy season). Based on our interviews, C-band is currently the only frequency band that can guarantee the quality of service requested by most professional users on a yearly basis.

- For example, according to service provider ITC Global that manages oil exploration sites for the IOC "Total" in Angola, the oil drilling is generally stopped in case the communication link is lost. This would lead to a risk of losing around $500,000 a day for the company in terms of production as well as the tubing that has already been sunk[3]. Another major company, Nigerian National Petroleum Corporation (NNPC), stated that many of their sites are located in high rain areas, where the link can go off for up to three hours a day due to signal attenuation. Even with C-band, the company has been able to reach around 98% SLA levels, as many of their sites are often plagued by power outage issues as well[4].
- According to global service provider Hughes that manages sites for international corporations, embassies and global banks operating in Africa, their customers often have no terrestrial backup network due to data security reasons. They use C-band links as the primary connection, as their customer networks often need 24/7 connectivity to their corporate headquarters[5].

### Availability of wide beams

The wide coverage area of C-band offers customers single-hop connectivity solutions. The corporates, NGOs, embassies and global banks operating in the region often have seamless connectivity requirements across Africa as well as to Europe, the Middle East, Asia or North America.

Also, most of the reported air navigation networks in the region (except a few domestic sites in South Africa) are in C-band, as seamless and single-hop connectivity is critical for air navigation communication services.

Another example cited in our interviews is the sharing of backup capacity for mobile operators for multiple national markets. This is particularly relevant in the African context due to the large operations of leading mobile operators, to the extension of networks and capacity needs and to the limited reliability (or lack of availability) of terrestrial backbone solutions in large areas. The wide coverage area of C-band is consequently a clear advantage for such capacity-sharing schemes.

The service providers operating networks of large regional companies have also stated that East Africa to West Africa connectivity is often needed for their end-user networks[6].

### Existing C-band infrastructure and costly migration process

Many of the existing users have deployed legacy SCPC C-band systems, and hence the migration and adaptation to a higher frequency band will be both costly and challenging[7]. Also, it is noteworthy that end users typically have to change the complete infrastructure including base band and antenna units to migrate to other frequencies.

According to one service provider that manages more than 600 VSATs in the region, they find it uncommon for individual end-user entities to operate in both C-band and Ku-band, and typically a single band is selected for an application. Therefore, the adaptation of a new frequency would make a large part of the existing infrastructure unusable[8]. The migration of an entire network including antenna repointing can also be challenging.

- According to QKon, South Africa that operates in multiple countries in Africa, the availability of qualified technicians for VSAT installation in the region are still limited, and obtaining work permits in certain countries is highly procedural and difficult[9].
- Another service provider, Infrasat Angola, told us that the antenna repointing and migration often costs around $1,000 per site, and the networks under USO and government programs often have no fund provision for these types of contingencies[10].

# 2. The use of C-band in Africa

## 2.1 DYNAMICS IN CAPACITY SUPPLY AND USAGE

Satellite operators have made use of C-band capacity in Sub-Saharan Africa for several decades. C-band currently represents an important part of the satellite business in the region. The 2014 edition of the annual report Euroconsult publishes on satellite capacity demand and supply reported the following indicators:

### Capacity supply

Close to 50 satellites cover at least part of Sub-Saharan Africa with C-band capacity in 2014. Our databases further indicates that the total number of satellites offering capacity in Sub-Saharan Africa stands at around 72 for 2014. This implies that two-thirds of all satellites active in the region carry a C-band payload.

Overall, satellite operators supply a total capacity of around 14 GHz in C-band in 2014 for Sub-Saharan Africa. This figure discounts part of the C-band capacity carried on satellites offering coverage of both Sub-Saharan Africa and other regions, suggesting that in practice the potential supply of C-band in the region could even be larger than indicated in our yearly survey[11].

Overall, C-band capacity supply represents approximately 50% of the total satellite capacity currently supplied by satellites qualified as regular satellites (i.e. excluding HTS and proprietary military capacity).

A recent trend in Africa has been the emergence of regional and national satellite systems. While two satellite systems, Rascom and Nigcomsat, are currently operational, two new systems are currently under procurement for DRC and Angola. It is noteworthy that all of the satellites procured by organizations located in Sub-Saharan Africa are carrying a C-band payload. Information available suggests that the C-band payload represents between 20% and 70% of the total capacity of the satellites, with an average of around 45%.

### Capacity demand and revenues

Satellite capacity usage in C-band stood at around 10.5 GHz in Sub-Saharan Africa in 2013. This corresponds to a fill rate of close to 80% of capacity supplied for that year and to around 58% of the total satellite capacity used in the region.

In Africa, the C-band capacity for telecom applications is typically sold by satellite operators in the range of $1,100 to $3,200 per MHz per month, depending on technical factors such as beam illumination, look angle and availability of in-orbit backup satellite from the operator. The prices also tend to be cheaper for service providers that indirectly buy capacity from satellite operators' offices stationed outside the continent, like in Europe where the C-band capacity tends to be 15 to 20% cheaper. However, for such purchases, the service support from operators in case of satellite outages, interference or similar technical failures may be compromised.

Since the late 2000s, the arrival of international submarine cable bandwidth has resulted in the satellite bandwidth price levels going down by the order of 10 to 20% in many countries, particularly in the East Africa region. However, the pricing remains stable or even tends to go higher ($3000/MHz/month) for operators who can offer better bandwidth efficiencies (i.e. Mbps per MHz) as well as redundancy and "non-preemptible" contract terms. The new satellite operators in the market tend to sell capacity at prices around $2,000-2,500/MHz/month in order to capture market share. Prices for extended C-band tend to be much cheaper in Africa compared to normal C-band and are

available at around $1,000-1,100/MHz/month. One of the reasons is the diminished usability and the high risk of interferences in areas where Wimax networks are using the same frequencies.

C-band capacity used for video distribution applications may be sold at around $2,500/MHz/month, although pricing can be significantly higher, particularly for certain DTH services.

We estimate that the C-band capacity market stands at more than $300 million in Sub-Saharan Africa, under a conservative assumption of global average of around $2,500/MHz/month for leased capacity.

**Exh. 2: AFRICA: REPORTED SALES OR LEASES OF C-BAND CAPACITY, JAN. 2013 – AUG. 2014**

| MONTH OF RELEASE | VENDOR | CUSTOMER | TYPE OF SERVICE |
|---|---|---|---|
| Aug 2014 | Intelsat | MSTelcom, Angola | C-band capacity on Intelsat-4 satellite for GSM backhaul and oil & gas corporate networks |
| May 2014 | SES | CETel Group (Germany) | 72 MHz of C-band capacity on NSS 7 for VSAT services in Africa |
| Apr 2014 | Intelsat | MultiChoice Africa (South Africa) | Additional C-band capacity on Intelsat 904 to distribute DTT GOtv to terrestrial emitters in Nigeria, Ghana, Uganda, Kenya, Rwanda, Zambia, Namibia, Malawi and additional countries |
| Mar 2014 | SatLink Communications | Ethiopian Radio and Television Agency | Uplinks, C-band capacity on Amos 5 and Ku-band capacity on Galaxy 19 and on a Hot Bird satellite at 13 °E for news channel ETV |
| Feb 2014 | Arabsat | Morgan for Information and Communications Technology (UAE) | Capacity on Arabsat 5C for VSAT services in Africa and the Middle East |
| Jan 2014 | Arabsat | Sudanese Television | "Contract to broadcast the Sudanese TV channels bouquet exclusively on Arabsat satellites" |
| Jan 2014 | Arabsat | Nileen Sports Channel (Sudan) | "Contract to exclusively broadcast the channel on Arabsat satellites" |
| Dec 2013 | Eutelsat | PPC (fka Philips Projects Centre, Nigeria) | 20 MHz of C-band capacity on Eutelsat 10A for VSAT services to oil companies in Africa |
| Nov 2013 | Measat | Sat Space Africa (UK) | C-band capacity on AfricaSat 1a for VSAT services in Africa |
| Oct 2013 | Eutelsat | UltiSat (USA) | C-band capacity on Eutelsat 5 West A for VSAT services to NGOs in Africa |
| Sept 2013 | Asia Broadcast Satellite | Hummerlton Security Services (Botswana) | "Multi-transponder" lease on ABS 2 and ABS 3 in C- and Ku-band for enterprise and banking services in Africa including the Africa Innovation Hub Project |
| June 2013 | Arabsat | Geolink Satellite Services (CETel subsidiary, France) | "Multi-year", "multi-transponder" lease on Arabsat 5A for VSAT services in Africa |
| May 2013 | Hermes Datacommunications | Tullow Oil plc (UK) | Teleport service and C-band link between Tullow offices in Ethiopia (1.8 m antenna) and London, with full redundancy in Addis Ababa |
| | SpaceCom | Southern African ISP | $3.2 m; additional C-band capacity on Amos 5 for VSAT services in Southern Africa |
| Jan 2013 | Eutelsat | Belgium Satellite Services S.A. | 46 MHz of additional C-band capacity on Eutelsat 10A for VSAT services in Africa and the Middle East |

## 2.2 VIDEO DISTRIBUTION

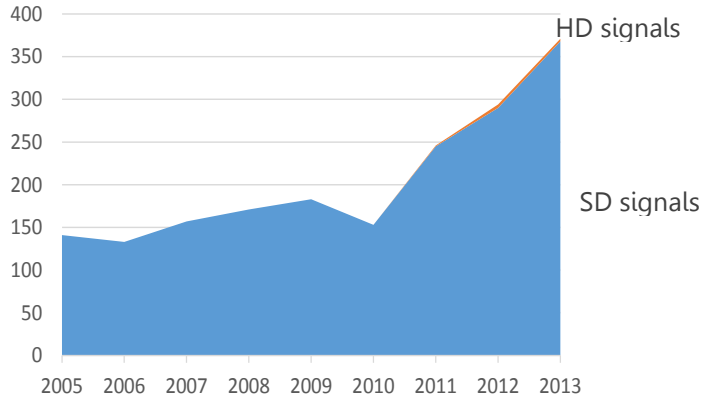
### Trends for the number of TV channels distributed over satellite

The distribution of TV channels through C-band satellite capacity has been a fast-growing market since 2010 across Sub-Saharan Africa. Main reported usage of C-band includes:

- The transmission of TV channels to the head-ends of terrestrial networks, and in particular Digital Terrestrial Television (DTT) networks;
- The broadcast of TV channels over-the-air (in analog format) through networks of terrestrial emitters; and
- The broadcast of TV channels direct-to-home (or to individual sites such as hotels) for free-to-air satellite reception.

The number of TV channels distributed in C-band in Sub-Saharan Africa reached around 370 in 2013[12], compared to around 150 in 2005. This corresponds to a 12% CAGR over the eight-year period. If we take the last three years, the number of C-band channels increased by an annual average of 34%. In 2013, C-band channels represented approximately 19% of total channels carried over satellite in the region (versus 16% in 2010). If we exclude TV channels distributed by satellite pay-TV platforms, the share reached 49% in 2013.

**Exh. 3: TV SIGNALS DISTRIBUTED BY SATELLITE IN C-BAND IN SUB-SAHARAN AFRICA[13]**




Source: Euroconsult analysis of transponder monitoring by Lyngemark Satellite [Lyngby, Denmark; www.lyngsat.com]

With the exception of pay-DTT services (StarTimes TV with 134 channels in 2013 and GoTV), most channels broadcast in C-band target a free-to-air reception, either:

- Following retransmission by a national network of terrestrial emitters; or
- directly through a satellite dish.

As for pay-TV services, the increase in the number of free-to-air channels results both from economic growth in Africa and from a progressive liberalization of the broadcasting sector in various African countries.

The roll out of DTT services has largely driven growth in the number of C-band channels in the region in recent years and represents a new step in the digitization of the African TV market. Two trends must, however, be mentioned:

- > Pay DTT services have now started in several countries. As previously stated, the introduction of packages of local and international channels has boosted the number of C-band signals, while DTT services have started to sign subscribers.
- > Free-to-air DTT networks are still under planning or development in most countries. When in place, free-to-air DTT networks should favor the introduction of new TV channels in most countries, with a large part of these requiring a satellite transmission in C-band.

The distribution of TV signals in standard definition currently accounts for most transmissions, representing 99% of total channels.

### Access to television and transmissions through C-band

The access to television in Sub-Saharan Africa has strongly improved in recent years. The number of TV households increased from approximately 42 million in 2010 to more than 48 million in 2013 according to Digital TV Research[14]. Sustained economic development has contributed to that growth in a large number of African countries. Still, the primary limiting factors to TV reception remain power availability and the purchasing power of households. Television is often limited outside of capital cities and other main cities throughout the region due to the fact that it is mainly available to higher-income households.

The improving economic context in recent years has benefitted both the free-to-air and the pay-TV markets in Sub-Saharan Africa in the last three years, with 2 million and 4 million households added, respectively. In 2013, the African free-to-air market (i.e., terrestrial and satellite) remains by far the largest in terms of TV households, with approximately 37 million TV households or more than three-quarters of the total according to Digital TV Research.

In 2013, the primary reception mode for free-to-air television in Africa remained terrestrial TV with 34.5 million TV households. An estimated 27.3 million households out of 34.5 million watched analog TV content in the region in 2013 according to Digital TV News, with the rest accessing digital content. Many Africans own or have access to equipment that can receive digital media including TV sets. However, usage currently remains limited due to the low level of development of the digital media infrastructure.

The ITU deadline for the migration from analog broadcasting to digital terrestrial television in Africa is June 2015. Once this deadline passes, it is understood that there will be no more international support of analog spectrum. Today, many African countries are not expected to meet this deadline. Various factors are impacting the ability for certain countries to reach their targets, including misinformation, the supply and cost of set-top boxes and/or the absence of solid policy or plan. According to Balancing Act[15], only nine countries in Africa had officially launched national DTT in June 2014, and two countries had completed the analog switch-off in January 2014 (Tanzania and Mauritius). Several other countries such as Nigeria have announced that they expect to meet the 2015 deadline, but various countries are expected to be late in switching off analog signals. This is notably the case of South Africa where delays by the government and the department of communications have made it virtually impossible for the country to meet the 2015 deadline.

In 2020, when all African countries should have switched over to digital, the number of FTA DTT households in the region could reach 37.5 million according to Digital TV Research, with more than 30 million new digital households expected to be added over the 2013-20 period.

Free-to-air satellite reception remained limited to around 2.5 million households in Sub-Saharan Africa in 2013. The two primary inhibitors include the access to power and the purchasing power. Most TV households with sufficient purchasing power tend to pay for satellite TV services, given the larger availability of content in DTH platforms offerings.

The African free-to-air television market is highly reliant on C-band satellite capacity, principally for contribution to earth stations that enable the broadcast of over-the-air channels in analog and digital format. Given the fact that terrestrial reception remains the principal TV reception mode for a large

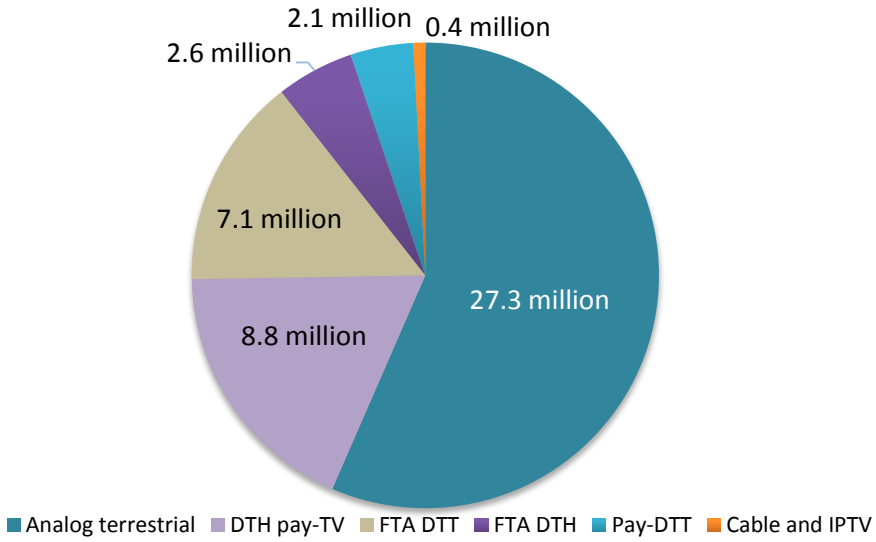
part of the population, C-Band is technically required for the television industry to operate. Based on our analysis of Lyngsat[16], C-band provides most of the unencrypted terrestrial channels freely accessible to TV viewers. Following the digital switchover, C-band is expected to continue to be used for a large part of DTT broadcasts. This is the case for the countries we specifically assess in this report. As DTT signals allow for more efficient use of spectrum, TV households should have access to more differentiated content after the analog switch-off.

Several factors justify the preference given to C-band as opposed to other frequency bands for the transmission of terrestrial FTA channels including:

- C-band guarantees a higher stability of transmissions than Ku-band and other frequency bands, particularly during adverse weather conditions. C-band usually allows an uninterrupted transmission of the feed during rainfall. This is essential in a region where a majority of the population has very limited access to media. One interviewed executive confirmed possible cuts for up to a full week of TV signals distributed in Ku-band in case of heavy rain[17].
- C-band offers broadcasters and service providers a wider coverage (i.e., usually pan-African) than other frequency bands. Large coverage beams allowed by C-band offer the opportunity to deliver each channel to many terrestrial head-ends through a single signal, thus optimizing transmission costs.

The situation is different for free-to-air channels distributed by satellite for direct-to-home reception that often use Ku-band. This is particularly true for packaged free-to-air services provided by companies such as Computer Warehouse Group in Western Africa and Continental Digital Media Content Services in Tanzania. Worth noting is the fact that the latter FTA services are currently not viewed by many households as they are relatively recent and as they require an antenna, which can be an inhibitor for a population with low purchasing power.

**Exh. 4: ESTIMATED AFRICAN TV HOUSEHOLDS BY TYPE OF DELIVERY (2013)**




Source: Digital TV Research and Euroconsult estimates

Digital TV is currently available mainly through pay-TV networks, including satellite pay-TV platforms, cable TV providers, IPTV providers and pay-DTT providers. The digital switchover process that should be completed by all countries of the region in coming years is expected to lead to free-to-air digital TV households accounting for a majority of households in the middle term.

In 2013, Sub-Saharan Africa had 11.3 million pay-TV households, with satellite pay-TV services leading the way (8.8 million subscribers based on Euroconsult research). Pay-TV services are more popular in

large towns than small cities and rural areas due to the fact that a larger share of the population can afford them. Nevertheless and despite the arrival of lower-priced pay-DTT services in recent years, only a small share of the African population can currently afford pay-TV services. Pay-TV services are currently available via satellite, DTT, cable and IPTV in the region:

- With approximately 8.8 million subscribers at YE 2013, satellite pay-TV services accounted for three-quarters of pay-TV households in the region in 2013. They have experienced strong growth since 2010, with close to 3 million added in the past three years. There were close to 15 active DTH platforms in 2013. Regional platform DSTV (Multichoice) led the way with close to 7 million satellite subscribers at YE 2013. All DTH platforms use Ku-band capacity.
- DTT services were the fastest-growing pay-TV services in Africa in the past three years. The region currently has two main players, StarTimes TV ad GoTV (Multichoice), which had a combined 2.1 million active subscribers at YE 2013. This figure is even higher when including StarTimes TV's 1.5 million inactive set-top-boxes. DTT services have benefitted from lower prices than satellite and cable TV competition to rapidly increase their market share in Africa. They have also taken advantage of the slow pace of digital migration in Africa that has so far limited the number of free-to-air terrestrial deployments. Both pay-DTT services use C-band capacity only to distribute content to their terrestrial towers. They distributed a combined 176 channels in 2013, using seven transponders on Eutelsat and Intelsat satellites. The success of pay-DTT services in Africa has pushed both service providers to increase capacity leases in recent months. GoTV was the latest of the two to add capacity in April 2014 on Intelsat 904 to expand the reach of its service.
- Cable TV ad IPTV services are currently limited in the region, with less than 400,000 estimated subscribers at YE 2013 according to Digital TV Research. This is due to the limited terrestrial infrastructure available in the region. C-band capacity is used for the broadcast of TV channels to cable head-ends.

Another segment of TV viewers benefiting from C-band satellite transmissions is minorities and foreign visitors. This is notably the case of Chinese workers and tourists. According to The Economist[18], an estimated 1 million Chinese were residing in Africa in 2013. Five Chinese channels are broadcast via a multiplex using C-band capacity on Eutelsat 10A. The situation is similar for the Indian expatriate community in Sub-Saharan Africa, which has access to five Doordarshan channels distributed on Spacecom's C-band payload on Amos-5.

### Synthesis on video distribution in C-band

We estimate that the distribution of the 372 TV channels over satellite in C-band in Sub-Saharan Africa required around 1.3 GHz of leased satellite capacity in 2013, which corresponds to an average of approximately 3.5 MHz leased per channel. If we take an average pricing assumption of $2,500-3,000/MHz/month, the capacity cost for the transmission of channels represented an investment of close to $40-45 million in 2013. Based on interviews conducted, prices paid by broadcasters and video service providers can be significantly higher. One video service provider told us the price they pay is approximately $3,000-4,000/MHz/month depending on the satellite operator[19].

Based on our analysis of the market, it is likely that any interference in the C-band would have a strong impact on the TV market in Africa and more particularly on the terrestrial distribution of channels in the region. The end of C-band usage would potentially impact directly more than 35 million households (or about 140 million individuals if we take a conservative number of individuals/household) in the region in the short term, and a larger number of viewers when we consider that the usual access to TV is two to three times higher than the number of TV owners. This audience is furthermore likely to strongly increase in the coming years.

If we take into account the indirect impact of C-band as well, the entire television industry and viewership depend on C-band, which is used by broadcasters including DTH platforms for contribution/sourcing of the content.

## 2.3 COMMUNICATION SERVICES

C-band VSAT networks are currently a major communication channel in many African countries, even though the arrival of submarine and fiber networks in the past five years has resulted in the transfer of certain types of communication traffic to terrestrial networks. Usage of C-band capacity for communication services in Africa is diverse, though three major segments can be highlighted, which are further detailed in the country analyses of this report.

- Connectivity in support of professional services;
- Backhaul of traffic for mobile networks and international gateway connectivity;
- Government networks.

**Exh. 5: AFRICA: SAMPLE OF APPLICATION SEGMENTS FOR C-BAND VSAT SERVICES**

| SAMPLE OF MARKET VERTICALS/SEGMENTS | EXAMPLES OF USES |
|---|---|
| **Connectivity in support of professional services** | |
| Oil and gas sector | Connectivity to oil exploration sites. Linking retail gas stations and also monitoring pipelines. E.g.: NNPC(Nigeria), Sonangol(Angola), SEP (Congo), Total(Angola), Chevron, Shell, Agip, CONOIL, SAPETRO, Eni (Angola, Nigeria), Tullow Oil (Kenya) etc. |
| Mining sector | Data & Voice connectivity to remote exploration sites and for personnel welfare. E.g.: Allana potash (Ethiopia), DeBeers (Angola) |
| Banking/financial sector | Providing core banking solutions. Providing regular and backup connectivity to ATMs. E.g.: Zenith (Nigeria), BPC, BCI (Angola), BCDC, TMB, Raw bank (DRC), AfDB, VISA |
| Maritime sector | Data and voice connectivity to passenger and vessels. Welfare connectivity to crews. |
| Retail, FMCG & Agri-product trading companies | Connectivity between franchisees or branches and regional or global headquarters. Transmission of Point of Sale data. E.g.: NDAD (Angola), Olam international (Nigeria) |
| Internet service provider sector (ISP) | IP backbone connectivity to ISPs who provide Internet connectivity to cafes and SOHOs E.g.: Netcom Africa Ltd, Internet solutions (Nigeria) |
| Air Navigation | Air traffic management (ATM) services and meteorology services E.g.: NAMA, NIMET (Nigeria), TAAG Angola Airlines |
| **Backhaul of traffic for mobile networks and rural connectivity** | |
| Cellular backhaul | Connecting remote mobile towers (BTS) to base stations (BSC). E.g.: Movicel, Unitel (Angola), MTN, Glo, Airtel, Etisalat (Nigeria), Orange, Vodacom (DRC), Ethiotelecom (Ethiopia), Telma (Madagascar) |
| International voice and IP trunking | Gateway connectivity to international IP & Voice backbone E.g.: Globacom (Nigeria), Airtel (Kenya, Nigeria), MTN (Nigeria) |
| Communication terminals/kiosks for villages | Connectivity to Internet and telephone kiosks in villages. Trunking connectivity to telephone exchanges in remote regions. E.g.: Angola Telecom, MSTelcom (Angola); NIPOST, NICEP (Nigeria), Ethiotelecom (Ethiopia) |
| **Government networks** | |
| e-government | Connectivity solutions for e-Governance applications. Also for providing connectivity between provinces and state capitals. E.g.: NICEP, NIPOST (Nigeria), |
| Education | Voice, data and video connectivity to establish interactive satellite based distance education system for the country. E.g.: Anambara School project (Nigeria), NICEP (Nigeria), Pan e African network (ISRO) |
| Health | Connectivity to rural hospitals and mobile medical vans with specialty hospitals. Medical education and disaster management support. E.g.: Pan e African network |

| | |
|---|---|
| United nations network | Broadband connectivity to connect various UN agencies across Africa and to connect to their HQ in Europe/U.S. E.g.: UNDP, WHO, UNICEF (Nigeria, Angola, DRCongo),UNISFA (South Sudan and DRC), UNMACC(DRC),UNAMSIL (Sierra Leone) |
| NGOs | Broadband connectivity to connect NGO units working across Africa and to connect to their HQ in Europe/U.S. E.g.: Save the children (Nigeria), Oxfam, USAID (DRC) |
| Defense | Voice, video and data connectivity between army/navy user terminals and headquarters. E.g.: Ministry of Defense (Angola) |

In Africa, VSAT networks are today mainly deployed in C-band and Ku-band with only some limited Ka-band VSAT deployments by HTS operators Yahsat and Avanti in the past two to three years. Large Ku-band networks do exist in countries like South Africa, Kenya and Nigeria but are primarily used to provide Internet access to net cafes, schools or to consumers, for whom the size of the terminal and the price of equipment are the primary driver.

C-band has been the frequency of choice for most communication networks for which the quality of transmission is critical. For such organizations, the risk of rain fade outweighs the inconvenience that may result from the larger size antennas required for C-band transmissions. The fragmentation of the VSAT market into dozens of service providers and hundreds of users who rarely disclose the details or even the existence of their networks makes an exhaustive quantification of the number of installed terminals difficult. However, it is clear that C-band accounts for a large, and sometimes dominant, share of the market. Overall, information gathered for the present study suggests the number of active VSAT terminals operating in C-band to be higher than 7,000 in the three countries.

A sample of indicators support that estimate:

- Overall, our interviews with service providers and other research suggest that C-band accounts for almost all of GSM backhaul sites in Angola, Nigeria and DR Congo – or ~1,800 sites – for most of the oil and gas sites in Africa, for most of the enterprise sites in Angola and DR Congo, for most of the core banking network in Angola, Nigeria and DR Congo – or ~1900 sites – and for almost all air traffic navigation sites (except a few domestic networks) across Africa.
- One MNO that operates in 17 countries in Sub-Saharan Africa has more than doubled its C-band capacity lease for cellular backhaul and trunking from around 1.3 Gbps in 2012 to around 3.5 Gbps in 2013 from a single satellite operator[20].
- According to global equipment vendor Hughes, Ethiotelecom currently has around 3,000 C-band sites (@1.5 Mbps each) deployed for rural connectivity[21].
- Telma, Madagascar has around 200 sites (@2Mbps each) for GSM backhaul. Telma, which initially had tried to extend its rural connectivity Ku-band network for the above backhaul sites, couldn't succeed due to poor network availability and voice quality. So, they finally rolled back the 200 VSAT sites to C-band[22].
- According to one service provider that operates across the Africa region, the majority of large network tenders, particularly in West and Central Africa, are in C-band[23].
- One international bank confirmed the use of C-band VSATs in around 70 sites located in 12 countries. Total satellite capacity of 33 Mbps covers the carriage of business data as well as email and Internet access. SLA requirement stands at 99.99% with C-band consequently being the frequency band of choice. Even for sites now reached by fiber networks, the use of C-band would be kept at least as a backup solution. Another option is to maintain the use of VSATs for critical data and to migrate non-critical traffic such as Internet access to terrestrial networks[24].
- There is a significant usage of C-band satellite capacity for international gateway links used as both primary and backup connections. Kenya, which already has four submarine cables

providing around 850 Gbps international bandwidth, still uses more than 220 Mbps C-band satellite capacity as of March 2014 to provide redundancy and always-on experience to customers during fiber cuts[25]. Also, the low international cable bandwidth price is not always passed on to service providers and remains at almost 10 times higher than the wholesale price in many countries. According to West African Backhaul Company (WABCo), which is a major wholesale carrier across West Africa, the price is not expected to come down in the near term as the governments are reluctant to build infrastructure to further carry capacity inland. According to private carriers who invested in fiber roll-out, price reduction will happen once they are able to break even, which may take a long time[26].

- According to Comtech EF, which sells modems to high-end enterprise customers, 85% of their global C-band business is in Africa. The company annually sells around 800 modems in Africa, where the majority of sales come from Angola and DRC, with good take up in Kenya, Nigeria, Libya and Zimbabwe. The company only sells high-end modems with 2-25Mbps data traffic, costing in the range $10K-100K to segments including trunking/backhaul, oil and gas and mining[27].
- According to Arabsat, which is a major C-band capacity provider in Africa, they currently have around 80% fill rate for C-band capacity over the region, and out of this around 80% of the capacity is used for the connectivity segment. The Sudanese VSAT provider Sudasat leases around 10 C-band TPEs from Arabsat. Around 70% of this capacity is used for meeting cell backhaul demand of their parent national company Sudatel. According to Arabsat, Sudasat also tried to use Ku-band for backhaul and finally had to migrate back to C-band after finding it not viable[28].
- Global provider Bentleywalker is stated to operate around 35 C-band sites (at 3 Mbps each) for NGO networks in Africa[29].
- According to Angolan provider Infrasat, which uses more than 280 MHz C-band capacity, the company has plans to expand networks in neighboring country Mozambique, where C-band demand is more due to rain fade issues. South African provider Q-kom also reported the countries Mozambique along with DRC as their major enterprise markets, utilizing around 1 TPE capacity[30].
- Regional provider Liquid Telecom has reported to operate around 100 C-band sites for GSM backhaul and trunking applications, mainly in DRC, Zimbabwe and Somalia. In Botswana, the company operates around 13 backhaul sites for the MNO Mascom[31].
- According to satellite operator Amos, its 34 TPEs (36MHz) C-band capacity over Africa is nearly fully leased now. The capacity is being used at 80:20 ratios for connectivity and video applications, respectively. According to Amos, the demand for their C-band capacity in Africa is growing at 5-8% annually in the past two to three years[32].

It is noteworthy that political priorities of governments are driving part of the deployments. These can either be the result of regulatory constraints, such as universal service obligations for telecom operators, or correspond to direct investment programs from governments (for civil security, defense, education, etc.). Although those networks tend to be of a limited size in terms of VSATs installed, they usually correspond to important national stakes.

# C-BAND USAGE IN NIGERIA

# 3. Country overview

Nigeria is the most populated nation on the African continent and the seventh most populous country in the world, with over 168 million people in 2012[33]. The country's population has been growing at approximately 2.7% per annum over the past five years.

The country is divided into 36 states and one federal capital territory Abuja. Major cities include the capital city Lagos, Kano and Ibadan. Population density in Nigeria was last measured at 185 people per $km^2$ in 2012, according to the World Bank. Nigeria has an average household size of around five people, and approximately 50% of the population lives in rural areas. In terms of demographics, more than 44% of the country's population is below the age of 14, and more than 53% currently fall into the working age group of 15-64.

The country of 923,000 $km^2$ is located on the western coast of Sub-Saharan Africa, bordered by Benin, Niger, Chad and Cameroon. The country has a varying topography with high plateaus, hills, river valleys, mountains, rainforests and coastal area stretching 850 km long. The country falls in a tropical zone with an average annual rainfall varying from 2,400 mm to 4,000 mm, with more rain observed in southern regions. The rainy season typically lasts from mid-May through September every year.

The country has been facing security and terrorism issues, particularly in the northern part of the country. Nigeria is classified as a mixed economy and emerging market and has already reached lower-middle income status, according to the World Bank, with its abundant supply of natural resources, well-developed financial, legal, communications and transport sectors and a stock exchange that is the second largest in Africa. Nigeria has maintained its impressive growth over the past decade with a record estimated 7.4% growth of real GDP in 2013, up from 6.7% in 2012[34]. The growth was mainly supported by improvements in non-oil sectors like agriculture, trade and services as the country has been trying to diversify its economy in the recent past. Growth of the oil sector was hampered throughout 2013 by supply disruptions arising from oil theft and pipeline vandalism, and by weak investment in upstream activities with no new oil finds.

# 4. Television broadcasting

## 4.1 OVERVIEW OF THE TV BROADCASTING MARKET

### Reach of television services in Nigeria

In Nigeria, the population receives information from a variety of media outlets, even though access may be restricted by cost, technology, circulation and other factors including the lack of electricity in some parts of the country. Radio is the leading media platform because of its relative affordability and ability to provide information without literacy barriers. Television is more available to urban-based and relatively higher-income households. Frequent power outages imply that even TV households with access to TV signals often spend weeks without watching TV.

Estimates vary on the actual number of households having access to TV in Nigeria.

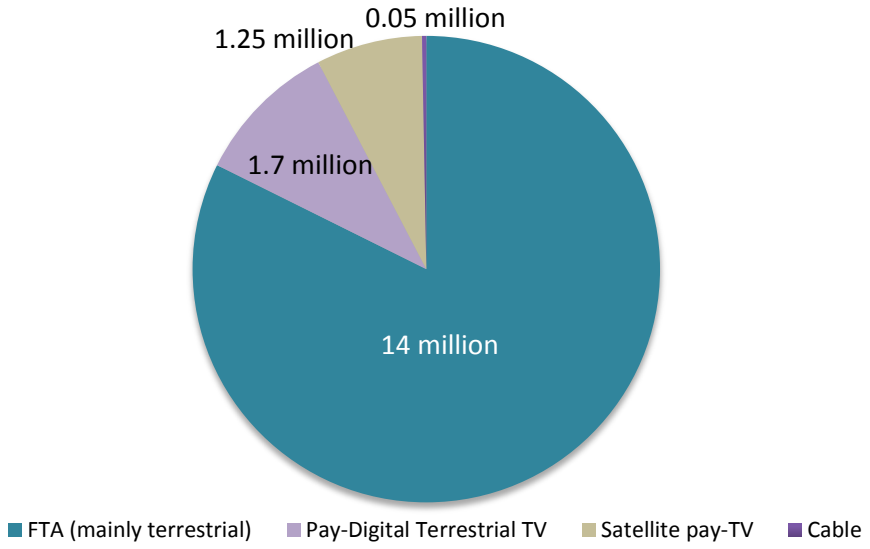
- The Open Society Foundations[35] mentions a survey conducted by the National Bureau of Statistics, which estimates that 51% of Nigerian households had access to TV in 2007 while 36.6% owned a TV set.
- Statistics from the International Telecommunication Union suggest that 40% of Nigerians had a television in 2008.

- Research organization PAMRO[36] estimated the reach of television across Nigeria at 85% in 2010.
- A 2010 survey of equipment availability in urban and semi-urban households by Media Planning Services indicates that 60% of households owned a TV screen in 2010, up from 43.2% in 2007[37]. This survey excludes the rural population, which accounts for around 50% of the total population. As a consequence, the share including the rural population is likely significantly lower. Media Planning Services estimates the number of TV households at 19.1 million in 2010 (again, excluding rural areas).
- The National Broadcasting Commission (NBC) of Nigeria estimates the number of TV households at 11.2 million in 2013 (out of 34.1 million households), representing a 33% penetration[38].

Large differences between several sources likely result from differences in the considered universe (full or urban-only population) and in the metrics measured (ownership of a TV set versus access to TV watching). Access to TV watching tends to be much larger than the number of owners of TV sets due to the importance of shared viewing, whereby one TV set can be watched by more than one family.

Based on the figures available, we can assume that the number of TV households has increased significantly in the last five years and that around 45-50% of households currently own a TV. If we take the number of households provided by the NBC of Nigeria, which was estimated at 34 million in 2013[39], this would lead to 15-17 million TV households in 2013. The share of Nigerians with access to TV content, including via shared viewing, is likely much higher and estimated at around 70% of the population (i.e. 115-120 million people in 2013).

**Exh. 6: NIGERIA - ESTIMATED TV HOUSEHOLDS BY TYPE OF DELIVERY (2013)**




Source: Euroconsult estimates.

Nigeria's broadcast industry was deregulated in 1992, leading to a proliferation of private TV stations in a highly competitive environment. Satellite pay-TV platform Multichoice (DSTV) was the first pay-TV provider to launch services in the country in 1994.

### Digitization process of Nigeria TV market

Despite the arrival of pay-TV in the mid-1990s, the primary reception mode for television in Nigeria remains analog terrestrial TV. Many Nigerians own or have access to equipment that can receive digital media, including TV sets. However, usage currently remains limited due to the low level of development of the digital media infrastructure. Digital TV is currently available mainly through pay-TV networks, including satellite pay-TV platforms, cable TV providers and pay-DTT providers. Nigerians also have access to digital video broadcast video via mobile phone (since 2010).

According to a survey from Media Planning Services[40], there were 22 million households with terrestrial free-to-air television reception in 2010 and about 3 million households with access to pay-TV (9% of households). This implies that 88% of TV households accessed content through terrestrial free-to-air reception.

Even though no public figures are available on the share of analog and digital in the total, we believe that all households with free-to-air terrestrial reception have access to analog content only as free-to-air DTT is not yet available in the country. Dozens of free-to-air television stations are broadcast on terrestrial networks in Nigeria. Apart from the main public networks such as NTA, TV signals are usually weak, leaving large parts of the country underserved or in complete blackout. The only terrestrial TV households that can access digital content are the ones paying for DTT services offered by StarTimes TV and GoTV (Multichoice).

The process of digitalization in the Nigerian broadcasting landscape began in 2007 when the government chose December 2007 as the start date for the transition from analog to digital. The adoption and implementation of policies for switch over has moved slowly since then. State broadcasters, who still account for the bulk of spectrum and audiences, have been criticized for failing to take a leadership role in driving the switchover.

In the absence of any policy or plan, the National Television Authority formed a pioneering partnership with Star Communication Network China to form StarTimes Nigeria, which has around 1.3 million subscribers[41]. Launched in July 2010, StarTimes Nigeria is currently one of two commercial digital terrestrial television (DTT) platforms known to be operating in the country alongside GoTV (Multichoice). According to an article published by All Africa[42], StarTimes Nigeria has assured consumers that the country is on path to meet the 2015 deadline for digital switchover.

In recent months, the process has accelerated, with the regulator announcing a switchover deadline set for January 2015[43]. Nigeria has decided to use the DVB-T2 standard, with the government approving three signal distributors. Set-top boxes will only be manufactured locally. Key recent events include the following:

- Nigerian city Jos, which is located in the Plateau State, should be the first city to switch from analog to digital in Nigeria, with the process starting in April 2014.
- Plateau Television Corporation (PRTV) was the first broadcaster to start the digitalization process from April 2014.
- A DVB-T2 pilot test is currently operating in 20 cities according to the NBC of Nigeria.
- Nigeria was expected to ban the import of analog TV screens by June 30, 2014.
- In August 2014, GoTV launched services in Abeokuta, which is the 21st city where it offers services. GoTV has partnered with the NBC of Nigeria to facilitate DTT rollouts across the country.

The rollout of the DTT network in Nigeria is expected to facilitate the expansion of the terrestrial TV coverage across the country, including in rural areas that currently have limited access to content. One of the issues in the short term could be that no free-to-air DTT services are available – an issue because people will be less willing to transition from analog to digital TV if they believe this will mean they have to start paying for TV. In 2013, StarTimes TV and GoTV broadcast a combined 120 TV channels. There should be more DTT channels in the future. According to NTA[44], the government

broadcaster, the approximately 100 analog channels currently available free-to-air are expected to migrate to DTT in the future, leading to more channels available for TV households.

**Focus on the pay-TV segment**

The pay-TV landscape has significantly evolved over the last three years. In 2010, the majority of pay-TV households accessed content via a satellite dish and decoder with a small part of them accessing content via cable TV networks and digital video broadcast technology on mobile devices. Since then, competition has intensified following the launch of the first pay-DTT services by StarTimes TV and GoTV (Multichoice). Several new direct-to-home satellite pay-TV platforms also started their operations in recent years.

Pay-TV services are more popular in larger towns and cities, with a small share of the population able to afford them. Most pay-TV channels broadcast international programs. Some channels, including Africa Magic, offer national and regional content.

The arrival of lower-priced competition via pay-DTT and the sustained growth of the Nigerian economy have boosted the pay-TV market in recent years, with the number of subscribers growing from an estimated 850,000 in 2009 prior to the launch of pay-DTT to around 3 million in 2013 (2009-13 CAGR: 37%). In 2013, pay-TV services were dominated by DTT and satellite service providers, while cable TV providers only account for a very small share of subscribers:

- We estimate that the two pay-DTT services, StarTimes TV and Multichoice's GoTV, have a total of approximately 1.7 million subscribers, or about 57% of Nigerian pay-TV subscribers. They have been the fastest-growing pay-TV providers in the last couple of years. DTT services use C-band capacity over satellite to distribute channels to their terrestrial emitters.
- Satellite pay-TV services direct-to-home have grown quickly in recent years. The launch of several new platforms resulted in more competition and provided more options to subscribers. In August 2014, five platforms were operational: DSTV Africa (Multichoice), MyTV, DaarSat, Montage TV and Consat. The two latter platforms were rolled out in 2014. We estimate that those companies had a total of around 1.25 million subscribers at the end of 2013, with DSTV being the market leader. All these satellite services rely on the Ku-band for their direct-to-home transmissions.
- Cable TV is very limited in the country. No figures are available but we estimate that service providers combine for less than 50,000 subscribers. By license, cable operators have a small range of coverage (50 km radius from where they are operating). Cable TV uses C-band, with each operator apparently broadcasting a limited number of analog channels with mostly local content.

We estimate that free-to-air DTH satellite reception is limited. The two primary inhibitors include the access to power and the purchasing power in the country. The satellite operator SES, in collaboration with Computer Warehouse Group, a pan-African ICT company, launched Nigeria's first free-to-air DTH satellite digital TV platform[45]. It will also be available across West Africa. It uses capacity on SES's Astra 2F at 28.2° E. This platform is designed to help broadcasters accelerate and adapt to the digital migration process. It will use Ku-band capacity.

## 4.2 C-BAND UTILIZATION FOR THE BROADCAST SECTOR

The Nigerian television market is highly reliant on C-band satellite capacity, principally for contribution to earth stations. Given the fact that terrestrial reception remains the principal TV reception mode for a large part of the population, C-Band is technically required for the Nigerian television industry to operate. Ku-band is mainly used by satellite pay-TV platforms, which account for less than 10% of TV households. As free-to-air television continues to make minimal use of Ku-band, C-band also provides most of the unencrypted channels freely accessible to viewers. Some free-to-air channels distributed by satellite do use Ku-band (e.g., recently launched SES service in collaboration

with Computer Warehouse), but they are recent and are not expected to be used by a lot of households in the initial development phase, as they require an antenna, which can be an inhibitor for a population with low purchasing power.

Geographical coverage of broadcast stations varies according to ownership and mandate. Stations owned by the federal government (NTA) have mandates for nationwide coverage. Those that belong to state governments cover their respective states. The coverage of private stations is not uniform. Some cover just one state, others a group of states. In recent years, a few have moved to establish a network of stations while others have started to service international audiences via digital satellite television (e.g., DSTV) arrangements.

The total number of broadcast stations (i.e., TV, DTH services and radio) in Nigeria currently stands around 267 according to the NBC of Nigeria[46], of which 109 are terrestrial TV stations. Out of these, only a few channels are present on a national scale. Each state in Nigeria has a broadcasting company that broadcasts one or two locally operated terrestrial stations.

The largest broadcasting company is government-owned Nigerian Television Authority (NTA). The Nigerian Television Authority (NTA) runs one national channel and has a national network of 101 stations, of which 89 are on air while others are at various stages of completion. It reaches over 90 million viewers[47], representing around 80% of Nigerians with access to television. Stations are located in the various states (36) and Abuja, the federal capital, and have their own programming but also link to network programming. NTA is the most popular television station in several Nigerian regions (see table below) and has the widest reach in the country.

**Exh. 7: NIGERIA – MOST POPULAR TV STATIONS (% OF TOTAL RESPONDENTS) – 2010***

| Lagos | | South West | | South East | | South South | | North West | | North East | | North Central | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Silverbird, Lagos | 18 | OSBC Akure | 12 | Orient (IBC) TV Owerri | 14 | AKBC Uyo | 16 | NTA Kano | 12 | NTA Maiduguri | 19 | NTA Makurdi | 20 |
| AIT Lagos | 17 | NTA Ch. 4, 5, & 7 Ibadan[23] | 9 | NTA Enugu | 11 | DBS TV Warri | 13 | NTA Sokoto | 10 | NTA Bauchi | 17 | NTA Minna | 15 |
| Galaxy TV, Lagos | 16 | OSBC Osogbo | 7 | NTA Abakiliki | 10 | STV CH 31, P/ Harcourt | 8 | Katsina State TV | 10 | NTA Yola | 13 | NTA Lokoja | 12 |
| LTV, Channel 8, Lagos | 14 | BCOS Ch 28, Ibadan | 7 | NTA Aba | 10 | AIT Port Harcourt | 8 | NTA Gusau | 9 | NTA Jalingo | 11 | NTA Jos | 7 |
| TV Continental | 3 | NTA Ado-Ekiti | 5 | MST Obosi | 7 | RSTV Port Harcourt | 6 | NTA Katsina | 9 | NTA Gombe | 10 | NTA Abuja | 6 |

*urban and semi-urban areas only
Source: Reporters' calculations based on survey data from Nigeria Media Planning Services, All Media and Products Survey 2010

NTA uplinks its signals in the C-band to reach terrestrial emitters in Nigeria and Europe. It operates two earth stations in Abuja and one earth station in Lagos. Apart from this NTA control 10 C-band uplink facilities across the country, which include seven DSNG terminals. They currently have 100 C-band TVROs that are analog terrestrial TV stations receiving TV signals from these uplink stations located in all state capitals and other community stations. These signals received by TVROs are further transmitted terrestrially in UHF and VHF bands to end customers. The 100 analog channels are all expected to migrate to DTT in the future according to NTA. The latter is currently not transmitting on Ku-band capacity, and there is currently no plan to use Ku-band[48].

Private players in the TV scene include: Silverbird Television (STV), Africa Independent Television (AIT), Channels Television and several others. Most of their programming is aimed at the African and global markets and is broadcast globally from Lagos, Abuja, Obosi and Port Harcourt with affiliated TV stations in several African countries. African Independent Television (AIT) is a high-profile satellite TV station broadcasting globally from its Lagos and Abuja centers. Other direct satellite TV stations with international reach include ON Television and Galaxy TV. Based on our monitoring of Lyngsat, all of the channels previously mentioned use C-band capacity (some of them also use Ku-band).

On top of free-to-air terrestrial content, pay-DTT services offered by StarTimes TV and GoTV (Multichoice) also use C-band capacity for content delivery to their terrestrial emitters. The two combined for around 120 TV channels at YE 2013. In April 2014, Multichoice expanded its C-band capacity on Intelsat 904 to further expand its GoTV service in Sub-Saharan Africa, including Nigeria[49].

C-band usage for TV is expected to continue to grow in Nigeria. According to Globecast[50], drivers for future C-band usage in Nigeria should include:

- High definition distribution growth
- DTT migration that will develop contribution needs to cover terrestrial head-ends
- Increase of international events taking place in Africa that will increase occasional use demand in C-band

Based on this market analysis, it is likely that any interference in the C-band would have a strong impact on the TV market in Nigeria and more particularly on the terrestrial distribution of channels in the country. The end of C-band usage would potentially impact up to 16 million households (or about 80 million individuals) in the country in the short term, and a larger number of viewers over time, as economic growth and the expansion of TV coverage, including through DTT, should enlarge the TV reach, enabling more households to access content.

# 5. Connectivity

## 5.1 OVERVIEW OF THE C-BAND SATELLITE CONNECTIVITY MARKET IN NIGERIA

The Nigerian VSAT market is estimated to be one of the largest if not the largest VSAT market in Africa when including VSAT networks operating in the C-, Ku- and Ka-band. The market was driven in the last decade by growth in the retail ISP market as well as by the liberalization of telecom services, which commenced in early 2000[51]. As a result, the market flourished, and the country had as many as 80 domestic VSAT licenses and 12 international VSAT licenses as of 2003[52]. But the market was impacted by the consecutive arrival of three new submarine networks between 2009 and 2012, resulting in prices for international bandwidth reducing by as much as 90%[53]. The retail ISP market suffered the largest contraction, as the fiber cuts and resulting unavailability of links were not as critical for such networks as the low bandwidth prices offered by fiber. As a result, the number of domestic VSAT licenses reduced to 50 and international licenses reduced to around six, as of December 2013[54].

However, critical sectors of Nigeria's economy, including oil and gas, banking, mobile communication, air navigation and public services are still dependent on VSAT services, particularly in C-band, as terrestrial networks with limited reliability and availability outside of main city centers could not replace them. The fiber penetration is more prevalent in western Nigeria, while the other parts including the conflict-affected northern regions, are still unserved or underserved by fiber.

The service provider market is large with about 25-30 domestic providers and 15-20 global and regional service providers operating in the country. Domestic providers include the national VSAT

backbone provider Galaxy Broadband Ltd, Direct-on-pc, Discoverytel Africa, MTN Nigeria, Nitel, VGCCL, Prestel, Netcom, DCC Networks, Globacom, IPNex, Excelon, Telnet, Hyperia and Airtel Nigeria.

**Ex. 8: NIGERIA - C-BAND VSATS, AUGUST 2014**

Dialogue Computer Institute, Katstina state

Kutugi Local government, Rijau, Niger State

Aba Town hall, Abia State

College of education, art & science, River state

Oyingbo River State School

Industrial Training Fund (ITF), Sokoto State

Local government, Lavuu, Niger State

Local government, Lapai, Niger State

source: Coollink, VSAT installer, Nigeria.

In addition, global and regional providers like Gateway communications, EMC, Skyvision, Hughes, Harris CapRock, Internet solutions, Bentley Walker, Intersat Africa, SAT-ADSL, i-SAT Africa, CETel and Onlime are also present in the country. Exhibit 9 tallies the networks we were able to identify from interviews with major service providers that share this market and from secondary research, coming to a minimum of about 3,740 terminals.

## EXH. 9: NIGERIA: REPORTED ACTIVE C-BAND TERMINALS, 2014

| USER | TERMINALS |
|---|---|
| **BANKING** | **~1,501** |
| ZENITH | ~360 |
| AfDB | ~1 |
| Community banks | ~640 |
| Others | ~500 |
| **Oil & Gas** | **~529** |
| NNPC | ~350* |
| Shell | ~25 |
| Chevron | 1** |
| CONOIL | 3** |
| Others | ~150 |
| **Cell backhaul & rural connectivity** | **~450** |
| Globacom | 15 |
| MTN Nigeria | 30 |
| Etisalat & MTN (managed by Discoverytel Africa) | 275 |
| Nigcomsat rural telephony | ~30 |
| Others | ~100 |
| **Government networks*** ** | **~1,202** |
| Schools | ~160 |
| Primary health care centers | ~80 |
| Local governments for MDG conditional grant scheme | ~62 |
| Locations for FRSC (Driver's license scheme) | ~136 |
| Locations for Petroleum Equalization Fund Management Board (PEFMB) | ~20 |
| Agriculture field offices | 47 |
| PAN African e-Network Project | 3 |
| Anambara State School connectivity | ~44 |
| Others | ~650 |
| **Air Navigation** | **~30** |
| NAMA (TRACON &AIS) | 20 |
| SADIS | 8 |
| Other networks | ~2 |
| **Others** | **~30** |
| UNDP | 1 |
| UNICEF | 5 |
| WHO | 8 |
| Others | 16 |
| **Total** | **~3,740** |

*Includes 300 sites to be added by NNPC by December 2014
**Includes only reported sites for Chevron and BP. The companies are estimated to have more sites, which are included in others
***Includes national public networks as well as at least one international public network

We further detail below the largest application segments for C-band usage.

## 5.2 BANKING

Nigeria has one of the most advanced finance sectors in Africa with approximately 24 banks operating in the country, including five international banks[55]. The country also has a dynamic informal financial sector, with more than 750 community banks serving more than 1 million customers as of 2006[56]. Since the occurrence of the Nigerian bank crisis in 2009, the banking sector has undergone significant consolidation as well as growth as a result of the reformatory measures taken by CBN.

- There were 89 banks in Nigeria ten years ago in 2004, with many having less than $10 million capital, but the number decreased up to 2013 primarily due to consolidation[57].
- Though the number of banks has come down, the bank branches have grown at a 10-year CAGR of more than 5% to reach over 6,000 branches in 2014 from around 3,300 branches in 2004.
- A number of Nigerian banks have also gone international since 2002, opening branches in other parts of Africa as well as in Europe and America. The West African countries, including Ghana, Gambia, Sierra Leon and Liberia, have significant presence of Nigerian banks now, with asset share of Nigerian banks in those countries going up to 40%[58].

But according to the Central bank of Nigeria, the country is still lagging behind some of its peers in Africa with respect to financial inclusion. The CBN estimates that currently 46.3% of the total adult population of 84.7 million Nigerians remains excluded from financial services at the end of 2012. This figure compares with 26% in South Africa and around 33% in Botswana and Kenya[59]. The ratio of bank branch to total population is around 1 branch for 24,224 persons. With a population of 167 million people, the country's 21 banks had only 5,624 branches and 9,676 ATMs as of August 2012, compared with 24,000 ATMs in South Africa[60]. The lack of financial inclusion in Nigeria is also stifling the growth of start-up businesses and SMEs, which are often the engine of economic growth in developing countries. The financial inclusion strategy rolled out by CBN in October 2012 is expected to lead to the expansion of the bank network at least in terms of branches, if not in the form of new banks.

The banking sector is the largest VSAT customer service segment in Nigeria. Interviews confirmed that the branch networks and core banking applications are running on C-band VSATs, though the majority of ATM networks are on Ku-band. The consolidation that happened in the banking sector since 2004 and the cost-cutting measures taken by banks have also led to more branch networking needs (ICT) and growth in the number of C-band VSAT terminals[61]. Since 2010, many banks have rationalized and cut down the number of branches due to consolidation and proliferation of e-banking platforms. However, the Apex bodies are expected to intervene as this will further reduce the financial access to Nigerians, especially those at the grassroots level. The country's broadband infrastructure is also not well equipped for adaptation of e-platforms in all regions. Meanwhile, banks like Stanbic/IBTC Bank, UBA Plc and a few others have continued to invest in branch expansion projects across the country, adding new branches[62].

According to conducted interviews and secondary information, C-band VSAT is the main e-channel choice for banks. The major banks have VSAT networks of 35-40 sites (covering all 36 states), while some have much larger networks, going up to 300 sites.

- According to a service provider, Zenith bank has deployed over 300 C-band VSAT sites between March and July 2014. Banks use C-band VSATs to support interbank networks (Metro Area Networks (MAN) and Wide Area Networks (WAN)[63].
- Vodacom has another 60 sites running on C-band for Zenith bank, providing broadband connectivity between the head office in Lagos and remote branches. This includes remote branches in Sierra Leone and Ghana as well.
- MTN Nigeria stated that they have few (<10) VSAT sites on C-band for bank networks[64].

- Equipment vendor HNS stated that they have supplied C-band VSATs for a service provider that runs around 50 sites exclusively for banks and for another service providers managing around 200 sites for banks and enterprise applications[65].
- Apart from the local bank network, international banks also have C-band remote sites running in Nigeria. For example, African Development bank has 65 sites in C-band deployed across Africa, including sites in Nigeria. The case is similar for other organizations like World Bank and VISA, which typically has 50-65 sites across Africa including those in Nigeria[66].
- In 2008, the government approved deploying 1,500 sites for community banking as well as rural connectivity services by Nigerian Postal Services (NIPOST) to reduce digital divide in rural regions. The project was earlier planned to expand with help from CBN; however, it is stalled now due to lack of funding from the government.

We estimate that the C-band VSAT market for the banking sector currently stands at approximately 1,500 sites including the community bank network. Future growth drivers could be the ongoing domestic and international expansion of the Nigerian banks, partially aided by the financial inclusion project of CBN.

## 5.3 OIL & GAS

Nigeria is the largest oil producer in Africa and was the world's fourth leading exporter of LNG in 2012. The oil and gas industry accounts for 75% of the Nigerian government's revenue and up to 95% of export earnings according to IMF. The oil and natural gas industries are primarily located in the Niger Delta region, where they have been a source of conflict. Oil production, which reached its peak in 2005, began to decline significantly as violence from militant groups surged, forcing many companies to withdraw staff and shut down production. Oil production recovered somewhat after 2009-2010, but still remains lower than its peak because of ongoing supply disruptions and oil theft commonly referred to as "bunkering." According to the Central bank of Nigeria, the country lost $7 billion in revenue in 2011 due to oil theft, which is about a quarter of the country's national budget[67].

Nigerian National Petroleum Company (NNPC) is the leading oil and gas company in Nigeria with more than 60% market share[68]. In addition to its own projects, the company holds a major share in a number of major oil and natural gas projects, which are funded through joint ventures (JV) between international oil companies (IOCs) and NNPC. The international oil companies include Shell, Exxon Mobil, Chevron, Total and Agip. IOCs participating in onshore and shallow water oil projects in the Niger Delta region have been affected by the instability in the region. As a result, there has been a general trend for IOCs to sell their interests in marginal onshore and shallow water oil fields, mostly to Nigerian companies and smaller IOCs, and focus their investments on deep-water offshore projects[69].

The oil and gas industry is a large and growing segment for C-band VSATs in Nigeria, particularly in terms of bandwidth usage per site. The service level availability requirements for the oil and gas segment typically is above 99%, which can only be met by C-band VSATs. For example, according to the national producer NNPC, they have used only C-band VSATs since its beginning in 1977, as all of their remotes are in high rain areas where during rainy season Ku-band links are cut for around three hours per day on average. Even by using C-band, the company is only able to achieve around 98% availability due to power outage issues. VSATs are used for providing high-density mesh voice and fax and data interconnectivity between sites and the head office. They are also used for monitoring pipelines and petrol stations, through live streaming of metering data on the level/volume of product (crude oil, petrol, kerosene, etc.) carried through pipelines and stored at stations. According to conducted interviews, oil and gas companies involved in exploration and production have typically around 20-25 sites. The companies involved in both production and distribution use 50-60 sites, with the largest networks going up to 350 sites.

- NNPC currently has approximately 50 remote C-band sites managed by global service provider Gilat Satcom, mainly for pipeline monitoring. The sites are spread across the country including presence in all 36 states. The company uses 2 to 5 Mbps C-band links to connect their eight nodal stations and also 512 to 1000 Kbps links to connect their 42 petrol stations, utilizing in total around 20 MHz of C-band capacity. The number of sites has grown by about 25% in the past five years. The company is currently in the process of adding 300 more sites by the end of 2014, to connect their retail franchise petrol stations. These new sites will be carrying comparatively lower data rates at 256 to 512 Kbps and will be increasing the current bandwidth usage from 20MHz to 36MHz of C-band capacity[70].
- Global satellite service provider ITC global manages around 40 sites in Nigeria for oil and gas companies using around 95 MHz capacity[71].
- One European satellite service provider has stated that they manage around 50 C-band sites for oil and gas companies in Nigeria. Approximately half of these sites are i-Direct TDMA sites and the rest are SCPC sites. In total, the sites use around 20 MHz capacity (40 Mbps), including another 15 sites for mining construction companies[72].
- Hughes manages fewer than 50 sites in Nigeria for oil and gas construction companies. According to HNS, their customers typically have around a few dozen VSATs per network[73].
- One Nigerian service provider stated that it has three sites for their customer CONOIL. The sites are 3E1 (~7 Mbps) links and use around 11 MHz of C-band capacity in total. The company now plans to add a few more sites (less than five) for CONOIL and also for a new oil and gas customer in the coming months[74].
- The leading satellite provider in the region, SkyVision, has won a five-year contract from South Atlantic Petroleum (SAPETRO) in 2014 to provide voice and data solutions and services to connect the company's offices and operational sites[75]. Anticipating the growth potential in the oil and gas market, SkyVision has been in the process of the establishment of hubs and PoPs in Lagos and Abuja over the past decade.
- Another international firm, Nigerian Agip Oil Company Limited (NAOC), also intends to expand their C-band VSAT connectivity for national operations and invited RFPs from service providers in February 2013[76].
- Shell has released an RFP in July 2012, for provision of two C-band hubs and around 25 remotes including bandwidth provisioning, for connecting its offshore sites with hubs in Port Harcourt and Lagos[77].
- Chevron Nigeria Ltd invited an RFP in May 2011 for provision of a 6 Mbps international VSAT link for two years with an option of one more year of expansion. The minimum SLA requirement for the link is 99.99% availability per month[78].

We estimate that the C-band VSAT market for the oil and gas segment counts up to 550 units including those for exploration, construction, production and distribution. The majority of the sites (65%) will be used in the distribution segment, including 300 new TDMA sites installed by NNPC to connect retail petrol stations by December 2014. Other companies should mainly use SCPC links with data rates typically above 1 Mbps to connect to their exploration and production sites.

The future growth driver could be the several upstream deep-water projects scheduled to come online within the next 10 years, including five new projects by Chevron and Shell each[79]. Along with the new site deployments, one service provider also pointed out that the new applications like HD video transmission from offshore remotes are now driving the bandwidth leased by their customers[80]. The government is also liberalizing the DRP (Department of Petroleum Resources) and VSAT license regime in the country, allowing international service providers to provide satellite connectivity services directly to customers in the country. Typically, international energy companies operating in Nigeria, requiring satellite or fiber networks, earlier were forced to use small, local providers with limited capacity. C-band usage for connectivity should increase as customers are able to leverage one vendor for their connectivity requirements in Nigeria and in the rest of Africa. Global VSAT provider EMC was awarded the first DRP license in October 2013. However, the developments of the new

projects will still depend on passing the Petroleum Industry Bill (PIB 2008), which would have removed the regulatory uncertainties, making deep water exploration projects financially unviable[81].

## 5.4 GOVERNMENT NETWORKS

In Nigeria, government networks were established with the objective of achieving national development through the provision of ICT infrastructure, which can provide reliable services to public institutions, underserved communities and other stakeholders[82]. Government networks are used for providing ICT services including financial services, e-governance solutions, national ID management systems, tax services, e-agriculture and polling information to federal ministry departments and agencies (MDAs). They are also used for supporting rural development, tele-education and telemedicine programs. The Galaxy backbone system was established by the Nigerian government in 2006 to support the above services in a fully commercial manner to public service entities and underserved communities in the country. The system includes a VSAT network and one MPLS backbone, which currently support National Information Communication and Education Programme (NICEP) and the National ICT Infrastructure Backbone (NICTIB) projects. The projects are expected to bring significant cost savings of around $70 m per year by 2011 through economies of scale[83].


Galaxy earth station

The NICEP project is conceived as a national VSAT network that will support 5,000 sites deployed across the 36 states and 774 local government areas in the country with NOC located in Abuja[84]. Though the system is planned in both C- and Ku-band platforms, about 40% of the sites are expected to be deployed in C-band, as two out of the five hubs are in C-band and also considering the various project RFPs listed below indicating requirements in C-band[85]. According to Galaxy Backbone Ltd, they are now connected to over 4,000 locations nationwide via VSAT and fiber media, as of 2014. The major government network deployments as of 2011 are detailed below.

**Exh. 10: NIGERIA – REPORTED SITES FOR GOVERNMENT NETWORKS IN 2011[86]**

| APPLICATION | VSAT SITES |
|---|---|
| Schools | 400 |
| Primary health care centers | 200 |
| Local governments for MDG conditional grant scheme | 154 |
| Locations for FRSC (Driver's license scheme) | 341 |
| Locations for Petroleum Equalization Fund Management Board (PEFMB) | 51 |
| **Total for reported government VSAT sites** | **1,146** |
| **Out of which C-band VSAT sites** | **458*** |

*40% of total sites assumed as C-band sites

We detail below a number of other identified networks and requirements, which we do not consider to represent an exhaustive list.

- In a press release by Galaxy Backbone Ltd in February 2008, they announced the arrival of the first batch of the NICEP equipment, made up of a hub and 250 VSAT nodes for deployment to NIPOST/NETPOST, NDLEA, Unity Schools, and federal universities, FRSC, UBEC, NAN, Ministry of Energy, Osun and Delta States. According to Galaxy, actual rollout of the first phase, consisting of 2,500 VSAT nodes, was expected to commence in March 2008[87].
- According to GBL, they delivered 110 VSATs to Anambara state school connectivity program in February 2010[88].
- The ICT-Based Agricultural Extension Service Delivery (IAESD) proposed requirement of C-band VSAT system for delivering e-agriculture services in Nigeria in December 2013[89].
- Nigeria's government budget for 2012 allotted NGN63 million ($400,000) for five iDirect C-band hubs and 47 C-band VSATs for connecting the agriculture agency headquarters and state field offices[90]. The ONDO state budget for 2014 reported to spend a total of NGN48 million ($293,000) during the 2012-2013 period and also allocated NGN30 million ($183,000) in 2014 for paying subscription and maintenance of VSATs installed for government projects[91].
- Telecommunications consultants India Limited released a bid for annual maintenance contract for HUB Station at Senegal and VSAT locations in 48 African countries under the PAN African e-Network Project[92]. This includes three C-band VSAT sites located in Nigeria as well[93].
- The Cross Water state in Nigeria has proposed a C-band VSAT network for the integrated information system for efficiently managing the water supply in May 2006[94].

We estimate that the C-band sites for government projects as of mid-2014 stand at approximately 1,200 units, assuming around 75% of the Galaxy Backbone locations are connected by VSATs. These VSATs are served primarily by capacity on Nigcomsat-1R. There should also be a few tens of sites managed by other organizations like the pan African e-project for tele-education and telemedicine services. The NICEP project will be extended to another 1,000 locations in the coming years. The lack of funds had been a deterrent for the project growth, as it stalled expansion of NICEP and NIPOST networks, which started to roll out in 2008[95]. The government signed a loan deal with China for $1.1 billion to boost its public priority project including Galaxy Backbone in November 2012. GBL is estimated to receive $100 million aid out of this $1 billion loan, which should help them to complete the projects by 2015[96]. Other major challenges for the expansion of ICT infrastructure in the country have been the issues of power and theft, which increases the overall cost of access. Power supply across the nation has been the most significant issue as almost 40% of VSAT sites deployed by Galaxy have solar power systems integrated to support public power source[97]. To address the power issues, Galaxy has collaborated with MDAs to work on repairs of their installed power systems and also provided backup power for critical segments.

## 5.5 CELLULAR BACKHAUL AND RURAL CONNECTIVITY

Nigeria is Africa's largest mobile market with more than 110 million subscribers. The subscriber growth, which slowed down after reaching the 100 million mark, accelerated again in 2012 (20% annual growth), driven by lower prices and a growing demand for mobile broadband services. The four leading operators, MTN Nigeria (42%), Globacom (22%), Airtel Nigeria (20%) and Etisalat Nigeria (13%), together hold over 96% of the total subscriber base. There are another four to five small operators, including the public MNO M-Tel holding the remaining 4% of the market. The GSM operators have barely been able to keep pace with their infrastructure rollout to support the ever-increasing subscriber growth, which has led to severe problems with network congestion and quality of service.

There are now over 20,000 BTS stations installed across the country, with market penetration at only around 70% in early 2013. Much of the remaining addressable market is in the country's rural areas where network rollouts and operations are expensive. The operators are now investing additional billions of dollars to expand their coverage and capacity, partly due to sanctions imposed by government as well as supported by USO programs. For example, in 2007, NGN65 billion ($40 million) was released for the provision of GSM mobile infrastructure in rural areas across Nigeria as part of the National Rural Telephony Program (NRTP). According to the Association of Licensed Telecommunications Operators of Nigeria (ALTON), the number of BTS should increase to around 75,000 to address the total population[98].

According to the conducted interviews and available secondary information, C-band is the main choice for mobile operators to ensure the quality of voice calls. A few of the identified C-band VSAT networks include:

- Globacom Nigeria stated that they use around 43 MHz of C-band capacity to backhaul over 15 sites for Glomobile and Glo gateway services. Most of these 15 sites are for providing MSC to MSC links carrying high-data traffic in the range 3 E1s (around 7 Mbps), while there are few sites to connect BTS to BSC (Abis) links. Some of the sites are also used for providing gateway connections with their other operating countries including Ghana, Benin and Cote d'Ivoire[99].
- According to MTN Nigeria, they have around 30 sites using in total around 72 MHz of C-band capacity[100].
- According to satellite service provider Discoverytel, they manage around 275 sites, mostly in the northern part of Nigeria for Etisalat and MTN. According to them, the majority of the backhaul sites (>90%) in western Nigeria have now migrated to fiber due to cheaper cost[101].

Though the dependency on satellite has reduced in the past two to three years with the arrival of three undersea cables, mobile operators in Nigeria still use a significant amount of satellite capacity for domestic and international gateway traffic. The government removed restrictions on international gateways in 2006, enabling GSM operators with their own gateways to carry third-party traffic. There are now six international gateway licenses issued in Nigeria. A few examples of gateway contracts include:

- MTN uses the satellite network of Gateway Communication Ltd (former GS Telecom, and now part of PCCW), connecting Lagos, Port Harcourt and Abuja, to carry mobile traffic and to provide international connectivity to the U.K.[102].
- Etisalat has signed a two-year contract with Gateway Communications Ltd. worth $6 m in 2010, to provide satellite backhaul for two years, connecting three major cities[103].

We estimate that the C-band sites for backhaul and trunking currently stand at around 350 units based on reported deployments. Capacity usage should be around 350-360 MHz as a significant share of sites (around 20%) will be used for providing high-traffic gateway and trunking connectivity.

As of January 2013, Nigeria has over 406,000 fixed-line subscribers representing 0.2% penetration. The average monthly income in rural Nigeria is just NGN5,000 ($34), making many areas unviable for telecom network operators[104]. The government has therefore launched a number of initiatives aimed at subsidizing the rollout of infrastructure in rural areas.

- The National Rural Telephony Programme (NRTP) was proposed in 2004 to provide 500,000 new lines in 343 local government areas (LGA) within a year through an investment of NGN28 billion ($200 million). However, since the program had a slow progress, the government handed over the project to five private companies in 2009. According to the ministry of communication, the first phase of the projects is expected to start by March 2014[105].
- In 2009, the government approved $12 m for the installation of 1,500 VSATs for the Nigerian Postal Services (NIPOST) to reduce the digital divide in rural areas. The program was proposed to provide rural telephony, Internet as well as community banking services in partnership with Central Bank of Nigeria (CBN). Though the system is planned in both C- and Ku-band platforms, about 40% of the sites are expected to be deployed in C-band, as two out

of the five hubs are in C-band. However, lack of funds is holding up the deployments as of 2012 and substantial investment including support from CBN is required to renew it[106].

> The government also had plans to offer rural telephony end-user services at NGN10 ($0.08) per minute directly through Nigcomsat satellite capacity. However, the Nigerian Communication Commission (NCC) has rejected this proposal, as these services will be in direct competition with other Nigcomsat customers. To resolve the situation, the President of Nigeria agreed in August 2008 to the transfer of 15% of the government's shares in fixed-line operator Nitel to NigComSat, to pave the way for NigComSat to offer direct telecom services to Nitel subscribers. NigComSat had implemented 78 community telecommunications centers across the country as of 2013 and also forged co-operation agreements with Galaxy Backbone and ISP Linkserve[107].

We estimate the C-band sites used for rural connectivity to stand at around 100 sites, considering about 40% the sites are expected to be deployed in C-band.

## 5.6 AIR TRAFFIC MANAGEMENT AND METEOROLOGY DATA DISSEMINATION

Air transport is a key driver of the ongoing transformation of Nigeria's infrastructure. The growth in both domestic and international passenger traffic in the country had been around 20% per year as reported in 2011. Nigeria is positioning itself to take advantage of both its substantial 150 million population and its advantageous location at the center of Africa to promote the state as an air transport hub for West and Central Africa. For this, the country is working on new projects in Lagos and Abuja through public private partnerships (PPP), so that new routes to Europe, the Middle East, Asia Pacific and the Americas will fuel future growth[108].

While the Nigerian Civil Aviation Authority (NCAA) is the regulatory body for aviation activities in the country, the Nigerian Air Space Management Agency (NAMA) and the Nigerian Meteorological Agency (NIMET) oversee the air traffic management and weather information management, respectively. Both agencies use VSAT networks for air navigation management services in Nigeria, as terrestrial network deployment for managing such networks are both challenging and not reliable as there are frequent fiber cuts and network outages[109]. According to the regional service provider ATNS, C-band is the preferred band for ATM services and meteorology data dissemination.[110] Reasons for that are:

> The wide footprint of C-band covers all of Africa. This ensures seamless communication and single-hop voice communication, which is critical for air traffic management.
> Rain fade, which make the use of higher frequency bands (e.g. Ku-band) for air traffic management too unreliable.

A few of the identified C-band VSAT networks in Nigeria include the following:

> NAMA installed a VSAT backbone infrastructure to carry VHF voice (air to ground/controller to pilot), ATS DS (ground to ground/controller to controller), AFTN, radar data, video and Internet at eight airports and one non-airport location in 2010. This network should at least have 20 C-band sites for both TRACON (10 sites) and AIS automation projects (10 sites)[111].
> There are another eight C-band sites deployed under the Satellite Distribution System for Information Relating to Air Navigation (SADIS) network at the airports as of May 2014. These sites are for providing aeronautical meteorological information for the safety of flight operations[112].

Based on reported deployments, we estimate the number of air traffic management and meteorology data sites to stand at around 30 VSATs in Nigeria.

## 5.7 OTHER NETWORKS

Other key C-band connectivity users in the country are international and non-government organizations (NGO) active in humanitarian aid in the region as well as international corporations

present in agriculture, retail and trading sectors. C-band is often privileged, as NGOs and corporations often need wide pan-African coverage and connectivity to their corporate headquarters located in the U.S. or Europe. Part of their operations is also located in areas where C-band is more reliable.

Our research identified the following examples:

> The United Nations Development Programme (UNDP) requested the supply and installation of C-band VSAT solutions for various UN agencies in Nigeria, as follows, in May 2012[113]:

**Exh. 11: NIGERIA – UN VSAT C-BAND SITES**

| AGENCY | VSAT SITES | TRAFFIC PER SITE | CAPACITY |
|---|---|---|---|
| UNDP | 1 | 2.8 Mbps | 2.8 Mbps |
| UNICEF | 5 | 2 Mbps (4 sites), 3 Mbps (1site) | 11 Mbps |
| WHO | 8 | 768 Kbps | ~7 Mbps |
| **Total** | **14** | | **~21Mbps** |

> NGO "Save the Children" invited tenders to provide C-band capacity for three years to operate their 33-site network (~10 Mbps) in Africa including one site in Abuja in January 2014[114]

Overall, we estimate the number of C-band sites for NGOs and corporations to be at least 25-30 units.

# 6. Socio-economic benefits

The previous sections have highlighted both the diversity and importance of satellite C-band usage in Nigeria. The reported usage involves both the public and private sectors, and ultimately underlies services touching a very large part of the population on a daily basis and impacting major economic sectors.

Exhibit 12 provides a synthesis of the findings of our research on current C-band usage. It does not include full findings on the potential development of C-band usage for several segments, with further details being presented in the previous sections.

Three particular impacts can be highlighted:

> The presence of a **specific ecosystem of companies** specialized in satellite communication services, with a direct investment in C-band capacity. Many of these companies, and their employees, are at the top of the country's high-technology sector.

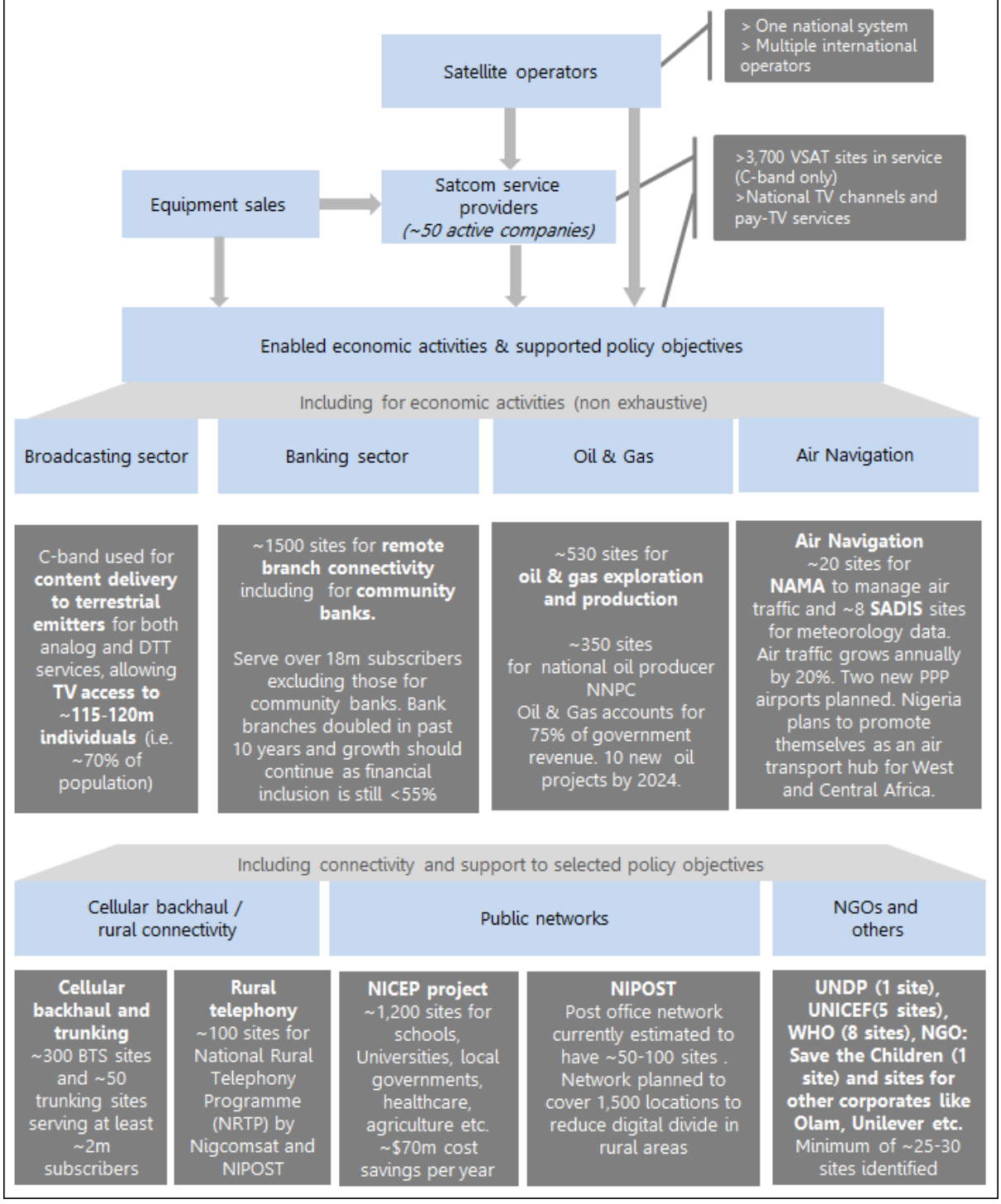
> The role of C-band is as an **enabler of major economic activities**, notably television, banking and oil and gas.

> The importance given to C-band is in efforts to bridge the digital divide, provide **uniform connectivity**, to **improve government efficiency** and for **critical services** such as air traffic management.

The following table summarizes sources for key assumptions supporting Exhibit 12.

| SEGMENT | NOTES ON ASSUMPTIONS |
|---|---|
| Satellite operators | Derived from separate Euroconsult research [115] |
| Satcom service providers and gray box | Channels – see page 21; VSAT sites see Exh. 9 |
| Broadcasting sector | See pages 21-26 |
| Banking | See pages 29 |
| Oil & gas | See page 30 |
| Government networks | See pages 32-33 |
| Cellular backhaul / rural connectivity | See pages 33-34 |
| Air traffic management and mete data dissemination | See page 35 |
| NGOs and others | See pages 35-36 |

**Exh. 12: NIGERIA: SYNTHESIS OF SOCIO ECONOMIC IMPACT OF SATELLITE C-BAND USAGE**



# C-BAND USAGE IN DEMOCRATIC REPUBLIC OF CONGO (DRC)

# 7. Country overview

DRC is the fourth-most-populated nation on the African continent with over 65 million people in 2012[116]. The country's population has been growing at approximately 2.7% p.a. over the past five years.

The country is divided into 10 provinces and one city-province. The provinces are further subdivided into districts and then into territories. Major cities include capital Kinshasa, Lubumbashi and Goma. Population density in DRC was last measured at 29 people per km2 in 2012, according to the World Bank. DRC has an average household size of around five people. In terms of demographics, more than 45% of the country's population is below the age of 14, and more than 52% currently fall into the working-age group of 15-64.

The country of 2.3 million km2 is located in the center of Sub-Saharan Africa and has a varying topography, with plains in the center surrounded by tropical rainforests and mountainous regions. As a result of its equatorial location, the DRC experiences high precipitation and has the highest frequency of thunderstorms in the world. The annual rainfall can total upwards of 2,000 mm in some places, and this sustains the Congo Rainforest, the second-largest rain forest in the world after the Amazon. The rainy season typically last from October through May every year.

Though the country has a vast potential of natural resources and mineral wealth, economic development has been hampered by recurring insecurity and armed conflicts over the past decades. Still, economic growth has been sustained in recent years, with a reported GDP growth higher than 6% in all years between 2007 and 2013 (except for 2.9% growth in 2009), including a peak growth of more than 8% in 2013[117]. Recent growth has been overall supported by the mining, trade, construction, agriculture and communication sectors. Mining has been the main driver of growth, and several mining companies have passed from exploration to production since 2013. Growth is expected to remain at around 8.5% in 2014 and 2015, to be driven by mining (copper, cobalt and gold), reconstruction of roads and energy infrastructure investments, and by the impact of the agricultural campaign launched in 2012[118]. Agriculture accounted for almost 45% of the GDP in 2012.

# 8. Television broadcasting

## 8.1 ACCESS TO TELEVISION

While television currently represents the second media in DRC in terms of reach-behind radio, reception of TV channels remains still limited to a relatively small fraction of the population.

The primary limiting factors to TV reception are power availability and the purchasing power of households. According to statements in RDC Senate, only around 9% of the population had access to power in 2013[119]. In Kinshasa, only 44% of the 9.5M inhabitants have access to power[120]. Considering the total population of approximately 65 million, the statements suggest that approximately 6 million individuals have access to power including around 4 million in Kinshasa.

Sources say access to TV of households remain limited, but tend to suggest a higher penetration than the one suggested by power availability.

A demographic survey conducted by the DRC government in 2007[121] found the following:

- Ownership of TV sets stood at 14% on average for DRC households with 34.2% in urban areas and 0.6% in rural areas. Considering population, this corresponded to an average penetration of 17% (urban 38.5%, rural 0.9%).
- Access to TV viewing at least one time per week stood at around 40-50% in urban versus 2-4% in rural areas, and at a global average of 25% in the country.

Another report provided access information focusing on the main cities and other localities, as detailed in Exhibit 13. Overall, results of the two sources appear relatively consistent.

**Exh. 13: DRC - ESTIMATED ACCESS TO TV SETS IN 2008[122]**

| CITY/AREA | TOTAL POPULATION (MILLION) | REPORTED ESTIMATE % OF ACCESS TO TELEVISION | RESULTING POPULATION WITH ACCESS TO TV (M) |
|---|---|---|---|
| Kinshasa | 9.5 | 97% | 9.2 |
| Lubumbashi | 2 | 90% | 1.8 |
| Matadi | 0.3 | 92% | 0.3 |
| Mbuji Mayi | 1.7 | 82% | 1.4 |
| Bukavu | 0.8 | 65% | 0.5 |
| Kisangani | 0.9 | 61% | 0.5 |
| Rural localities | * | 10% to 48% | * |
| **Total for reported cities** | **15.2** | | **13.8** |

*The number of assessed localities and associated population was not available

The relatively high access to television compared to power access (e.g.: 97% versus 44% in Kinshasa) can be explained by the shared viewing of TV programs, whereby one TV set can be watched by more than one family. Assuming an average access of 5-15% of the population not directly reported in the table above suggests that approximately 15-20 million individuals would have access to television, or 23-30% of the population.

The primary reception mode for television is through a network of 53 terrestrial emitters currently operated by Teleconsult broadcasting channels in analog format. These emitters are concentrated in cities with access to power. Plans for the deployment of digital terrestrial television have been discussed in DRC, according to the objective agreed with ITU of an analog switch-off occurring no later than in 2020. So far, 12 DTT emitters have been installed by Teleconsult, and tests have been conducted.

Primary challenges for the rollout of DTT include:

- The investment and operation cost of TV transmission and services: in DRC, the advertising market is currently very limited and not well structured. One source stated an advertising revenue of around $3 per second combined with a very limited number of advertisers (including mobile operators). In addition, no tax is currently in place to support public broadcast operations. As an outcome, transmission costs (for investments and operations) have to be covered by the government budget.
- Regulatory decisions including frequency allocations—decisions remain to be made regarding the allocation of frequencies to DTT and the licensing process with channels.
- Technical choices—largely connected to previous points, different technical choices are currently pending, including, for example, the use of the DVB-T2 standard as a potential replacement for current DVB-T transmissions.

Technically, the DTT network could support the broadcast of about 12-13 national channels (with potential local versions) as well as up to 20 local channels. This, however, would again depend on future technical and regulatory choices.

In the middle term, the rollout of a DTT network could facilitate an extension of the terrestrial TV coverage. Trials have been conducted for the use of solar panels in support of emitting stations. Teleconsult stated that while five to six analog antennas are usually required per emitting station, a single antenna would be sufficient for DTT transmission. And while the power consumption of a DTT antenna is higher than that of an analog antenna, the overall power consumption of a station would be significantly reduced. This, combined with a new generation solar panels, could make the use of solar power relevant for TV transmission.

Direct-to-home satellite TV reception appears to be very limited in DRC:

- Considering pay-TV services, five services are currently available including DSTV Africa, My TV, CanalSat, Afrique and TV Sat Africa. All those services are transmitted in the Ku-band. Although no detailed information is available on subscriptions in DRC, total subscriptions for those services in Africa is estimated at approximately 2.9 million. Considering the reach of those platforms (more than 10 countries) and their main markets (ex: Nigeria for DSTV Africa), we estimate that subscriptions in DRC should represent no more than 3-5% of total subscribers, i.e. no more than 90,000-150,000 subscribers in total.
- Free-to-air satellite reception in the C- and Ku-band is also estimated to be limited. The two primary inhibitors include the access to power as well as the purchasing power in the country and the penetration of TV sets. According to the United Nations Development Program (UNDP), around 88% of the population has a purchasing power parity of $1.25 per day[123]. No real counting or reporting of receiving antennas has been conducted. One study in 2000 identified 318 receiving antennas in Lubumbashi (for a population of 1 million) at the time[124]. In total, such reception antennas would likely not represent more than dozens to a few hundreds of thousands of dishes. Most of these would likely be for Ku-band reception, as suggested by the different interviews conducted.

## 8.2 CHANNEL OFFERING AND C-BAND UTILIZATION FOR THE BROADCAST SECTOR

The total number of channels in DRC currently stands at about 80, of which about 50 are only available in Kinshasa. Out of these, only a few channels are present on a national scale (i.e. in all locations covered by terrestrial emitters) or at least in multiple cities. These include:

- The Radio Télévision Nationale Congolaise (RTNC)—the state broadcasting corporation, which operates two channels including a national channel and a second entertainment channel in Kinshasa coupled with regional stations;
- The RTG private channel of the Radio Television Groupe l'Avenir, which is present in different cities of the country; and
- Digital Congo TV, a private TV station co-owned by Croatian journalist Nicola Vadjon and Jaynet Kabila, which is also present in all provincial capitals.

Many channels have been reported to be operated by religious interests and political personalities, and to be economically fragile.

Téléconsult is in charge of the operation of terrestrial TV transmissions. Channels are distributed to terrestrial emitters through a multiplex of channels using 17 MHz of capacity on the Rascomstar QAF 1R satellite. The choice of the C-band is due to the stability of transmissions that are not impacted by weather conditions. With a guaranteed availability of 99.9%, Téléconsult never faced a total interruption of TV transmissions in DRC, which could happen with Ku-band distribution. The company also confirmed that C-band transmission would most likely be used to support a potential future DTT network, with no relevant alternative.

As a consequence, any interference in the C-band would impact the distribution of channels in DRC and potentially impact up to 20 million individuals in the country in the short term and a large number of the viewers over time, as economic growth and the expansion of coverage, including through DTT, should enlarge the TV reach.

# 9. Connectivity

## 9.1 OVERVIEW OF THE C-BAND SATELLITE CONNECTIVITY MARKET IN DRC

The political instability since the mid-1990s has deterred development in the DRC, and as a result, the national telecom system is one of the least developed in the region. Rural areas, where almost 70% of the population resides, are still virtually devoid of telephone or Internet service[125]. Satellite communication plays a major role in the communication sector given that the country is landlocked and fiber connectivity is only progressively rolled out. The key economic growth sectors like mining, oil and gas, telecommunication, and banking utilize VSAT as a key communication channel for applications including backhaul, remote and backup connectivity. Many of these networks rely on C-band for primary or back-up connectivity, as they demand much greater reliability than rain fade would allow in other frequency bands.

The supply and use of C-band-related services currently involves a large number of organizations in DRC. The government has issued VSAT licenses to over a dozen private players. The telecom regulator ARPTC's recent decision in September 2012 to limit the number of VSAT licenses to only three players—Vodacom, Cybernet and Ragasat—was later overturned by the Ministry of Communication in December 2012. The ministry stated that it would be unfair to other players in the market[126]. The other major domestic players in the market include Microcom, Celtel Congo, SATTEL International, Afrinet, Cielux, Global Broadband Solutions, Paconet and I-burst. In addition to this, global and regional service providers like Sky Vision, Hughes, Gilat, Bentley Walker, EMC, i-Sat Africa, i-Way Africa and Harris CapRock, as well as some European teleport providers like CETel, Onlime and Global TT, are also present in the country. In addition, a specialized company, Teleconsult, is in charge of managing the terrestrial network for TV transmission.

A recent major initiative in DRC has been the signing in 2012 of a procurement agreement with the China Aerospace & Technology Corporation (CASC) and China Telecom to place the country's first satellite, CongoSat-01, into orbit within three years. DRC is the second African country after Nigeria to ink a satellite delivery contract with China[127]. Part of the payload on the future satellite will be in the C-band, with the satellite also having Ku-band and Ka-band capacity onboard.[128] The project should give a renewed importance to Renatelsat, a state agency historically in charge of providing satellite connectivity and video transmission solutions for the country.

### Exh. 14: DRC: REPORTED ACTIVE C-BAND TERMINALS, 2014

| USER | TERMINALS |
|---|---|
| **MNO & ISPs** | **~800-1,000** |
| Orange | ~200-500 |
| Others | ~300-500 |
| ISPs | ~70 |
| **Banking** | **~150** |
| BCDC | ~40 |
| TMB | ~20 |
| Others | ~90 |
| **Public Services and Education** | **~136** |
| Ministry of finance—Tax services | ~10-11 |
| Ceni-Election commission | ~15 |
| Police network | ~50 |
| Régie des Voies Aériennes (RVA)—Air Traffic management | ~12 |
| Satellite Distribution System (SADIS)—Meteorology information | 1 |
| Régie de Distribution D'eau de la République Démocratique du Congo (REGIDESO)—Water distribution management | ~8 |
| Ministry of Education (EPSP )—School connectivity | 29 |
| Universities (UNIKIS, UCB, ISTA, UPN, UNIKIN, UNILU and UCC) | 7 |
| Pan-African e-Network project (Tele-education & Telemedicine) | 3 |
| **International Organizations and NGOs** | **~300** |
| United Nations High Commissioner for Refugees (UNHCR) | ~10 |
| Directorate General Humanitarian Aid and Civil Protection (ECHO) | ~3 |
| US Agency for International Development (USAID) | ~3 |
| United Nations Office for Projects Services (UNOPS) | ~4 |
| Oxfam | ~13 |
| UNICEF | ~12 |
| United Nations Mine Action Coordination Centre (UNMACC) | ~9 |
| United Nations Interim Security Force for Abyei (UNISFA)* | ~40 |
| Save the Children (NGO) | ~4 |
| Others | ~201 |
| **Mining and Oil & Gas** | **~250** |
| SEP Congo | ~30 |
| Perenco | ~5 |
| Others | ~215 |
| **Other Networks** | **~3** |
| Delmas Groupe | 2 |
| MAERSK Congo RDC Company | 1 |
| **Total** | **~1,839** |

* Spread across DRC and South Sudan

Below, we further detail the largest application segments for C-band usage.

## 9.2 CONNECTIVTY

C-band is currently used both for cellular backhaul that represents a major application and for ISPs offering Internet access.

The development of the mobile communication market is still relatively limited in DRC, with:

- Approximately 15 million people owning a SIM card out of a potential market of around 45 million[129], corresponding to a penetration rate of about 30% of the addressable market and 23% of population.
- 25 to 30 million mobile subscribers, taking into account the fact that many subscribers own at least two lines, partly due to interconnection issues between mobile networks.

The market has largely increased since 2011 when the regulator Autorité de Régulation des Postes et Communications (ARPTC) estimated the market at 11 million subscribers[130]. It keeps however a large growth potential across the country.

The five cellular operators, Vodacom, Airtel, Tigo, Orange and Africell, have all expanded their subscriptions and coverage in recent years. Market leaders are Vodacom with close to 8 million subscribers and Airtel with around 7 million subscribers, according to estimates from Budde Telecom in March 2013[131]. Orange DRC had around 2.3 million subscribers at the end of 2011 and claims to have experienced a yearly growth or about 20% of its revenues since then[132], suggesting about 3 million subscribers at the end of 2013.

**Ex. 15: DRC – C-BAND SITES, AUGUST 2014**

Site for terrestrial TV transmission in La Gombe

VSAT sites of the Central Bank of Congo (Kindu, Kisangani)

Microcom teleport (Kinshasa)

Source: Teleconsult, Global Broadband Solutions , Microcom

As DRC lacks terrestrial backbone networks in the largest part of the country, satellite remains a primary option to connect a large part of mobile networks and at least a backup network in other areas. Different interviews that we conducted have confirmed the importance of satellite connectivity for mobile operations in the country.

- Comtech EF, a leading modem supplier for high-end customers requiring SCPC (i.e. dedicated) links, stated that majority of their sales in Africa were for DRC and Angola in recent years[133], suggesting an average of around 400 C-band-supported terminals per year for the two countries. Considering that cellular operators are leading customers for those solutions

(likely over 75% of terminals in DRC), this could suggest average sales of at least 150-200 units per year.

> CETel is servicing around 50 sites for cellular backhaul and around 10 for ISPs.
> Hughes has around 100 terminals used by a mobile operator[134].
> A service provider stated that it is supplying over 500 Mbps of capacity to Orange DRC, and that it is only one of two capacity suppliers for the telecom operator[135]. With an estimate of 1-3 Mbps per cellular site, 500 Mbps suggests the support of approximately 200-500 cellular sites and suggests a large overall cellular network supported by satellite. It is noteworthy that part of the capacity also supports trunking between the three main cities.
> A mobile operator (different from Orange Congo) operating in multiple countries in SSA contracted 1.3 Gbps C-band backhaul capacity with a single satellite operator in 2012 and upgraded its lease for next year to 3.5 Gbps. While the contract was for 17 countries, a significant amount of capacity was estimated to be for DRC operations. In November 2012, Vodacom signed an agreement with Intelsat for new capacity on C-band, apparently as part of its plan to extend its 3G network in DRC[136].

Mobile operators demand high availability and high redundancy for BSC-BSC and BSC-MSC connection. Large size C-band antennas at hubs tend to give better performance with the option to use lower-size 1.8m C-band antennas at remote sites. In the event of migration to higher frequencies, both modems and RF units should be changed, including the redundant systems. So, the cost would be anywhere between $40-80K per terminal for BSC site migration according to Comtech[137].

Overall, researched information in the course of this study, as well as information previously researched in a study on cellular backhaul that we released in 2013, suggests C-band satellite links support at least 800 to 1,000 mobile BTS in DRC today.

Considering Internet service providers, five ISPs are currently licensed, while over 70 companies apparently provide Internet connectivity in Kinshasa[138]. ISPs are currently using C-band capacity either as a primary backbone network for International connectivity or as a backup option now that fiber progressively is becoming available. The two ISPs that we interviewed confirmed their use of multiple hubs in different cities of DRC in support of their WLLs. One of the interviewed ISPs is currently using approximately 200Mbps for its Wimax/WLL networks. While an increasing number of Internet subscribers should progressively move to 3G connectivity for Internet access, ISPs should continue to play a significant role in the coming years and serve a mix of private and business users.

While satellite connectivity and wireless local loops used to be the only backhaul options to connect mobile BTSs, the launch of the West African Cable System (WACS) that got delayed until June 2013 will provide another backbone option in at least part of the main cities in DRC. However, the initial rollout has highlighted a number of issues with regards to the actual data rate available and to the reliability of transmissions[139]. This should push ISPs and cellular operators to maintain the use of satellite network, either as primary network or for backup purpose.

One interviewed ISP stated in July 2014 that despite the arrival of fiber in Kinshasa, they would maintain at least the same volume of satellite connectivity for the coming year and would continue to use satellite over the long term. Another service provider based in Europe has contracted 72 MHz of C-band capacity in May 2014 for providing IP trunking services to ISPs in rural areas of DRC. According to the service provider, the number of new sites added will be less, but data usage will be in the range of 5 to 50 Mbps per link as ISPs are using these links to operate Wimax/Wi-Fi networks in local rural areas[140].

Fiber connectivity should also reach the southeastern part of the country (i.e. around Lubumbashi) through access to a fiber network in Zambia. However, despite the arrival of fiber in several cities, the largest part of the country should remain out of reach of terrestrial networks, making satellites a key network for national coverage.

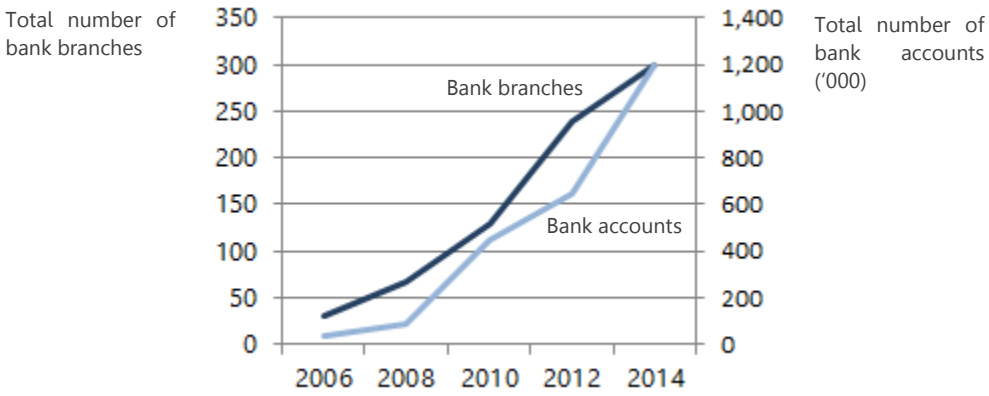
## 9.3 BANKING SECTOR

The economic rebound observed in DRC from the second half of the last decade has come along with a fast development of the banking sector, as highlighted by different metrics:

- The number of active banks in DRC increased from nine in 2004 to 11 in 2008 and then to 18 to 20 over 2010-2014[141].
- Bank branches have increased from approximately 30 in 2006 to approximately 300 in 2013[142].
- The number of bank accounts increased from around 40,000 in 2006, to around 450,000 in 2010 and to more than 1 million in 2014. Certain sources even put the number of bank customers to more than 1.2 million with the number of accounts standing over 1.8 million (likely when including credit unions)[143].

Despite this large growth, banking remains largely underdeveloped in DRC, with less than 2% of the population currently having a bank account. At least one source suggested in January 2011 a potential of at least 13 million clients[144].

**Exh. 16: DRC – SELECTED DEVELOPMENT INDICATORS FOR THE BANKING SECTOR IN DRC**




Source: Press articles[145], annual reports and websites from DRC banks

The addition of new bank branches should continue to support the sector growth. As a first example, Trust Merchant Bank (TMB) increased its number of branches and desks from eight in 2008 to 31 in 2010 and 67 in 2013[146]. TMB plans to extend its network to at least 80 branches and desks[147] with plans for a network of at least 80 branches and desks. The bank is now present in all 11 provinces and 23 cities against 14 cities in 2010 and five cities in 2008. Another leading bank, Rawbank, increased its number of branches from 23 in 2010 to 36 branches and 12 desks in 2013. It has announced the opening of five new bank branches and three desks in 2014[148].

Besides economic growth, a current major driver of the growth of the banking sector is the agreement passed in 2012 between the DRC government and banks for the payment of civil servants through bank transfers and bank accounts[149]. The decision by the government to apply such payment processes was meant to normalize and improve the payment of civil servants, increase transparency and reduce fraud. Following the start of operations in mid-2012, the DRC bank association mentioned that around 450,000 government employees already received their salary through banks in early 2013[150]. In its 2013 annual report, Trust Merchant Bank stated that in December 13, 15 banks shared the payment responsibility for 640,000 civil servants[151], which would further exclude soldiers and military personnel. As government employees are spread around the full country, this payment scheme should push for the opening of new bank branches and ATMs in the coming years. Banking networks also consequently become more and more critical for government activities.

The banking sector is a large and growing segment for the use of C-band VSATs in DRC. Interviews confirmed that banks privilege C-band to other frequency bands due to its reliability. VSATs are often considered as the primary option to connect branches spread around the country to the central office[152]. Typical data rates would currently be of 128/256kbps or 256/256kbps per site[153].

According to conducted interviews, banking VSATs networks for the major banks are usually of 20-25 units, with largest networks going to 50 VSATs.

- Banque Centrale du Congo had a network of 40 C-band VSATs in 2012[154] and likely has maintained or extended its network since then.
- TMB stated that it is currently using a network of 20 VSATs[155]. Considering that several branch offices located in the same city could be connected through local loops (with multiple branches in Kinshasa and Lubumbashi, as well as three offices in Goma), this suggests that the vast majority of branches are connected over satellite,
- Banque Commerciale du Congo (BCDC) stated that all branches inside the country are connected to headquarters in Kinshasa through VSATs for the live transmission of data, with radio local loop being used for branches located in Kinshasa[156].
- Rawbank reported an upgrade of its VSAT network in 2013 to optimize communications within its network of branches[157].

We estimate that the C-band VSAT market currently stands at approximately 150 units. One executive interviewed suggested that this market could represent one of the fastest-growing segments in the coming years for the C-band VSAT market[158], due to the increase in the number of branches, in the number of customers served and operations and in the related increasing communication needs.

An addition growth driver could be the rollout of backup network. A service provider stated that several banks are interested in having two VSAT networks, one acting as the primary network and the second for backup purpose. This would double the number of VSAT units installed and increase capacity requirements. The service provider mentioned an ongoing tender for approximately 20 backup sites. This trend further highlights the importance of C-band transmissions for the operations of banking networks.

A service provider estimated that the number of VSAT sites could double in the next year, with the increase of bank branches and required VSAT sites[159]. Interviewed executives did not consider that a realistic alternative to C-band VSAT networks could be envisaged in the coming years.

## 9.4 PUBLIC SERVICES AND EDUCATION

A number of government organizations have been using and are currently investing in VSAT networks, including the C-band, to improve their operations. We detail below a number of identified networks, which we do not consider to represent an exhaustive list.

- The Ministry of Finance released a tender for the installation of a C-band VSAT and for the supply of related bandwidth in 2011, as part of a project to improve governance capabilities[160]. The Minister of Finance further reported in front of the Senate in 2010 that a VSAT network was under deployment between the central tax office, the provincial head offices and certain banks in order to improve data gathering and tax recovery including for VAT[161]. Considering the central offices and the 11 provinces of DRC, this would suggest a network of at least 10-11 VSATs, most likely operating in the C-band. The Minister also confirmed that the budget for the global modernization program was backed by the DRC government as well as by international organizations including the African Development Bank and the European Union.
- The office in charge of elections (La Commission électorale nationale indépendante - Ceni) has deployed a network of 169 VSATs across RDC to collect voting information, including 154 VSATs using the Ku-band and 15 VSATs using the C-band[162]. In 2012, CENI stated that 25 million voters already registered with the objective of further increasing this number. The VSAT network is used

to connect villages to the central CENI office, and allows for voice and video conferencing exchanges in a private network[163].

> The modernization of the communication infrastructure of police forces is listed in the priorities of the 2012-2016 plan for police reform. The availability of such an integrated communication network is foreseen, with the aim of making police forces more efficient and accessible to the population[164]. Further official speeches by police officials in 2013 and 2014 confirmed the deployment of VSATS in all provinces and from the central office to the lowest levels[165]. The five-year development plan for 2011-2015 of the province of Sud-Kivu includes the deployment of 50 terminals in police stations[166].

> The Régie des Voies Aériennes (RVA) is in charge of air management and safety, as well as of the building and operations of airports in DRC. To support its operations, RVA currently uses a network involving C-band VSATs and VHF connections. Available maps suggest that at least 12 VSATs are currently deployed in the different airports to allow communications and optimize operations and safety[167]. However, an article of July 2014 stated that only three of the installed VSATs are currently operational, with a clear need to operate them all[168]. In addition, DRC is also connected to the Satellite Distribution System (SADIS) operated by the U.K. Met Office on behalf of the International Civil Aviation Organization (ICAO). SADIS provides a point-to-multipoint service over satellite that distributes flight-related meteorology information. While the central office is located in the U.K., DRC operates a receiving station in Kinshasa airport, with information managed by the National Meteorological Service[169].

> A network of eight VSATs was procured in 2009 to support the activity of Régie de distribution d'eau de la République Démocratique du Congo (REGIDESO) that is in charge of the deployment and maintenance of water distribution networks. VSATs have been deployed in the offices located in several provinces, including two in Kinshasa (Gombe and Ngaliema), two in Bas Congo, two in Equateur and two in Kasai Occidental[170]. Although the reviewed document did not specify the frequency band associated with the VSATs, the location of certain sites (such as in Equateur) and information we collected from interviews suggest that part or all of the VSAT sites must operate in the C-band.

> In 2010, the company SATTEL International installed a network of 29 VSATs for the Ministère de l'enseignement primaire, secondaire et professionnel (EPSP—Ministry of Education) to connect 29 "educational provinces" out of the 30 existing "educational provinces" defined in the country. These are spread across the 11 DRC provinces[171]. The Minister stated in 2011 during the inauguration of the network that it would both improve the governance of EPSP and improve the quality and relevance of teaching. The new Intranet would allow for continuous training of teachers and other employees of the ministry, and the distribution of teaching material[172]. Although the frequency band associated with the network, the spread of sites and use suggest the use of C-band.

> VSAT networks are deployed in a number of universities of DRC, with the support of the UniveriTIC program. This program, backed by the Commission Universitaire pour le Developpement (CUD) of Belgium, aims at providing connectivity to seven universities in DRC. VSATs are currently in service in campuses of UNIKIS, UCB, ISTA, UPN, UNIKIN, UNILU and UCC[173]. We received confirmation that the site of UNILU in Lubumbashi is using C-band, which would suggest that other university sites within the network use the same frequency band.

> India started in 2009 a Pan-African e-Network project, that aims to connect Indian institutions to 53 countries in Africa through satellite and fiber links to provide tele-education and tele-medicine services. The network is designed to have 169 C-band VSAT terminals, including three VSAT terminals in each country (one for Tele-education, one for Tele-medicine and one for Heads of State). The Tele-education services will be provided from seven reputed universities in India and five leading regional universities in Africa. The Tele-medicine program for specialist healthcare services to African countries will be provided through 12 Super Specialty Hospitals in India and five Super Specialty Hospitals in Africa[174]. The website of the program states that one learning center (LC) and one patient end hospital (PE) in DRC are currently integrated in the network[175].

Reported networks only would represent over a hundred VSAT sites currently, supporting a variety of important public policies. While available government budgets can represent an important hurdle to the deployment of new networks, the progressive rollout of new VSAT systems remains likely to improve public operations. One service provider mentioned, for example, an ongoing tender for around 30 sites across the country for custom offices.

## 9.5 INTERNATIONAL ORGANIZATIONS AND NGOS

DRC has experienced large challenges in its development over several decades, due to the largely continuous presence of armed conflicts particularly in the eastern part of the country. The United Nations Development Program (UNDP) ranked DRC in the 186th position out of 187 countries surveyed in its Human Development Report 2013[176]. A sample of indicators measured by UNDP includes:

- An average of 3.5 years of schooling in 2013, with a current expectation of 8.5 years for new children;
- Approximately 70% of population below the national poverty line, and 88% under a purchasing power parity of $1.25 per day;
- Large disparities in wealth between the different parts of the country, including between urban and rural areas[177];
- High mortality rates and limited life expectancy of 46 years[178].

This situation has resulted in the large presence of international organizations and more largely of non-government organizations (NGOs). Reports from the United Nations Office for the Coordination of Humanitarian Affairs (OCHA) on the activity of NGOs in RDC give a good overview of the presence of these organizations.

**Exh. 17: DRC – REPORTED HUMANITARIAN OPERATIONS IN THREE PROVINCES[179]**

| PROVINCE | NUMBER OF ORGNIZATIONS | | | | | | REPORTED PROJECTS |
|---|---|---|---|---|---|---|---|
| | Government partners | UN agencies | International organizations | International NGOs | National NGOs | Total | Total |
| Sud-Kivu | * | 8 | 6 | 47 | 56 | 117 | 618 |
| Katanga | 2* | 7 | 1** | 19 | 25 | 53 | 61 |
| Maniema | 1* | 6 | 3 | 10 | 20 | 40 | 250 |

Reported organizations are activity in a large diversity of programs, from sheltering to food support and security, education, water, logistics and protection. In Katanga only, total reported projects represented an effort of $564 million in 2013.

For international organizations and NGOs, benefiting from efficient communication is key for the efficiency of operations and the security of personnel. As reported in interviews, the use of VSATs is widespread among NGOs to connect different offices. C-band is often privileged, as part of the operation is located in areas where C-band is more reliable. In addition, interviews confirmed that international organizations tend to privilege by far the use of C-band for their connectivity.

On average, NGOs have been reported to often have two to three sites in service, with certain networks reaching up to 10 or more VSATs. Our research identified a number of examples:

- The United Nations High Commissioner for Refugees (UNHCR) reported the presence of around 10 sites connected in C-band in DRC, with bandwidth requirements standing at

768/1,024 Kbps per site except for the Kinshasa office (1,024/2,048 Kbps)[180]. Overall, the operations of the UNHCR had a budget of $183M in 2013, up from $109M in 2010. The UNHCR supported approximately 667,000 individuals in 2013, with plans for the support of more than 1 million in 2014 and 2015.

- The Directorate General Humanitarian Aid and Civil Protection of the European Commission (ECHO) requested in 2013 the installation of C-band VSATs in three of its four offices in DRC (Kinshasa, Bukavu, Bunia and Goma), likely as an upgrade to existing solutions[181].
- The U.S. Agency for International Development (USAID), for its Food Production, Processing and Marketing (FFPM) project, requested in January 2014 bandwidth to support its VSATs in its offices in Kikwit, Mbanza Ngungu and on the Batéké Plateau in Kinshasa[182]. Reliability rate was stated at 98.5%, suggesting the use of C-band capacity. The objective of the FFPM project is to improve the food production of several key goods including cassava, corn, peanut, bean, soya and cowpea and delivery to markets in Kinshasa, Bas-Congo and Bandundu.
- The United Nations Office for Projects Services (UNOPS) requested the supply and installation of C-band VSAT solutions in four offices in Kinshasa, Goma, Boende and Bukavu[183].
- Oxfam has had a long haul presence in DRC and claims to support approximately 800,000 individuals. An interviewed executive confirmed that up to 13 sites were in service for Oxfam before 2012.
- UNICEF stated in its 2013 annual report for DRC that the data rates available on its VSAT units connecting all of its 14 offices nearly doubled in 2013[184]. Another tender from UNDP in 2012 regrouping capacity requirements for different UN agencies including UNICEF suggests that those VSATs are all operating in the C-band, with 12 VSATs reported[185].
- The United Nations Interim Security Force for Abyei (UNISFA) has more than 40 VSATs spread across South Sudan and DRC. The United Nations Mine Action Coordination Centre (UNMACC) would also have nine VSATs in service in DRC,
- The NGO Save the Children released a tender for the supply of satellite bandwidth for their communication network in Africa, including for four sites using C-band and five sites using Ku-band in DRC[186],

**Exh. 18: DRC – IDENTIFIED VSAT SITES FOR UN OFFICES IN 2012[187]**

| UN OFFICE | NUMBER OF SITES | LOCATIONS | BANDWIDTH (UP/DOWN IN MBPS) |
|---|---|---|---|
| UNHCR | 9 | Baraka, Bukavu, Bunia, Dungu, Goma, Kinshasa, Lubumbashi, Moba and Uvira | Kinshasa: 1,024/2,048<br>Others: 768/1,024 |
| UNDP | 1 | Kinshasa | 1,024/1,536 |
| UNICEF | 12 | Bandundu, Bukavu, Bunia, Goma, Kananga,Kinshasa, Kisangani, Lubumbashi, Matadi, Mbandaka, Kalemie, Mbuji-Mayi | 8 sites: 512/1,024<br>2 sites 1,024/1,024<br>1 site: 1,280/1,280<br>1 site: 1,024/2,048 |
| WHO | 1 | Kinshasa | 384/512 |
| WFP | 12 | Bukavu, Bukavu Warehouse, Bunia, Dungu, Goma, Kalemie, Kindu, Kinshasa, Lubumbashi, Mbandaka, Mbuji Mayi, Uvira | 1 site: 32/64<br>9 sites: 128/160<br>1 site: 256/320<br>1 site: 512/640 |
| **Total sites** | **35** | | |

A service provider estimated that NGOs and mining represented about 50% of the remote sites it served with a relatively even split between the segments. This likely represented about 70 sites.

We estimate that approximately 300 C-band VSATs should currently be in service for international organizations and NGOs in DRC. Besides UN offices, it takes the assumption of an average of about

five sites for other international organizations, three sites for international NGOs and one site per national NGOs. For the latter, this would represent the fact that certain NGOs could have several VSATs while other would operate without proprietary communication solutions.

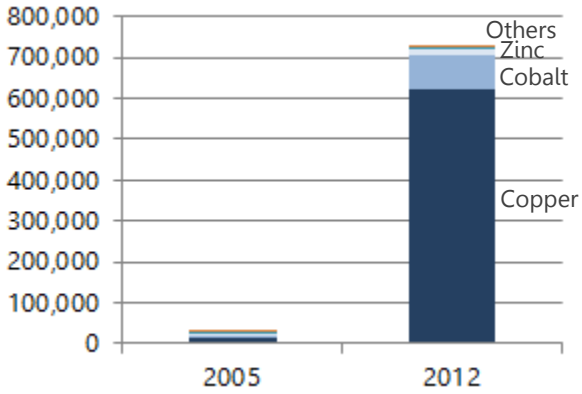
## 9.6 MINING AND OIL & GAS

The mining sector represents key economic activity in DRC. Despite a decrease in production until the mid-2000s due to insecurity issues, the Finance Minister stated that it represented about 30% of the GDP and 10% of public resources in 2012, figures that the Minister considered as still relatively weak[188].

The Ministry of Mining reported in 2014 the presence of 468 mining operators with 45 in production stage and others at different stages ranging from exploration (260) to advanced exploration (145) and development (18[189]). The largest part of resources is located in the eastern part of the country, including in the Katanga province. A registry of companies in operation identified over 135 operating mining sites in the different provinces, excluding research operations[190]. This only includes large mining companies and excludes the smaller/individual mining sites.

It is noteworthy that the production of several goods has dramatically increased in the last eight to 10 years, which largely contributed to economic growth in DRC. Several examples are presented in the chart below. Although production suffered from the financial crisis of 2009 and from an oversupply of certain minerals in the last few years, growth in mining production remains an important priority for economic growth in the country.

**Exh. 19: DRC – GROWTH IN MINING PRODUCTION FOR MAIN MINERALS[191]**




As highlighted through several interviews, the mining sector is a large user of VSAT connectivity, essentially using C-band connectivity. Four service providers started operating together around 130 sites, with some of the terminals potentially being used for oil and gas for two of them[192]. Furthermore, interviewed executives confirmed that they only represented a part of the market.

Overall, the VSAT market for the mining sector appears significantly fragmented. Because part of the mining operations in DRC is conducted by international mining companies, these then use the same VSAT suppliers in various countries. This results in a mix of international and local VSAT providers operating in the market.

Although it is difficult to identify individual mining networks across the various sites spread across DRC, the presence of at least one VSAT could be identified for African Minerals, for AMCK Mining, for the Société Minière de Kolwezi (SMK), for Boart Longyear Drilling Services and for several sites for Anvil Mining, Boss Mining and Long Fei Mining[193].

Overall, mining companies use VSAT connectivity for Internet access, including potentially for the working camps around the production sites, as well as for their VPNs. Networks of mining companies tend to go up to a few dozen of sites[194]. As international mining companies tend to have only part of their sites in DRC, our assumption would then be for networks of one to five VSATs for their operations in DRC.

Data rates tend to be lower than for the oil and gas sector, but can still reach up to 1-2Mbps[195]. Needs tends to increase, and consumption tends to be relatively independent from short-term changes in the price of minerals.

In at least the Katanga province, the reach of fiber from neighboring Zambia could offer connectivity options to certain mining sites. In such a case, interviewed executives all stated that VSAT connectivity would be kept either as a primary or backup option, due to reliability issues associated with the use of fiber. In addition, a large part of mining sites should remain out of reach of fiber connectivity for a number of years.

Considering the oil and gas segment, the only current oil producer in DRC is Perenco. The company produces 28,000 barrels per day. According to the production map of the company and taking into account the company offices in Kinshasa, Perenco would operate in about 15 locations in DRC, with all of them but the Kinshasa office being located in the same area of 1,466 $km^2$. In parallel, Perenco is stated as having a private satellite telecom network involving 17 ground stations in Africa. Perenco is active in Gabon, Congo Brazzaville, Cameroon and DRC, which would suggest the presence of approximately five sites in DRC, most likely in the C-band.

SEP Congo is in charge of supplying oil and products across DRC. To achieve this, the company uses a network of 39 oil storage depots and logistics centers in the 11 provinces of the country, as well as one oil terminal in Ango-Ango and a network of offices connected to custom offices around the country for oil imports[196]. One service provider stated in an interview that SEP Congo would use a network of around 30 VSATs[197], which seems consistent with their presence around the country and with the potential use of WLL connectivity for certain offices. According to our general research, those sites would most likely use C-band connectivity, as for other companies involved in the oil and gas sector.

Overall, available information suggests the presence of about 250 C-band sites for the mining and oil and gas sector.

## 9.7 OTHER INDUSTRY SECTORS

The use of VSAT connectivity for various other sectors and applications has been reported through different interviews, although those networks tend to be small in size and spread across a variety of users. Such users would typically include a variety of international companies having one to several offices in DRC, as well as certain local companies. As previously stated, most of the professional users would currently use C-band VSATs for their connectivity. In addition, a large portion of users would maintain their VSATs at least as a backup option even in the case of fiber availability.

Examples of identified users include:

- Use of at least two VSATs by the company Delmas-Groupe CMA CGM[198];
- Use of at least one VSAT by the MAERSK Congo RDC company[199];
- Mentions of the use of VSATs for a number of other organizations, including for example international airline companies.

# 10. Socio-economic benefits

The previous sections have highlighted the importance of the use of C-band for the human and economic development of the Democratic Republic of Congo. The reported usage involves national public and private sectors as well as a number of international government and non-government organizations. Overall, the availability of C-band-related services directly impacts more than 15-20 million individuals on a daily basis, ranging from the access to fundamental needs such as water and food, to access to television programs. It is furthermore a key communication tool for several critical economic sectors including banking, mining, and oil and gas.

Exhibit 20 provides a synthesis of the findings of our research on current C-band usage. It does not include full findings on the potential development of C-band usage for several segments, with further details being presented in the previous sections.

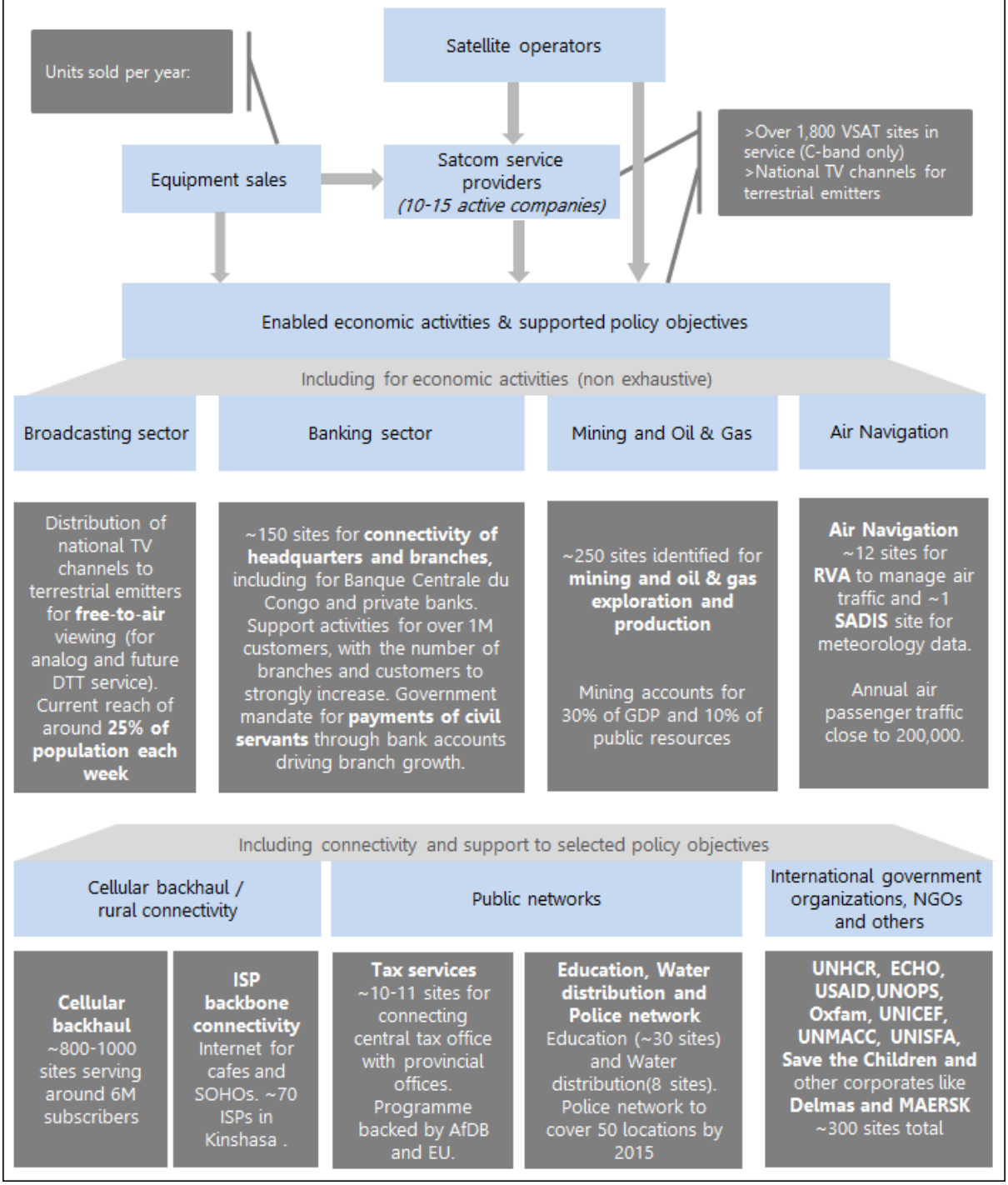
Five particular impacts can be highlighted:

- The presence of a **specific ecosystem of companies** specializing in satellite communication services, with a direct investment in C-band capacity. Many of these companies, and their employees, are at the top of the country's high-technology sector.
- The rollout of C-band networks is part of a large number of **government programs** to improve the efficiency of public services. Such networks contribute to different public policies ranging from security (police, customs) to education, elections, air navigation, fiscal administration, water supply and other needs.
- C-band connectivity is an important tool for the extension and efficiency of **banking networks**. This is a critical stake for DRC, as the larger access to banking services, including the payment of civil servants and the private sector, will favor the modernization and growth of DRC economy. It should also support the objectives of reducing the issues related to the lack of transparency and corruption that have hampered economic growth.
- **The mining industry** and its renewed growth has been a key driver for economic growth in DRC in the last eight years. C-band connectivity is of a high importance for the sector, in order to optimize exploration and production activities.
- **International organizations**, including offices from the United Nations, the European Union, U.S. development offices as well as a number of non-government organizations, provide a daily support to DRC population, often in cooperation with national government offices and NGOs.

The following table summarizes sources for key assumptions supporting Exhibit 20.

| SEGMENT | NOTES ON ASSUMPTIONS |
|---|---|
| Satellite operators | Derived from separate Euroconsult research [200] |
| Satcom service providers and grey box | Channels – see page 39; VSAT sites see Exh. 14 |
| Broadcasting sector | See pages 39-42 |
| Connectivity | See pages 44-45 |
| Banking | See pages 46-47 |
| Public services and education | See pages 47-49 |
| International organizations and NGOs | See pages 49-51 |
| Mining and oil & gas | See pages 51-52 |

**Exh. 20: DR CONGO: SYNTHESIS OF SOCIO ECONOMIC IMPACT OF SATELLITE C-BAND USAGE**



# C-BAND USAGE IN ANGOLA

# 11. Country overview

Angola is the sixteenth-most-populated nation on the African continent with over 20 million people in 2012[201]. The country's population has been growing at about 3.2% p.a. over the past five years and is expected to grow to over 47 million by 2060.

The country is divided into 18 provinces and 163 municipalities. Major cities include capital city Luanda, Huambo and Lobito. Population density in Angola was last measured at 17 people per km2 in 2012, according to the World Bank. Angola has an average household size of approximately five people, and about 40% of the people live in rural areas. In terms of demographics, more than 48% of the country's population is below the age of 14, and more than 50% currently fall into the working-age group of 15-64.

At 1.2 million square kilometers, Angola is the world's 23rd-largest country in terms of land area. The country is located in the western coast of Sub-Saharan Africa, bordered by DR Congo and Zambia to the east. The country has a varying topography with a high plateau in the center surrounded by mountains, rainforests and coastal lowlands to the west. Like the rest of tropical Africa, Angola experiences alternating rainy and dry seasons. The average annual rainfall is around 1,000 mm in Angola. The rainy season typically last from October through May every year with heaviest rainfall occurring in April.

Oil is the backbone of Angola's economy, and the country is currently the second-largest oil producer in Africa. Oil sector accounts for more than 46% of the GDP and 90% of the export revenue. Other key economic sectors include agriculture, fisheries, manufacturing and construction. Angola's GDP grew by 5.1% in 2013, below the target figure (7%), but a new burst is expected from 2014 as major public infrastructure investment kicks in to expand electricity, water and transport facilities[202]. To boost business, financial sector policies are being modernized with the introduction of a new foreign exchange currency law for the oil sector and a mining law. China is Angola's biggest trade partner and export destination as well as the fourth-largest importer. However, social indicators have not kept pace with the strong economy, as a large part of Angola's population remains poor and as a third of the population relies on subsistence agriculture.

# 12. Television broadcasting

## 12.1 ACCESS TO TELEVISION

In Angola, the population receives information from several media outlets including television, radio and Internet. Radio is the country's most developed medium ahead of television, thanks to a wide coverage of the country (i.e. the National Radio of Angola — RNA, which is available in most parts of the country) and because of its relative affordability. Television is limited outside Angolan capital Luanda. This is due to the fact that it is only available to higher-income households. It is also linked to the limited access to electricity. According to the Minister of Energy and Water, electricity is only available to 33% of the population in 2014, and 90% of the citizens that have access to electricity live in cities or high-density areas[203].

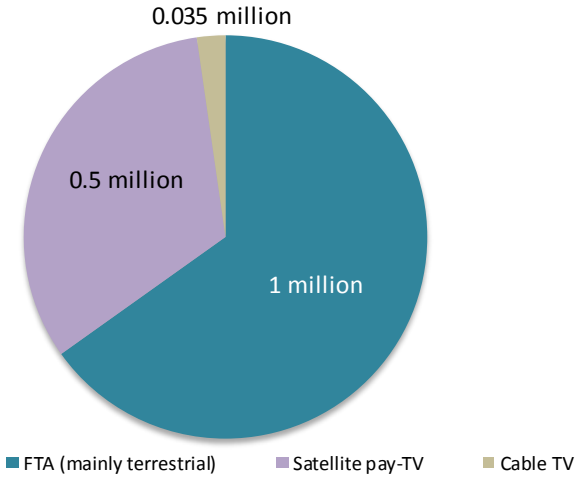
Frequent power outages are also an issue for TV viewing in Angola, where the electricity system is insufficient because of infrastructure damaged by a 27-year civil war that ended just over a decade ago, as well as by rising consumption.

Estimates are scarce and vary on the actual number of households having access to TV in Angola.

- According to data provided by EconStats, 34% of Angolan households had a television in 2007[204]. Considering the population of approximately 20-22 million and an average household of five individuals, this suggests that about 1.3-1.6 million households own a TV set.
- ITU data indicates that the television penetration rate in Angolan households was about 70-85% in 2006[205]. This would suggest that 2.8-3.4 million households, or around 14-17 million individuals, have access to TV viewing.

The large difference between these figures may be explained by the fact that the former takes into consideration TV households only while the latter takes into account TV households and the number of people that access TV content through the shared viewing of TV programs, whereby one TV set can be watched by more than one family.

**Exh. 21: ANGOLA – ESTIMATED TV HOUSEHOLDS BY TYPE OF DELIVERY NETWORK (2013)***




*This is a breakdown of households owning a TV set. It does not include all individuals with access to a TV.

Source: Euroconsult estimates are based on available data.

With the enactment of the 2006 Press Law, state monopoly on television ended in 2008. TV Zimbo was the first private Angolan TV station to be rolled out in December 2008 after the end of the monopoly. The Angolan TV market is mainly a terrestrial TV market with state-run TPA as the main player. Two TPA channels, TPA 1 and TPA 2, are available via terrestrial TV. Apart from analog terrestrial TV, digital services are also available in the country via satellite (mostly pay-TV) and cable services. DTT services have not yet been launched in Angola.

The Angolan free-to-air TV landscape remains of a limited size. The vast majority of television viewers watch a limited number of television services: TPA 1, TPA 2 and Zimbo (mainly in Luanda). Terrestrial broadcasts are largely focused on events within the capital Luanda. The only alternative is satellite pay-TV and cable TV services, but they are relatively expensive and therefore cannot be accessed by a large part of the population.

Many Angolans receive television by means of simple indoor antennas. Some rooftop antennas can also be observed in Luanda. Public television is accessible in all provincial capitals, from where the signal is transmitted to the municipalities. TPA has the widest terrestrial coverage in the country. According to Carolina Cerqueira, the Angolan Social Communication minister, the broadcaster covered 90% of the national territory in 2012[206]. According to the ITU, TPA1 used 159 sites in 18 provinces in 2012 and TPA2 used 57 sites in 17 regions[207]. TPA1 and TPA2 use C-band satellite

capacity on Intelsat 901 for delivering the channels to analog transmitters. They also use Ku-band capacity for free-to-air and pay-satellite services.

In addition to analog terrestrial TV, Angolan TV households can also access digital pay-TV services via satellite or cable. Four pay-TV service providers are currently active in the country:

- Three platforms currently offer satellite pay-TV services: Zap (owned by NOS, a Portuguese media holding company), DSTV Africa (Multichoice) and UAU!TV (Infrasat). The three service providers were estimated to have a combined 500,000 subscribers at YE 2013, with Zap leading the way. The latter had more than 300,000 subscribers in 2013[208], while DSTV and UAU!TV combined for about 180,000 subscribers[209]. The market has experienced strong growth since 2010, driven by the rapid development of Angola's economy and the rollout of services by Zap, which offers a larger number of Portuguese-language channels than its competitors. Despite the recent dynamism of the market, price levels (recurring and one-off costs) make satellite pay-TV services beyond the reach of many households in Angola.
- Digital cable TV is offered by the Portugal-based TV operator TV Cabo in Luanda and Benguela. The company has an estimated 35,000 subscribers[210].

Free-to-air DTH satellite reception is estimated to be limited. The two primary inhibitors include the access to power and the purchasing power in the country. Most TV households with sufficient purchasing power to buy a satellite dish are estimated to pay for satellite TV services, given the limited amount of Angolan TV channels available free-to-air.

The final switch-off date has not been politically endorsed in Angola, and the roadmap duration may consequently still vary. The simulcast period in which the DTT network is rolled out and the analog transmitters are switched off will span a number of years. Five multiplexes should, when available, be introduced at the same time[211]. Two of the multiplexes will be publicly financed and operated by a new broadcast transmission operator with Angola Telecom and TPA as shareholders, and the other three will be privately financed. The digital switchover objectives indicate that Angola plans to carry up to 50 SDTV channels on the five multiplexes.

In March 2012, the Ministry of Communications gave the green light for the adoption of the ISDB-T standard in Angola. This was expected to make Angola the first country to adopt this TV standard[212]. The first DTT transmitter was installed by TPA at its Huila production center in October 2012. Despite the slow start to the digital switchover process, the head of state, José Eduardo dos Santos has recently said that he expects Angola to comply with the deadline of June 17, 2015, set by the ITU. The president approved the Angola Terrestrial Digital Television Programme and its budget to install DTT services in 117 localities.

## 12.2 CHANNEL OFFERING AND C-BAND UTILIZATION FOR THE BROADCAST SECTOR

Due to the late liberalization of the market and the larger focus on the development of satellite pay-TV services in recent years, terrestrial TV households currently have access to a limited number of TV channels (three on a national scale). The number of free-to-air satellite TV channels is also low in comparison with most other Sub-Saharan African countries (six in August 2014, according to LyngSat). Pay-TV services, led by satellite pay-TV platforms, offer a wider variety of channels (25 to 130 depending on the service provider). However, most of these channels are either pan-African or international (often from Portugal or Brazil).

The Angolan television market uses C-band satellite capacity principally for contribution to earth stations. Given the fact that terrestrial reception remains the principal TV reception mode for a large part of the population, C-Band is technically required for the Angolan television industry to operate.

The volume of capacity used in C-band remains limited by the small number of terrestrial channels available in the country. C-band is used by two of the three main free-to-air channels broadcasting in Angola based on our monitoring of LyngSat (i.e. TPA1 and TPA2 use C-band while TV Zimbo only uses

Ku-band). Channels are distributed to terrestrial emitters through a multiplex of channels using capacity on the Intelsat 901 satellite. The choice of C-band is likely due to the stability of transmissions that are not impacted by weather conditions. Two-thirds of Angolan households are estimated to access TV programs only via terrestrial free-to-air broadcasts. Without C-band, most of these households would not have access to TV programs.

C-band is also used by cable operator TV Cabo. The latter's channels are broadcast via satellite to the head-ends of its cable network in Luanda and Benguela.

Ku-band is mainly used by satellite pay-TV platforms, which account for about 1/3 of TV households. Some free-to-air channels distributed by satellite do use Ku-band, but they are not estimated to be used by a lot of households as they require an antenna, which can be an inhibitor for households with a low purchasing power.

Based on this market analysis, it is likely that any interference in the C-band would have a strong impact on the TV market in Angola and more particularly on the free-to-air terrestrial distribution of channels in the country.

In coming years, the expansion of TV coverage, mainly through DTT, should enlarge the C-band TV reach, enabling more households to access content. This should notably be favored by Angola's plan to invest $23 billion on its electricity network by 2017[213], which should enable more households to access terrestrial TV channels. The latter frequently use C-band capacity in Sub-Saharan Africa, notably because it offers more reliability in adverse weather conditions. The digital switchover is expected to lead to the availability of a wider range of free-to-air channels viewable by Angolan TV households. The objective is to broadcast up to 50 SDTV channels on the DTT network.

The planned launch of Angosat, the first Angolan Satellite Communications System, which is notably expected to provide satellite capacity to support television network services, should also drive the broadcasting market, including C-band usage. Angosat will support the national telecommunications infrastructure and digital television broadcasting across the country thanks to enhanced capacity brought about by 16 C-band and six Ku-band transponders over Africa. The satellite is notably expected to help with the development of DTT. Based on current utilization of capacity by DTT providers in Africa, it is likely that a large part or all of the capacity used for DTT services on Angosat will be in C-band.

# 13. Connectivity

Though being located on the western coast with access to a submarine cable network, Angola continues to be one of Africa's largest markets for satellite communications, as much of the country's telecommunications infrastructure outside of the capital city Luanda was destroyed by the 27-year civil war, which lasted until 2002. The key economic growth sectors like oil and gas, telecommunication, and banking utilize VSAT as their main communication channel for applications including backhaul, remote and backup connectivity. Since many of these requirements demand much greater reliability than rain fade would allow in other bands, the networks rely primarily on C-band. The two main telecommunication companies along with their subsidiaries lease an estimated 900 MHz C-band capacity for GSM backhaul and enterprise VSAT applications in Angola.

There are around 7 to 10 VSAT providers based in Angola, including Angola Telecom, MSTelcom, Infrasat, Angola Communication System (ACS), Nexus, SISTEC, Net One, Global Telesat and ITA (Maxnet). Among these operators, the national telecom operator Angola Telecom wholly owns the service provider Infrasat, while its main competitor MSTelcom holds majority stakes in ACS, Nexus and Net One.

**Ex. 22: ANGOLA: ANGOLA - C-BAND VSATs, AUGUST 2014**

Bank site, Cabinda

Oil & Gas Site, Cabinda Basin

GSM Backhaul site, Lobito

GSM backhaul site, Conda

C-Band earth station, Luanda

GSM backhaul site, Kuito

Backhaul site, Lobito

Source: MSTelcom, Angola.

Global service providers like SkyVision, Hughes, Gilat, Bentley Walker, EMC and Harris CapRock as well as some European teleport providers like CETel, and Global TT are also present in the country, primarily serving international oil and gas, and corporate customers.

Exhibit 23 tallies the networks we were able to identify from interviews with major service providers that share this market and from secondary research, coming to a minimum of about 1,440 terminals.

**Exh. 23: ANGOLA: REPORTED ACTIVE C-BAND TERMINALS, 2014**

| USER | TERMINALS |
|---|---|
| **MNO** | **~560** |
| Movicel | ~160 |
| Unitel | ~400 |
| **Rural Connectivity** | **~150** |
| Angola Telecom | ~50 |
| MSTelcom ( Dial@away) | ~100 |
| **Oil & Gas** | **~231** |
| Sonangol | ~60 |
| Chevron* | 1 |
| BP* | 5 |
| Total (managed by Newsat) | ~40 |
| Other IOCs | ~125 |
| **Banking** | **~250** |
| BPC | ~69 |
| AfDB | 1 |
| Other banks | ~180 |
| **Others** | **~251** |
| ID Card project & government security (Managed by Infrasat) | ~200 |
| Angola press (ANGOPEC) | 20 |
| SADIS(Air Navigation) | 1 |
| Angola domestic air traffic management network (ENANA) | 5 |
| Other networks | ~25 |
| **Total** | **~1,442** |

* Includes only reported sites for Chevron and BP that are estimated to have more sites which are included in others

## 13.1 CELLULAR BACKHAUL AND RURAL CONNECTIVITY

A key use of C-band satellite capacity in Angola is in support of the backhaul needs of cellular carriers in remote areas. Public telecom operator Angola Telecom (AT) introduced the first cellular service in the country through its MNO Movicel way back in 1994. The mobile market was opened to competition by telecom regulator INACOM in 2001 with the launch of Unitel's GSM 900 network. Since then, the market has a duopoly between Unitel and Movicel and has grown rapidly with SIM card penetration, which is now exceeding 60%. The mobile subscribers stood over 13 million as of March 2013, with the Movicel holding more than 75% of the total subscriber base. 3G and LTE services were launched in 2007 and 2012, respectively, in the market, and the mobile Internet subscribers stood over 2 million as of mid-2011. In addition to the two mobile operators, service provider Omnidata offers Inmarsat mobile satellite phone services in rural parts of Angola[214].

The public MNO Movicel is one of the largest CDMA operators in Africa with more than 10 million subscribers. However, their coverage remains limited to around 25% of the country's land area, though it includes all of Angola's 18 provinces and most major towns. The network has now around 300 base stations spread across the country. The operator has started the process of migration to GSM/UMTS network from CDMA in 2010 and is investing $1 billion during the 2010-2014 period to complete the migration[215]. Angola Telecom exclusively uses C-band capacity for its fixed-line trunking needs as well as to provide GSM backhaul services for their subsidiary Movicel. According to the AT's

satellite service subsidiary Infrasat, Angola telecom currently uses around 200 MHz of C-band capacity on various satellites of a single operator to backhaul about 120 BTS sites. In addition to this, Infrasat operates 30-40 BTS sites for Movicel using capacity from two other operators. All of the sites of Movicel carry about 2 Mbps of traffic each at an estimated 1.2 Mbps/MHz spectrum efficiency (as they have yet to use carrier in carrier [CnC] bandwidth compression)[216].

The second operator Unitel has now about 300 BTS sites (@2 Mbps) backhauled over satellite, managed by their parent company MSTelcom. The parent Portuguese company MSTelcom leases about 7 TPEs (600Mbps) to manage these sites, using CnC bandwidth compression technology. In addition, Angola telecom's subsidiary Infrasat operates around 100 BTS sites for Unitel. The majority of these 100 sites are 2 Mbps links, while there are also 700 Kbps Abis links and a few 8 Mbps MSC-MSC links. According to Infrasat, they lease around 280 MHz of C-band capacity for providing GSM backhaul services to both Unitel and Movicel[217].

**Exh. 24: ANGOLA - GSM BACKHAUL SITES[218]**

| MOBILE OPERATOR | SITES | AVERAGE SITE TRAFFIC | TOTAL CAPACITY (MBPS) | TOTAL CAPACITY (MHZ) |
|---|---|---|---|---|
| Movicel | ~120 | 2Mbps | ~240 | ~200 |
| Unitel (MSTelcom) | ~300 | 2 Mbps | ~600 | ~300 |
| Movicel managed by Infrasat | ~40 | 2 Mbps | ~80 | 280 |
| Unitel managed by Infrasat | ~100 | 700kbps-8Mbps (Majority 2 Mbps) | ~250 | |
| **Total for reported sites** | **560** | | **~1,170Mbps** | **~780MHz** |

There is an overall C-band capacity usage of over 1.1 Gbps to backhaul over 560 sites in Angola, by the two mobile operators. This should represent about 3.4 million subscribers (28% of total), assuming that an average 6,000 subscribers connected over a BTS site. In addition to the domestic GSM backhauling, Angola also depends on C-band satellite capacity for connecting to IP and voice backbone network located in Europe and the U.S. For example, telecom provider MSTelcom recently expanded their network to add two international Points of Presence (PoPs) in London and Lisbon, with two additional international PoPs planned for connection in the short term (Houston, Texas, U.S. and Aberdeen, Scotland)[219].

The GSM backhaul market using C-band has been growing in the past and is also showing good growth potential. For example, according to service provider Infrasat, it derived more than 90% of its $27 million revenue in 2013 from C-band backhaul services. The company also registered a 38% CAGR in revenue for the past three years, which also has mostly come from C-band backhauling business. In 2014, a new mobile operator is expected to start operation in the country. Regional heavyweights such as South Africa's Vodacom and MTN have expressed interest in a license in Angola with investment in the $100 million range. Fiber infrastructure rollouts to deploy the network will be a challenge to the new operator, as the already existing two MNO's will not likely share their infrastructure with the third operator[220]. So, this should result in good demand take up for satellite backhaul in next two to three years.

Much of Angola's telecommunications infrastructure outside of the capital city was destroyed by the war, and so around two-thirds of the fixed lines are in Luanda. In 2014, the number of fixed-line subscribers stood at about 320,000, representing 1.5% penetration. The government has started rolling out VSAT public telephone booths to address the shortage of fixed-line infrastructure from early 2000's[221]. Our research identified a few examples of major VSAT rollouts:

- Angola telecom is now rolling out around 500 public payphones in rural areas based on VSAT technology. Another push to deploy public telephone booths throughout the country was announced in April 2013[222].
- MS telcos signed contract with Gilat Satellite Networks in 2004 for the deployment of up to 1,000 sites using Gilat's VSAT-based "DialAw@y IP" and "FaraWay" products. While "DialAw@y IP" provides rural telephony applications throughout the country, the "FaraWay" network delivers data and voice solutions to enterprise clients[223].

Though the majority of the more than 1,500 site deployments are expected to be in Ku-band, part of them should be also in C-band (around 150 sites or 10%).

In addition to this, Infrasat operates around 300 Ku-band sites for rural connectivity. The company now has plans to connect 760 localities through the installation of 2,300 Ku-band VSAT. According to Infrasat, the unavailability of satellite capacity is delaying the expansion[224].

## 13.2 OIL AND GAS

Angola's is the second-largest oil producer in Sub-Saharan Africa, behind Nigeria. According to IMF, oil revenue accounted for nearly 80% of total government revenue and grants in 2011. The economic growth in the country is closely associated with oil production, which is evident as the GDP has grown at an average annual growth rate of 15% during the oil production boom between 2002 and 2008. Currently, oil production comes almost entirely from offshore fields in the coast of Cabinda and deep-water fields in the Lower Congo basin. There is small-scale production from onshore fields, but onshore exploration and production have been limited in the past due to the civil conflict. The national oil company Sonangol, is a shareholder in almost all oil and natural gas projects. International oil companies (IOCs) like Total, Chevron, Exxon Mobil, Eni and BP have joint-venture projects with Sonangol in Angola[225].

As most of the oil exploration now taking place in the country is through deep water projects, VSATs are a major communication channel for the industry. C-band is mainly preferred, as the oil fields in the west coast are affected by high rainfall and customers often require SLA levels above 99% for awarding contracts. The importance of reliable communication networks given by oil companies is evident from the fact that the state oil company Sonangol fully owns a telecom provider 'MSTelcom', the second-largest telecom operator in the country. MSTelcom has a 25% stake in GSM operator Unitel and majority shares in ISPs ACS, Nexus and Net One. The company offers VSAT solutions both directly as well as through its subsidiaries to oil and gas corporate customers in Angola[226]. According to conducted interviews, VSATs networks for the major oil and gas companies are usually of 30-50 units, with the largest networks going up to 60 VSATs.

- According to MSTelcom, they manage 50 to 60 sites for parent company Sonangol to connect the remote exploration sites to the company headquarter in Luanda. The average traffic for the above sites range from 512 Kbps to 2 Mbps. In total, MSTelcom use 36 MHz capacity (one transponder) for managing Sonangol sites. They plan to lease 18 MHz more capacity in the next few months for adding more sites for new Sonangol projects[227].
- In addition, MSTelcom operates one site for Chevron (~1Mbps) and five sites for BP (@512Kbps each) in Angola[228].
- In August 2014, MSTelcom signed a multiyear contract with Intelsat to offer broadband services largely focused on corporations in the oil and gas and banking sectors in Angola. Through the contract, MSTelcom will avail C-band capacity on Intelsat-14 satellite as well as utilize the IntelsatOneSM terrestrial network to provide point-to-point (SCPC) and point-to-multipoint services[229].
- Global service provider ITC Global (Newsat) has reported that it manages about 40 sites in Angola, utilizing in total around 90MHz C-band capacity[230].

- Europe-based service provider CETel stated to operate 15 C-band sites in Angola for two to three O&G companies using 5MHz capacity[231].
- According to Hughes, they manage around 10 sites for IOCs operating in Angola[232].
- Global VSAT provider Harris Caprock is stated to operate few dozens of high data rate sites on C-band for international oil companies[233].

We estimate that approximately 230 C-band VSATs should currently be in service according to the typical number of sites deployed for oil companies as well as considering the current major offshore and deep water projects by Sonangol, Total, Exxonmobil, BP, Chevron, and other small players.

Angola has around 10 new oil projects scheduled in the next five years by IOCs Chevron (4), Total (2), Eni (2), Exxonmobil (1) and BP (1). Angola is targeting a crude oil production rate of 2.0 million bbl./d in 2015 from 1.8 million bbl./d in 2013, as new deep-water oil fields are scheduled to come online. The C-band usage in the O&G segment is also expected to grow in the next five years as new deep-water sites at depths of over 1,200 meters with no terrestrial network coverage are expected to get deployed[234].

## 13.3 BANKING

The continued and increasing foreign investment has contributed to a general boosting of the Angolan economy in various sectors, including the banking sector. The banking sector, along with telecommunications, manufacturing and agricultural activities, continues to be an engine of the economy that has grown at 5.2% in 2012 and helped to reduce the country's dependence on oil[235]. The banking sector continues to grow in the country, which is evident from the fact that:

- The number of banks has almost doubled to 24 registered banks in 2012, while in 2005 the country had only 13 banks[236]. The banks have also made an effort to present in most provinces in the country and to offer clients more diversified products. A consequence of this is the increase in the number of branches to 1,120 in 2012 (almost double from 665 in 2009) and banking sectors' decentralization from Luanda[237].
- In 2012, though the number of banks remained the same, there was an annual increase of 10.5% in the number of branches, 13.8% in the average number of employees and 14% in total assets. The number of ATMs in the country has grown to reach over 2,000 units in 2012, representing 23% CAGR over the past five years. At the same time, the POS terminals have reached over 23,000 units, registering a whopping 72% CAGR in past five years[238].
- The exponential growth trend for ATM transactions observed in previous years continued in 2012, with the average monthly volume of transactions increasing to 9.3 million (35% annual growth). Similarly, the number of Point-of-Sale terminal (POS) transactions increased by about 72% over the same period[239].

Nevertheless, the level of banking service access of the population still falls short of what the sector aspires to (amounting to about 23% in December 2012), notwithstanding an increase in the number of agencies and diversification of services provided by financial Institutions to businesses and families[240].

Considering the precarious state of ICT infrastructure, especially in rural areas, the Ministry of Finance, the banking system and state-owned telecom company Angola Telecom decided to implement an independent VSAT network for the country's financial system in 1996. Under this agreement, the central bank and four other commercial banks implemented a VSAT network with a hub located in South Africa to interconnect the branches with headquarters in Luanda in 1997[241]. Since then, the banking sector continues to be a large and growing segment for the use of VSATs in Angola, which is evidenced by reports that Angola Telecom's most enterprise VSAT users are foreign banks with Portuguese shareholders[242]. Interviews confirmed that banks privilege C-band to other frequency bands due to its reliability. Our research identified few examples of major VSAT rollouts:

- MSTelcom is stated to operate 49 sites for connecting branches of the public bank Banco de Poupança e Crédito (BPC) with its headquarters in Luanda. The sites are 256 kbps to 1 Mbps links, operating on iDirect hub. BPC has the largest branch network in the country with 68 branches[243].
- Angolan service provider STARTEL operates about 90 C-band sites (@256 Kbps each) for banking networks connecting remote branches to bank HQs. Around 70 sites are for Banco de Comércio e Indústria (BCI), while Banco Keve and Banco solo use about 10 VSATs each[244].
- Angola-based service provider Nexus also owns and operates a VSAT hub station in Luanda, providing voice and data services to a significant corporate customer base using around 100 remote terminals in both C- and Ku-band. Nexus is stated to operate a private network of 20 C-band sites for BPC bank in Angola. Other bank customers of the company include Banco Nacional de Angola (BNA), Banco Comércio Indústria (BCI), Banco Africano Investimento (BAI) and Banco Comercial Angolano (BCA), each managing an estimated less than 10 C-band sites[245].
- Angola Communication System (ACS), which is majority owned by MSTelcom, also is reported to provide VSAT services with around 350 sites around the country. Customers include banks, government departments and companies in the mining and oil sector. Though the majority of ACS sites are stated to be in Ku-band, part of them should also be C-band sites for bank and oil & gas networks[246].
- Apart from the local bank network, there are also international banks that got C-band remote sites running in Angola. For example, African Development Bank invited an RFP in December 2013 to provide C-band VSAT network connecting 32 office Locations in Africa with NOC/hub station located in Abidjan, Ivory Coast. This RFP includes one C-band VSAT link (4 Mbps) to Luanda office as well[247].

We estimate that there should be around 250 C-band bank sites deployed in the country based on the reported deployments and estimations[248].

## 13.4 OTHERS

Other key C-band connectivity users in the country are public networks, air traffic networks, International and Non-government organizations (NGO) as well as international corporates. Our research identified the following examples:

- Infrasat manages around 200 C-band sites (@1 Mbps each) for the government ID card and social security projects[249].
- Nexus is stated to operate a private network of 18 C-band sites for Angola Press (ANGOP). These are for connecting the agencies' provincial offices to the headquarters in Luanda[250].
- STARTEL manages around 10 sites for Angolan FMCG retailer NDAD to manage POS data at their retail branches[251].
- Other public, corporate and NGO VSAT customers of Nexus include Angola airlines, Ministry of Defense, Universidade Catolica, Universidade Lusiada, UNDP, UHCR, UNICEF, USAID, WFP, DeBeers, Bureau Veritas, Toyotta de Angola and Porto de Luanada. The above sites include both C-band-dedicated sites (32 Kbps-8 Mbps) and Ku-band TDMA sites (up to 256Kbps)[252].
- There is one C-band site deployed under the Satellite Distribution System for Information Relating to Air Navigation (SADIS) network at the Luanda airport as of May 2014. According to ATNS, SADIS subleased 3 MHz C-band capacity to the domestic air traffic communication provider ENANA to manage about five sites. In addition, there are also new domestic networks planned in Angola for air traffic management[253].

Overall, we estimate the number of C-band sites for public services, air traffic management, NGOs and corporates to stand at about 240-250 units.

# 14. Socio-economic benefits

Our assessment shows that the use of C-band satellite capacity is of primary importance to a number of economic sectors in Angola and offers large social benefits. Exhibit 25 provides a synthesis of the findings of our research on current C-band usage. It does not include full findings on the potential development of C-band usage for several segments, with further details being presented in the previous sections.

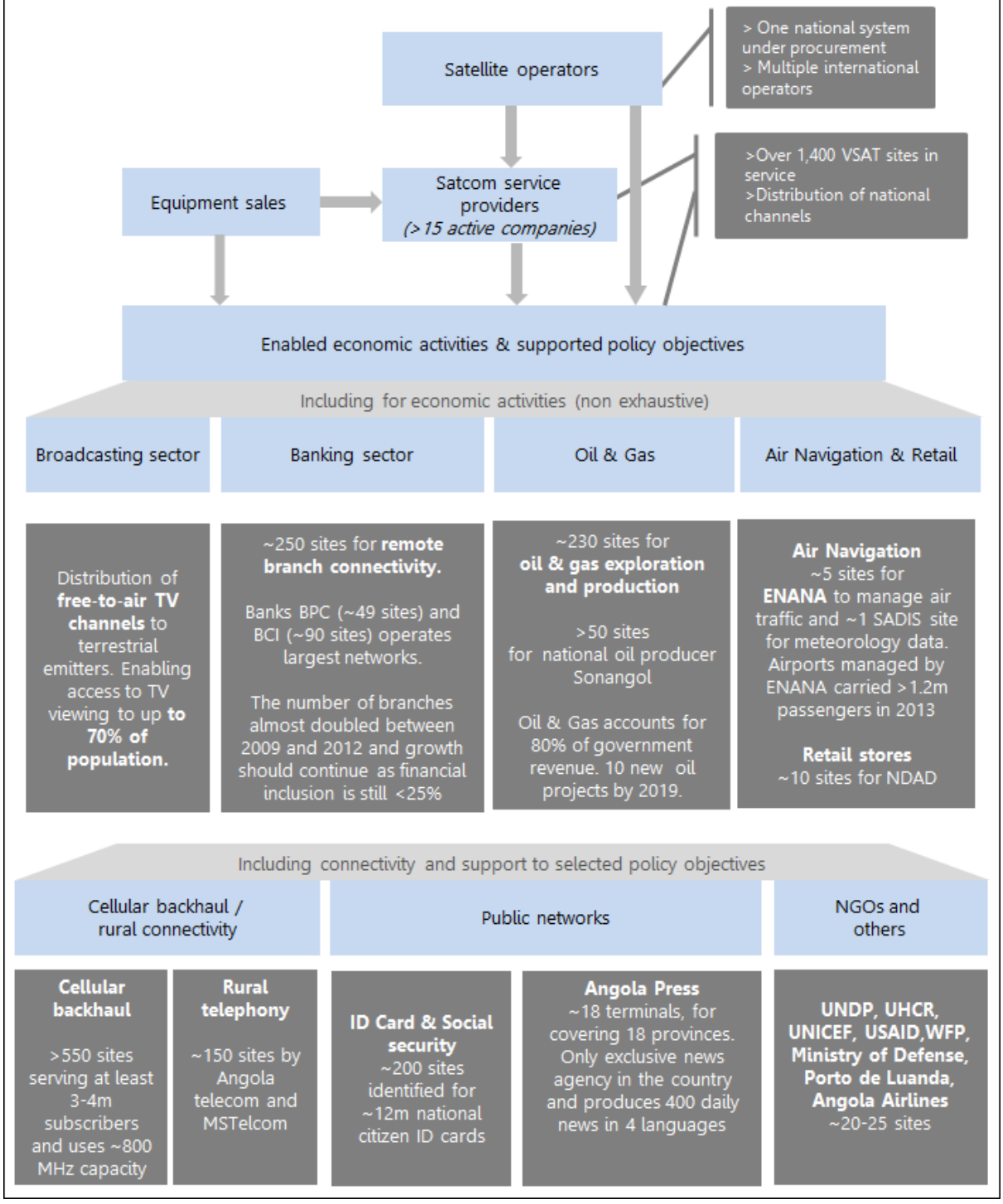
Five particular impacts can be highlighted:

- The presence of about 10 companies specializing in satellite communication services, with a direct investment in C-band capacity. Many of these companies and their employees are at the top of the country's high-technology sector.
- The large use of C-band networks for the **oil and gas industry**, with a direct impact on daily operations. C-band is currently the only frequency band meeting the industry's requirement of a 99% availability of transmissions.
- The use of C-band capacity is a key factor for the **universal access to communication services**. Mobile operators in particular make a large use of C-band for cellular backhaul.
- **The banking industry** is a large and growing user of C-band capacity, in particular to connect bank branches to headquarters and improve the automation of operations.
- C-band networks are also largely used in **support of government services,** including for defense, ID cards, social security projects, education, air traffic management, etc.

The following table summarizes sources for key assumptions supporting Exhibit 25.

| SEGMENT | NOTES ON ASSUMPTIONS |
|---|---|
| Satellite operators | Derived from separate Euroconsult research [254] |
| Satcom service providers and grey box | Channels — see page 56; VSAT sites see Exh. 23 |
| Broadcasting sector | See pages 56-59 |
| Cellular backhaul and rural connectivity | See pages 61-63 |
| Oil & gas | See pages 63-64 |
| Banking | See pages 64-65 |
| Other networks | See pages 65 |

**Exh. 25: ANGOLA: SYNTHESIS OF SOCIO ECONOMIC IMPACT OF SATELLITE C-BAND USAGE**



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