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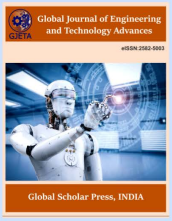

(RESEARCH ARTICLE)

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Deployment and Commissioning of Multiplex R1, R2, and R3 of Digital Terrestrial Television (DVB-T2 HD) in Matadi, Kongo Central Province, Democratic Republic of Congo

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Abstract

The transition to digital terrestrial television (DTT) represents a key step in modernizing the audiovisual landscape in the Democratic Republic of Congo. This work presents the study, design, and commissioning of multiplexes R1, R2, and R3 according to the DVB-T2 high-definition (HD) standard in the city of Matadi, capital of Kongo Central. The deployed architecture relies on a complete chain of processing and broadcasting, integrating DVB-S2 satellite contribution, IP and fiber optic transport, as well as a hybrid terrestrial network combining SFN (Single Frequency Network) and local MFN, in order to address topographical constraints linked to mountainous terrain. The analysis focuses on DVB-T2 transmission equipment, modulation and error correction parameters, as well as coverage strategies implemented to reduce shadow zones in the communes of Matadi, Mvuzi, and Nzanza. Commissioning tests and field validations confirm the compliance of the network with technical and regulatory standards, while ensuring satisfactory SD and HD reception quality for users. This experience serves as a reference model for the future deployment of DVB-T2 DTT in other cities of the DRC, thus contributing to equitable access to modern and high-quality television.

Keywords: Digital Terrestrial Television; DVB-T2; Multiplex R1 R2 R3; SFN; MFN; HD Broadcasting; Matadi; Kongo Central; DRC

1. Introduction

The transition from analog television to digital terrestrial television (DTT) marks a decisive step in modernizing audiovisual infrastructures in the Democratic Republic of Congo. By adopting the DVB-T2 high-definition standard, the country aligns with an international dynamic aimed at improving spectrum efficiency, reception quality, and public access to a diversified audiovisual offering [3]. In this process, multiplexes R1, R2, and R3 play a strategic role: they structure the national offering, pool broadcasting resources, and ensure service continuity [1]. Their deployment in Matadi, capital of Kongo Central, concretely illustrates this ambition. The objective of this work is to present the technical architecture implemented, the deployment stages, and the results obtained in terms of coverage and service quality, in order to propose a reference model for future DTT deployments in the DRC [6].

2. Context and State of the Art

2.1. History of the Transition from Analog to Digital (DVB-T2 HD)

Analog television, dominant since the mid-20th century, long enabled the dissemination of information and entertainment, but it presented significant limitations: poor image quality, high sensitivity to interference, and a limited

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number of channels. To overcome these constraints, the DVB-T (Digital Video Broadcasting – Terrestrial) standard was introduced in Europe in 1997 [2].

In 2006, ETSI launched DVB-T2, the second generation of DTT. This standard brought major advances: increased spectral efficiency, greater robustness under difficult propagation conditions, and the ability to broadcast high-definition (HD) and ultra-high-definition (UHD) content [3]. Today, DVB-T2 has become the reference standard for digital transition in many countries, as it combines technical performance with investment sustainability [7].

2.2. Presentation of DVB-T and DVB-T2 Standards

Table 1 Representation of DVB-T and DVB-T2 standards [2] and [3]

Standard	Main Characteristics	Advantages
DVB-T	First generation (1997), MPEG-2 stream, COFDM modulation	Better than analog, more channels, basic interactivity
DVB-T2	Second generation (2006), advanced modulation and coding (LDPC, QAM), HD/UHD support	+50% spectral efficiency, greater robustness, more interactive services, investment sustainability

2.3. Similar Experiences in Other Provinces or African Countries

In Sub-Saharan Africa, the official switch to digital terrestrial television (DTT) was set for 2015, but its implementation remains uneven across countries [4]. Some states advanced quickly, while others still face financial and organizational obstacles.

In Côte d'Ivoire, Senegal, and Burkina Faso, the adoption of the DVB-T2/MPEG4 standard was accompanied by subsidy programs for decoders, making DTT accessible at affordable prices. Nigeria, on the other hand, experienced difficulties related to financing and mass distribution of adapters, slowing the transition [5]. In Egypt, the state invested more than USD 70 million to subsidize equipment and accelerate deployment. Finally, countries such as Botswana and Angola experimented with other standards (ISDB-T and DTMB), but most African countries chose DVB-T2 as the reference standard, due to its performance and sustainability [2].

3. Methodology

3.1. Description of the Study Site: Matadi, Kongo Central Province

The city of Matadi, capital of Kongo Central Province, occupies a strategic position in the western part of the Democratic Republic of Congo. Located on the left bank of the Congo River, it is the country's main seaport, linking the capital Kinshasa to the Atlantic Ocean. This location gives it a major economic and logistical role, with a high concentration of population, industrial activities, and transport infrastructure [8].

Figure 1 shows the geographical map of Kongo Central Province and highlights the position of Matadi. This representation makes it possible to precisely locate the deployment area of the digital terrestrial television network in relation to other territories, road axes, and surrounding urban areas [8].

Figure 1 Geographical map of Kongo Central Province

3.2. Technical Approach

3.2.1. Implemented Infrastructure

The deployment of multiplex R1 in the city of Matadi represents a key stage in the digital transition in the Democratic Republic of Congo. This multiplex, considered the foundation of the national offering, mainly groups public channels and ensures homogeneous coverage for a wide audience [6].

From a technical perspective, the network relies on DVB-T2 transmitters configured to provide high-definition (HD) broadcasting and stable reception, even in an environment marked by complex terrain [3]. The infrastructure put in place—transmission stations, IP and fiber optic links, DVB-S2 satellite contribution—helps reduce shadow zones and improve service quality in the communes of Matadi, Mvuzi, and Nzanza [7].

This deployment illustrates the ability of DTT to provide modern and accessible television, while serving as a reference model for the future expansion of digital terrestrial broadcasting in other cities of the DRC [1].

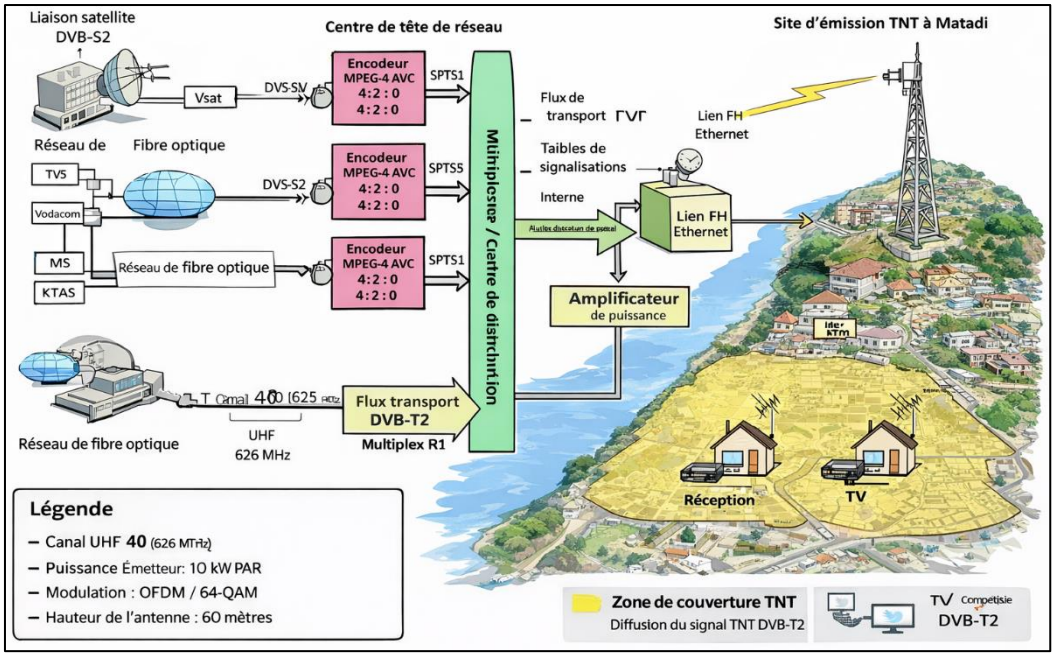

Figure 2 Deployment of multiplex R1 DTT/DVB-T2 HD in the city of Matadi

3.2.2. Broadcasting and Reception Equipment

The deployment of DTT in Matadi relies on modern equipment designed to guarantee reliable broadcasting and quality reception. On the transmission side, next-generation DVB-T2 transmitters were installed and configured to optimize modulation and error correction, ensuring stable transmission even under difficult propagation conditions.

For users, reception is made possible through DVB-T2 HD-compatible decoders, allowing access to both standard definition (SD) and high definition (HD) content. This combination of equipment ensures homogeneous coverage and provides the local population with an enhanced audiovisual experience, offering sharper images and a wider variety of channels accessible to all.

3.2.3. Configuration of Multiplexes R1, R2, and R3

Multiplexes form the core of digital terrestrial television organization, as they group and structure all broadcast channels:

- Multiplex R1: represents the foundation of the national offering, mainly integrating public channels to ensure universal access to information and public service programs.
- Multiplex R2: expands the offering by integrating private and commercial channels, promoting content diversity and competitiveness in the audiovisual sector.
- Multiplex R3: opens the door to thematic or regional content, allowing the promotion of local culture and strengthening proximity information.

3.2.4. Data Collection and Analysis Methods

To evaluate the deployment of DTT in Matadi, three complementary approaches were used:

- Coverage tests: measurements were carried out in several neighborhoods to verify the actual reach of the signal and identify well-served areas or those affected by terrain.
- Signal quality: technical indicators such as received power, error rate, and HD image stability were used to measure network performance.
- User feedback: surveys among residents collected their impressions on image clarity, channel diversity, and the ease of using decoders.

This combination of technical measurements and human feedback provides a comprehensive view: it not only validates network performance but also helps understand its concrete impact on the daily lives of users.

4. Results and Observations

4.1 Technical Deployment of Multiplexes R1, R2, and R3

Figure 3 illustrates the deployment of a digital terrestrial television chain according to the DVB-T2 standard in the city of Matadi. To overcome constraints related to mountainous terrain, a hybrid architecture was implemented, combining a Single Frequency Network (SFN) with local Multi-Frequency Networks (MFN).

Television programs are first collected via DVB-S2 satellite links and fiber optic networks. They are then processed at the headend, where they are encoded, grouped into multiplex R1, and converted into DVB-T2 transport streams.

This stream is carried through IP links and microwave relays to the main transmission site, which broadcasts the signal on a single UHF channel (SFN), covering mainly the commune of Matadi. However, due to shadow zones created by the terrain, gap fillers and local retransmitters were installed in the communes of Mvuzi and Nzanza. Some operate in local MFN mode, on different frequencies, to avoid interference in overlapping areas.

This hybrid architecture ensures homogeneous coverage, service continuity between communes, and reliable DVB-T2 signal reception. It optimizes spectrum use and significantly reduces shadow zones throughout Matadi.

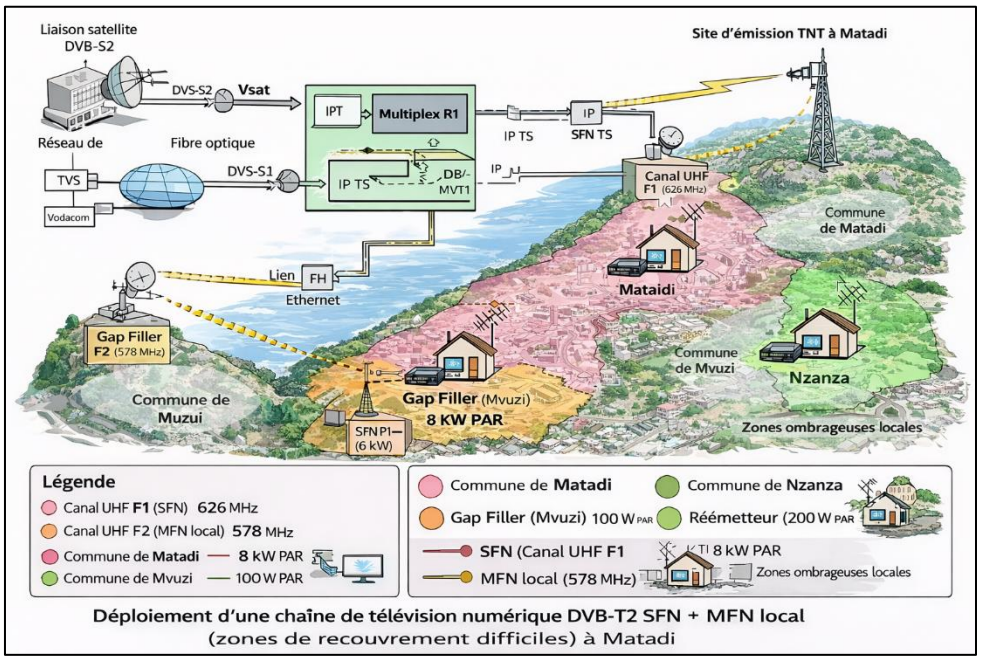

Figure 3 Deployment of a DVB-T2 HD DTT chain in Matadi

4.1. Measured Performance

The evaluation of the DVB-T2 DTT network in Matadi highlighted three main results:

- Geographical coverage: The commune of Matadi benefits from stable coverage thanks to the main SFN network. In Mvuzi and Nzanza, the installation of local retransmitters reduced shadow zones and ensured homogeneous reception.
- Signal quality: Measurements confirmed sufficient power and smooth HD image delivery. The error rate remained low, guaranteeing a good audiovisual experience for residents.
- Robustness against interference: The DVB-T2 standard proved resistant to terrain-related disturbances, climatic conditions, and local interference, ensuring reliable service continuity.

4.2. Comparison Between Multiplexes (R1, R2, R3)

Table 2 Comparison Between Multiplexes (R1, R2, R3)

Multiplex	Main Content	Objective	User Impact
R1	National public channels	Ensure universal access to information and public service programs	Guarantees homogeneous coverage and service continuity for all
R2	Private and commercial channels	Diversify the offering and stimulate competitiveness in the audiovisual sector	Provides more choice and fosters varied content
R3	Thematic and regional channels	Promote local culture and strengthen proximity information	Ensures better representation of regional and cultural realities

4.3. Coverage Maps and Technical Diagrams

Figure 4 shows the functioning of multiplex R1 under the DVB-T2 standard, from program collection to household reception.

Content comes from public channels, private broadcasters, and satellite packages. They are received via DVB-S2 satellite, fiber optics, or IP links, then sent to the headend. There, they are encoded in MPEG-4 AVC in SD or HD to optimize bitrate and ensure good image quality.

The streams are grouped into multiplex R1, with signaling information added and, if necessary, complementary services such as the Electronic Program Guide (EPG). Encryption functions may also be applied to certain content.

The stream is then prepared for DVB-T2 broadcasting: error correction to strengthen robustness and OFDM modulation (QPSK to 256-QAM) for efficient urban and SFN network transmission.

Finally, the signal is amplified and transmitted via UHF antennas at transmission sites. Coverage maps show the progressive distribution of multiplex R1 along the Kinshasa–Matadi axis. DVB-T2-compatible televisions or decoders receive and deliver SD and HD programs, ensuring universal access to DTT.

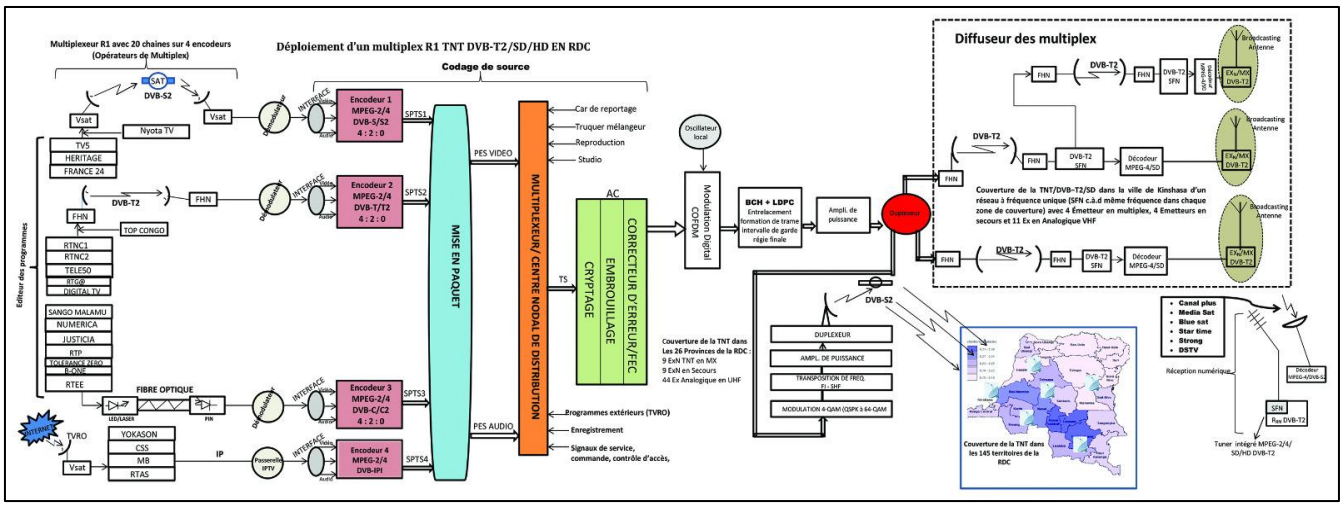

Figure 4 Deployment of multiplex R1 DVB-T2 DTT – Kinshasa–Matadi axis in the DRC

5. Discussion

The deployment of DVB-T2 DTT in Matadi shows that the combined use of SFN and MFN retransmitters can overcome terrain-related constraints. This approach improves coverage and reduces shadow zones in the affected communes.

Signal quality measurements confirm the reliability of the DVB-T2 standard, capable of resisting interference and ensuring stable reception. The multiplex distribution (R1, R2, R3) guarantees universal access to public channels, diversity of private content, and promotion of regional programming.

Coverage maps and technical diagrams make the results more accessible, linking technical data to concrete user benefits: better accessibility, HD image quality, and service continuity.

Overall, this experience demonstrates that solutions adapted to the local context can ensure reliable and equitable broadcasting, serving as a model for other cities in the DRC.

6. Strategic Analysis and Recommendations

The deployment of DVB-T2 DTT in Matadi shows that combining SFN and MFN networks is an effective solution for local constraints, as it improves coverage and reduces shadow zones. The use of the DVB-T2 standard guarantees good image quality and stable reception, reinforcing service reliability. The multiplex structure (R1, R2, R3) meets needs for universality, diversity, and proximity.

From a strategic perspective, it is recommended to extend this model to other cities in the DRC, considering geographical specificities. Strengthening infrastructure with new transmitters and retransmitters is essential to ensure homogeneous coverage. Local capacity building should be encouraged to guarantee network sustainability. Partnerships between the state and private actors can facilitate content diversification and cost-sharing. Finally, clear communication and awareness campaigns are necessary to support the digital transition and foster public adoption.

7. Conclusion

The experience in Matadi shows that digital terrestrial television, based on the DVB-T2 standard, can effectively adapt to local realities. The combination of SFN and MFN networks overcame geographical constraints and ensured homogeneous coverage, while multiplex structuring balanced universal access, content diversity, and regional promotion.

Beyond technology, this deployment illustrates the importance of DTT as a tool for social cohesion and democratization of information access. It demonstrates that digital transition is not only a technological evolution but also an opportunity to strengthen local culture and bring citizens closer to media.

Thus, the example of Matadi constitutes a reproducible model for other cities in the DRC. With adapted infrastructure, strengthened local skills, and public awareness, DTT can become a sustainable vector of modernization and equity in access to audiovisual services.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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