International Journal of Innovative Research and Scientific Studies, 8(2) 2025, pages: 1264-1273

IJIRSS
International Journal of Innovative Research & Scientific Studies

ISSN: 2617-6548

URL: www.ijirss.com

To solving the problem of the "last mile" of the cable TV distribution network

Isa MAMMADOV[1], Ilham AFANDIYEV[1*], Elvin MURADSADEH[1]

[1]*Dept. of Electronics and automation, Faculty of Information Technologies and Control, Azerbaijan State Oil and Industrial University, 16/21 Azadliq Ave, Baku, Azerbaijan.*

Corresponding author: Ilham AFANDIYEV (*Email: ilham.afandiyev@gmail.com*)

Abstract

Isa Mammadov1 The article studied the problem of using broadband radio access technology to solve the "last mile" problem in the cable television distribution network in Baku and the Absheron Peninsula. The noise immunity was ensured by adaptively changing the modulation method according to the measured level of the signal-to-noise ratio without changing the power of the transmitter in the direct channel. In order to reduce interference, it has been proposed and implemented to reduce the power of the main radio transmitter in the direct channel, but to ensure reliable reception of the signal in the service area, the use of a booster has been proposed and implemented. Due to these proposals and applications, a cable television distribution network has been established in the territory under consideration. Ilham Afandiyev1b, Elvin Muradsadeh1c

Keywords: Booster, Integral telecommunications technology, Log-normal distribution, Main transmitter signal/interference ratio, Wireless wideband radio access systems.

DOI: 10.53894/ijirss.v8i2.5446
Funding: This study received no specific financial support.
History: Received: 24 January 2025 / **Revised:** 27 February 2025 / **Accepted:** 10 March 2025 / **Published:** 17 March 2025

Competing Interests: The authors declare that they have no competing interests.
Authors' Contributions: All authors contributed equally to the conception and design of the study. All authors have read and agreed to the published version of the manuscript.
Research interests: Mobile communication systems, Television systems, Signal transmission theory, Radio engineering systems..
Transparency: The authors confirm that the manuscript is an honest, accurate, and transparent account of the study; that no vital features of the study have been omitted; and that any discrepancies from the study as planned have been explained. This study followed all ethical practices during writing.
Publisher: Innovative Research Publishing

1. Introduction

The program distribution network is designed to transmit signals from the television center to the different TV stations. Distribution systems are divided into physical delivery and electronic distribution systems (Figure 1) [1]. Electronic distribution systems include different types of communication channels – terrestrial radio relay links, satellite communication systems, trunk cable lines, and so on.

Traditional systems are now evolving and, in many cases, have been replaced by the latest technology systems. The possibilities of applying multi-channel broadcasting systems were first studied in the transmission network of terrestrial TV broadcasting and then in the distribution network of both this and cable TV. The research on cellular TV broadcasting also laid the foundation for a multi-channel TV distribution network [2]. The implementation of a conventional terrestrial TV broadcasting system involves the construction of costly infrastructure and the use of essential equipment, including program sources, program distribution networks, head-end stations, and re-transmitters of television programs.

The methods for constructing cable TV program distribution networks are well-known. Networks designed based on tree-like, radial, and circular principles simplify reception conditions. Although the application of terrestrial multi-channel systems (MMDS, LMDS, MVDS, and similar systems) allows for simpler and more flexible network designs, signal reception in such networks faces certain challenges. Therefore, implementing various technical measures in these networks is critically important.

The growing interest in the adoption of cellular TV systems is primarily driven by the undeniable advantages of their key performance indicators compared to conventional terrestrial TV broadcasting systems. This latest integrated telecommunications technology is used to solve the “last mile” problems. Various variants of the wireless broadband radio access systems – MMDS (Multipoint Microwave Distribution System; operates in the frequency range of 2.1 ÷ 2.9 GHz), LMDS (Local Multipoint Distribution System; operates in the frequency range of 27.5 ÷ 29.5 GHz), and MVDS (Multipoint Video Distribution System; operates in the frequency range of 40.2 ÷ 42.5 GHz) are known [3, 4]. However, in different countries, the specified frequencies may be slightly different [1, 2].

The above-mentioned systems of integrated telecommunication technology are high-speed and are built according to the cellular principle. Cellular TV broadcasting operates at an environmentally safe level, with the total transmitter power typically ranging between predefined limits of 1÷10 *Vt*.

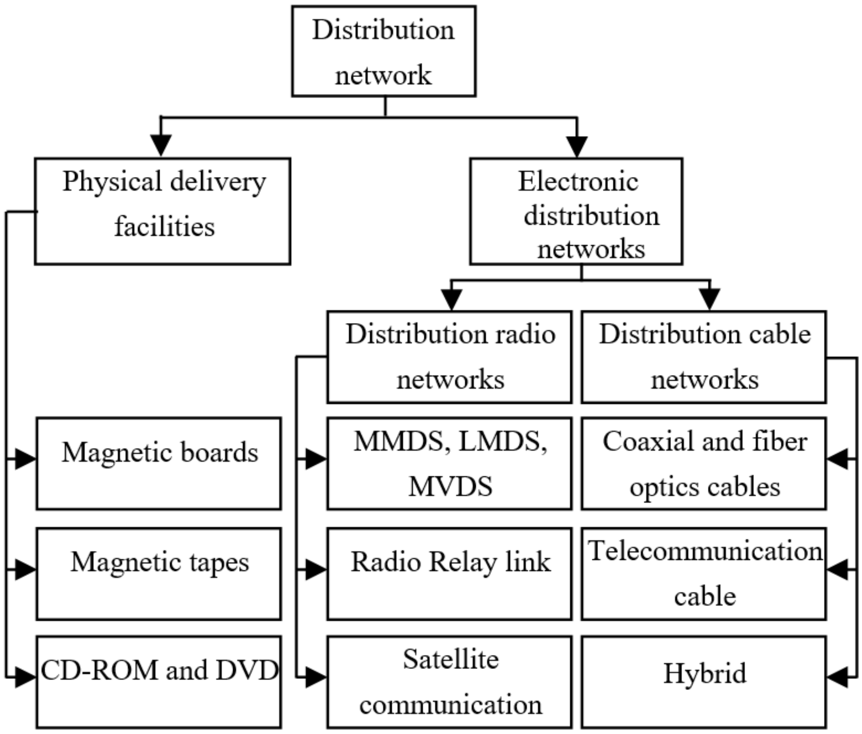


Figure 1.
Classification of the cable TV distribution network.

The main distinguishing feature of cellular TV systems is an excessively large number of transmitting stations in the network and a significantly lower power of each base station compared to the power of TV transmitting stations. In ordinary terrestrial TV broadcasting, the electrical field voltage near the TV station with high power significantly exceeds the permissible norms.

Multi-program TV broadcasting is another advantage of cellular TV broadcasting. Cellular TV laid the foundation for multi-channel terrestrial TV broadcasting systems. In addition, cellular TV uses mass multipurpose services, such as data transmission, Internet access, voice communication, interactivity, etc.

MMDS system is a system with a direct architecture, but in some cases, this system can be interactive [1, 2]. This system has a wide frequency band – 1…2 *GHz*. The LMDS distribution network operates in Europe in the frequency range of 40,5…42,5 *GHz*, used for small areas (whose radius is equal to several kilometers). The latter two systems are more widely used in cable TV [3-5].

High transmission speed, the ability to ensure confidentiality, low cost of equipment and low operating costs, fast network construction, and changing the location of subscribers without additional costs make it convenient to implement these systems in remote or off-land areas [2].

Based on these advantages, the question was raised about conducting research with the aim of introducing broadband radio access technology in the cable television distribution network in the territory under consideration. Although these systems have already found their application, there is a need to conduct research and obtain new results in order to increase their noise immunity and minimize the level of interference in the direct channel. For this reason, the article proposes the selection of the modulation method and its transition from one to another according to the current value of the signal-to-noise ratio.

In addition, the cable television distribution network is studied and established for each area, taking into account its geographical conditions. The issues of establishing this network in the territory of Baku city and the Absheron peninsula have not been studied.

The solution to the tasks is explained in several sections. After the problem to be studied was formulated, ensuring noise immunity by changing the modulation method was studied, the power of the main transmitter was calculated, and then the construction of the cable TV distribution network in Baku and on the Absheron Peninsula was established.

2. Problem Formulation

To reduce network topology-related interferences in the direct channel, the power of the base station (BS) radio transmitter is limited. Additionally, increasing the power of this radio transmitter does not eliminate "dead zones" caused by uneven terrain in the area.

For appropriate network design, it is important to conduct separate scientific and practical research for each region. Taking into account the geographical conditions, the network topology should be developed based on relevant studies to ensure complete area coverage with a minimal number of BS. When necessary, the broadcast area can be appropriately expanded accordingly by using boosters.

The majority of subscribers in cellular TV broadcasting systems are not mobile. As a result, the intensity of fast fading for such subscribers is relatively low. Fast fading occurs due to various factors, with multipath propagation of radio signals being the primary cause. At the reception point, the electrical field intensity is formed by the summation of radio signals arriving through different paths. Doppler spectrum broadening, which occurs during mobile reception, is also a consequence of fast fading. It is well known that even slight movements by a subscriber can lead to significant variations in the median value of electrical field intensity, primarily due to changes in the phase of the received signal.

In a multi-channel radio transmitter, the signal of each program is modulated by its own modulator [1]. It is proposed to apply two different types of modulations in the direct channel of the LMDS system [5, 6]. In this case, two types of modulation are applied in a multi-channel radio transmitter of the same BS, depending on the distance from the transmitter to the radio receiver. Typically, the signal power decreases as the distance to the receiver increases. For this case, it is proposed to use QPSK modulation for farther subscribers, and M-QAM modulation for closer subscribers.

Transmitters of multi-program cellular TV systems emit radio signals with multiple carriers. Based on their design configuration, these transmitters are categorized into single-channel and multi-channel MMDS transmitters.

In a multichannel transmitter, the power of each channel is approximately n^2 times less than the output power. It is obvious that a group signal is formed in the adder of the specified transmitter, which is distinguished by its bandwidth. Thus, the problem of eliminating nonlinear distortions arises. These distortions arise mainly due to the nonlinearity of the static and dynamic characteristics of electronic devices, the dependence of their reactive parameters, especially, the nonlinear capacity of the collector transition, and also due to the amplitude-phase conversion in the input circuit of the electronic device [2].

Namely, the noise immunity in QPSK modulation is higher than in M-QAM modulation. Therefore, it is assumed that the signal at the input of radio receivers of farther subscribers is weaker, and it is considered expedient to apply modulation that provides greater noise immunity for farther subscribers in order to keep this parameter stable.

Figure 2 shows the structure of the transmission part of the downstream of the LMDS system, which is based on changing the modulation method [4, 6]. Most of the blocks used here are similar to the blocks of ordinary terrestrial digital TV broadcasting systems. Randomization should be performed to approximate the distribution of energy and the transitions between bits in the flood to random statistics. Each traffic stream consists of synchronization words and bytes of multiplexed data. The pseudo-random sequence is generated after the recognition sequence is loaded into the scrambler. This sequence affects a group of transport packages.

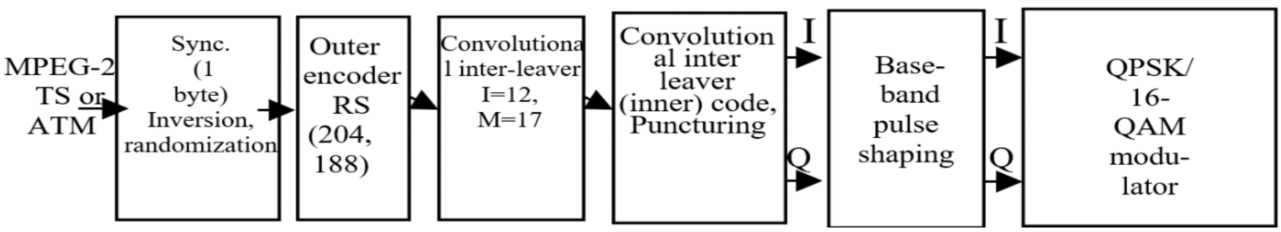


Figure 2.
Block diagram of the transmission part of the LMDS system based on modification of modulation method.

In Håkegård [6] along with coding methods, modulation methods and their selection are shown in LMDS-system. However, the issues of adaptive change of the modulation method depending on the level of signal attenuation are not studied here.

After QPSK/QAM modulation, OFDM modulation is applied in the next stage of the LMDS system. This modulation is particularly important for combating frequency-selective fading, and this issue has been studied in detail by Li and Liu [7]; Pollet, et al. [8] and Du, et al. [9]. In (8), the issues of Radio Resource Allocation in this system were extensively studied. In (9), the BER sensitivity of OFDM systems to Carrier Frequency Offset and Wiener Phase Noise was examined. In (10), the

Accurate Error-Rate Performance Analysis of OFDM on Frequency-Selective m-Nakagami Fading Channels was considered, and the problem of interference immunity was highlighted. However, in none of these papers was the effect of QPSK/QAM modulation applied in the first stage of modulation on interference immunity or the issues of transition from one modulation method to another studied.

The attenuation that occurs during the propagation of radio waves in space depends on a number of factors, and therefore the choice of any type of modulation depending on the distance may not be efficient. In Jensen and Wallace [10] the MIMO system is studied considering the problem of attenuation effect during signal propagation. However, the issue of its use in the construction of the cable TV distribution network, as well as in the selection of the modulation method, has not been touched on here.

At the same time, the use of low-position modulation for longer distances will reduce the transmission speed. From this point of view, it makes sense to measure and determine the current value of the power or signal/noise ratio at the input of the radio receiver. Such adaptive control of power and modulation type will directly increase energy efficiency in the channel.

It is of great importance to regulate the power in the direct channel of the considered systems [8]. The construction of the amplification tract in digital TV transmitters is expressed, and its use in multichannel systems is explained in Ivanyushkin, et al. [4]. Here it shows how the level of interference in other nearby sectors increases when the BS's transmitter power on the direct channel is higher than required. However, this power adjustment will reduce the interference level in the direct channel. The features of the construction of the cable TV distribution network have not been studied in Ivanyushkin, et al. [4].

Thus, unlike previous studies, adaptively changing the modulation method according to the measured current level of the signal-to-noise ratio, selecting the transmitter power in the direct channel at the minimum required level, and selecting the location and power of the booster for expanding the cable TV distribution network while taking into account the characteristics of the Absheron Peninsula territory are new issues studied in this article.

3. Ensuring the Noise Immunity by Changing the Modulation Method

In digital communication systems, the parameter commonly used to assess noise immunity is the ratio of bit energy to noise intensity E_b / N_0, rather than the signal-to-noise ratio, where E_b – is the bit energy, N_0 – is noise intensity. This parameter is only applicable in channels where the influence of noise is considered.

Researched the noise immunity of systems with M-QAM modulation [1, 8, 9, 11-13]. Also shown are dependencies of error probability on the E_b / N_0 ratio, as well as expressions for calculation of error probability at various types of digital modulation and influencing interference [1, 11, 13-16].

As the attenuation increases, the modulation method is changed to the simpler one [5, 6]. Suppose that the modulation method is changed depending on the level of the received signal (or signal/noise ratio) and 64-QAM modulation is performed when the signal level is too high. When this level decreases to a certain extent, it automatically switches to 16-QAM modulation, and when it decreases too much, it switches to QPSK modulation. Let's determine the threshold levels of the signal/noise ratio at which the modulation method is changed.

In order to keep the error probability constant without changing the modulation method, the power of the channels at multi-channel radio transmitter should be increased at high attenuation values [17-19]. To prove this, formulas or graphs derived from various literature can be used for calculating the error probability in the optimal coherence reception [1, 11]. For example, let us use the dependence of the error probability given in Cho and Yoon [11] on the energy parameter h_b^2 for the case where no corrective coding is performed (Figure 3). It is clear from the figure that in order to ensure the chosen error probability, for example, $p_s = 1 \cdot 10^{-7}$ in the QPSK modulation $h_{b1}^2 = E_{b1} / N_0 = 12$, in 16-QAM modulation $h_{b2}^2 = E_{b2} / N_0 = 16$, and in 64-QAM modulation $h_{b3}^2 = E_{b3} / N_0 = 20$ must be provided.

The error probability in M-QAM modulation is calculated by the following known expression [11]:

$$p_s\left(h_b^2\right) = \frac{2\left(1 - \frac{1}{\sqrt{M}}\right)}{log_2 M} Q\left(\sqrt{\frac{3 log_2 M}{2(M-1)} h_b^2}\right), \qquad (1)$$

where M - is the number of positions of the QAM modulation, Q - is the Error function.

If the permissible value of the error probability is given in the considered system, then the permissible value of the E_b / N_0 ratio for each modulation method can be determined from the expression (1). We determine the appropriate values of the E_b / N_0 ratio for the given error probability. In the Figure 4 it is shown the threshold values of this ratio for the two cases – $p_s = 1 \cdot 10^{-7}$ and $p_s = 1 \cdot 10^{-5}$. It is clear from the graph that these values depend on both the modulation method and the permissible value of the error probability. The lower permissible value of error probability, the lower the required value of the E_b / N_0 ratio. In addition, for example, for the $p_s = 1 \cdot 10^{-5}$ transition from 64-QAM modulation to QPSK the required value of the E_b / N_0 ratio reduces by about 1,8 times. This proves that the modulation method has a significant effect on noise immunity.

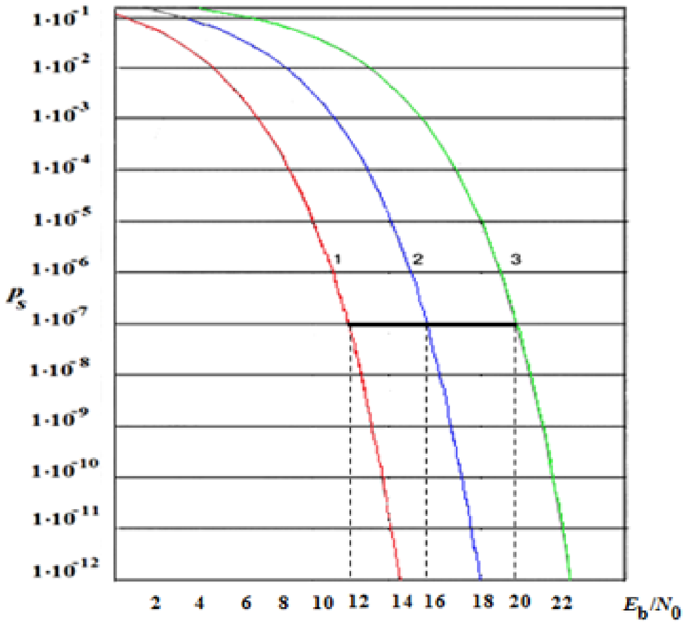


Figure 3.
The dependence of the error probability on the E_b / N_0 ratio for different types of modulations: 1 – QPSK; 2 – 16-QAM; 3 – 64-QAM.

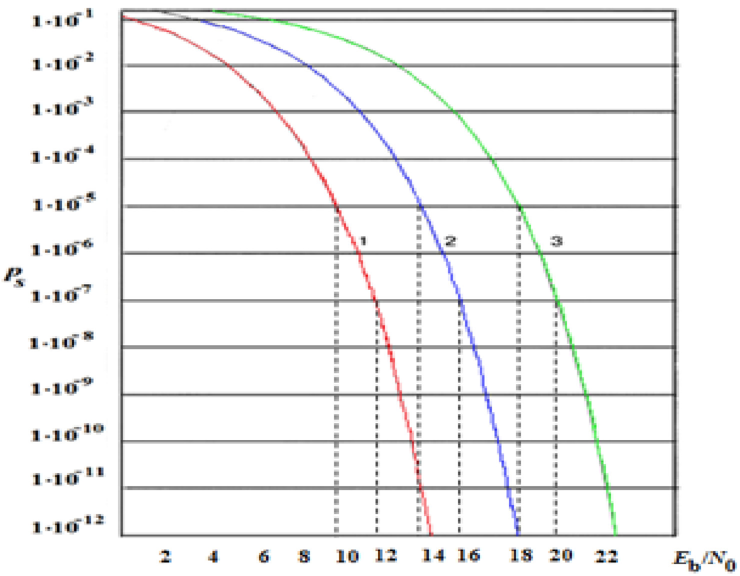


Figure 4.
To determination of the threshold value of the E_b/N_0 ratio for different types of modulation at a given error probability: 1 – QPSK; 2 – 16-QAM; 3 – 64-QAM.

Therefore, the changing of the modulation method was applied in the consideration system. We assume that at the condition $h_b^2 > h_{b3}^2 = E_{b3} / N_0$ 64-QAM modulation, at the condition $E_{b2} / N_0 \le h_b^2 \le E_{b3} / N_0$ 16-QAM modulation, and at the condition $h_b^2 < h_{b2}^2 = E_{b2} / N_0$ QPSK modulation are applied. In this case $p_s = 1 \cdot 10^{-7}$ is provided.

If the minimum permissible value of the error probability is $p_s = 1 \cdot 10^{-5}$ then by using Figure 3, we can establish the dependence of the error probability for different types of modulation on the ratio E_b / N_0. As can be seen from the figure, 64-QAM modulation is applied at high E_b / N_0 ratio.

. However, as this ratio decreases, the error probability increases, and when the minimum permissible level is reached, 16-QAM modulation is switched. In this case, the error probability is sharply reduced. With the further decreasing of the E_b / N_0 ratio, the process is repeated and finally switched to QPSK modulation. Although the error probability decreases sharply again during this transition, this reduction is not the same as before.

It can be seen from Figure 3 that the changing of the error probability in each interval depending on the E_b / N_0 ratio is determined by the error function. As the ratio E_b / N_0 increases in the first interval, the error probability decreases sharply.

Thus, noise immunity was ensured by adaptively changing the modulation method according to the measured level of the signal/noise ratio without changing the power of the transmitter in the direct channel.

4. Determination of the Power of the Main Transmitter and the Signal-to-İnterference Ratio at the İnput of the Receiver

It is necessary to determine the radiated power of the radio transmitter in order to provide the necessary power at the input of the receiver. In general, the required power of the BS transmitter can be defined based on the minimum required signal power (not less than the sensitivity of the radio receiver) at the input of the radio receiver or the minimum required electric field voltage intensity at the receiving point.

The electric field voltage intensity at the receiving point, located at a certain distance from the BS, depends on various factors, including the distance itself. MMDS and LMDS systems operate in Super-high frequency and Extremely-high frequency bands, where determining the power flux density is considered more favorable. This is because these bands experience minimal external interferences, therefore, the influence of noise should be taken into account, i.e., the signal/noise ratio should be calculated. It is known that noise is characterized by its power or intensity (power per unit frequency bandwidth).

The power flux density can be calculated from the known value of the electrical field voltage [14]:

$$\Pi = E - 145{,}8, \quad \text{dBVt/m}^2, \qquad (1)$$

where E – is the electrical field voltage, dBmkV/m.

Once the power flux density is determined, the signal power at the input of the radio receiver can be calculated using a known expression. For this purpose, factors such as the equivalent area of the receiving antenna, its gain factor, wavelength, and losses in the feeder must be taken into account

Expressions have been obtained for calculating the required power at the input of the receiver which depends on the modulation parameters. This power can be determined by the formula [12]:

$$P_0 = h_b^2 T_N k / \tau_s, \qquad (2)$$

where T_N – is the noise temperature, $k = 1{,}38 \cdot 10^{-23}\, J/K$ – is the Boltzmann constant, τ_s – is the duration of the channel signal, $h_b^2 = E_b / N_0$.

In the considered systems, for outer encoding, the Reed-Solomon code *RS* (204,188, t = 8) is usually used. For inner coding, a convolutional code with a rate of 3/4 or 5/6 is often used [2, 5, 6]. Therefore, the duration of the channel signal is defined as the duration of the information signal $\tau_i = 1/R$, multiplied by the rate of the Reed-Solomon code R_{RS} and the convolutional code R_c, taking into account the type of modulation K_m. For outer Reed-Solomon encoding we can define [12]:

$$\tau_s = \tau_i R_{RS} R_c K_m. \qquad (3)$$

For convolutional coding at a rate of 5/6, we can calculate: $\tau_s = 0{,}077 \cdot 10^{-6}\ s$.

It provides graphs of the error probability depending on the signal/noise ratio for the used corrective coding, code rate, and modulation method [1, 9, 15]. A minimal error probability value at the output of the decoder is also known [1, 5, 12]. For the error probability value $p_s = 10^{-5}$ and for the convolutional coding at the rate of 5/6, from the graphs in [4] can be found: $h_b^2 = 8{,}8\, dB$. For the given value k and τ_c at $T_N = 600^0 K$ from (2) can be determined: $P_0 = 8{,}157 \cdot 10^{-5}\, Vt$.

When the power of the BS transmitter is known, the radiated power of the transmitter can be calculated by taking into account the parameters of the transmitting antenna and the losses in the feeder connected between the transmitting antenna and the transmitter.

To ensure system interference immunity in the direct channel, considering the impact of interference, the signal-to-interference ratio (SIR) at the input of the radio receiver must be determined. For this purpose, the power levels of both the signal and the interference at the receiving point must be identified first.

Thus, the Signal-to-Interference Ratio (SIR) at the receiving point depends on the power of the signal and interference, the propagation conditions of radio waves, the distance between the useful and interfering stations and the radio receiver, and the number of interfering stations. The characteristics of communication channels and the slow and fast fading of radio waves during their propagation are provided using statistical, quasi-statistical, and deterministic models. By knowing the radiation power of the signal and interference, these models can be utilized to determine the power of the signal and interference at the receiving point.

As previously noted, the interference in the examined channel primarily originates from the network's own transmitters, which are associated with the network topology. The interference in the bands in which the MMDS and LMDS systems operate is mainly generated by other stations in this network and, therefore, harmful signals of the same band. In these systems, group signals are generated by the transmitters, and the spectrum of these signals is broad. Therefore, the influence of such interference can be evaluated, with a certain degree of accuracy, as the effect of noise [17]. The dependence of the error probability on the *SIR* is generally complex and highly dependent on the reception method. The algorithm and scheme for optimal coherent reception of symbols individually provide potential interference immunity. However, in this case, the characteristics of the interference must also be taken into account.

In channels where both noise and interference are present, determining the energy parameter becomes more complex.

However, since the spectrum of interference in the considered systems is very wide, the *SIR* is considered here as $h_{b\Sigma}^2 = \frac{E_b}{N_0 + N_{0i}}$. The definition of the expression has been proven in Banelli, et al. [17] here N_{0i} – is the intensity of the interference.

By writing $h_{b\Sigma}^2$ instead of h_b^2 in (1) we can calculate the probability of errors in conditions affected by broadband interferences.

5. Construction of the Cable TV Distribution Network in Baku and on the Absheron Peninsula

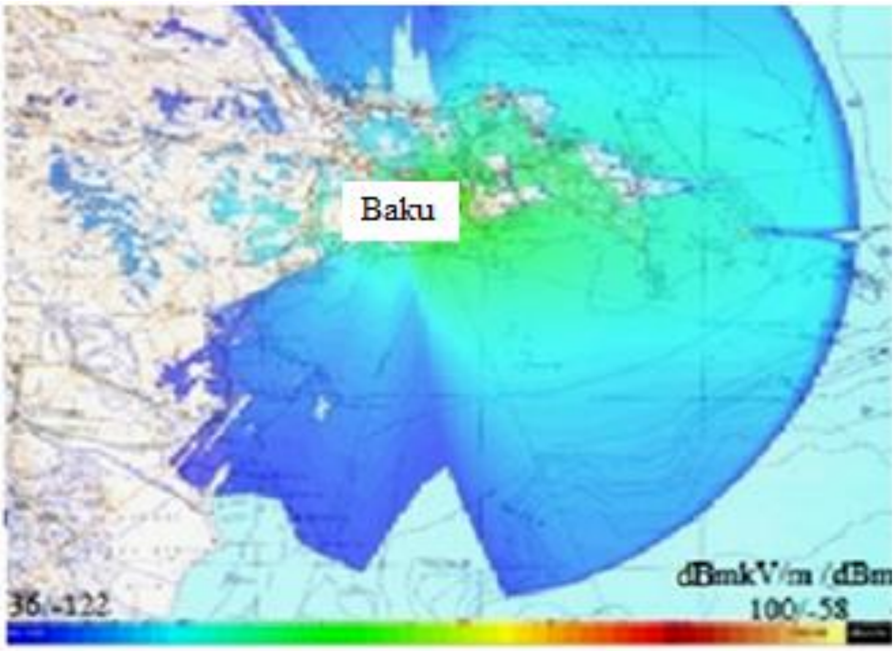
It is known that the cable TV distribution network is constructed according to various principles. But often the above-mentioned broadband radio access systems are used to solve the "last mile" problem. The use of such a system in Baku and the Absheron Peninsula has its own peculiarity. Here it is necessary to cover the main area of Baku and the Zikh district, where subscribers of the cable TV "Connect TV" are located. The main transmitter and nearby base stations (BS) create zones in the main part of the city. Figure 5 a shows the location of the main MMDS transmitter with a power of 2 *Wt*, operating at the frequency of 11,5 *GHz* with a transmitting antenna gain of 10 *dB*, installed at an altitude of h = 200 *m* on the Baku TV tower (note that in order to avoid interference with the signal of another similar system, installed on the Baku TV tower, a differ operating frequency was selected for the considered system). Figure 5 b shows the coverage area of this transmitter, in which electric field voltage levels are shown in different colors. At the bottom of the map in Figure 5 b, the power values in *dBm* and the electric field voltage in *dBμV/m* are indicated, where the indicated values increase from the left (blue color - 36 *dBμV/m*) to the right (red color - 100 *dBμV/m*). White color areas correspond to areas where the electric field voltage is equal to zero.

By using a computer program and a digital electronic map of the peninsula, a coverage area is compiled taking into account its terrain. It can be seen from the obtained diagram that in the area of Zikh and Qarachukhur districts there are zo nes, in which reception of the system signal is not possible (white color areas on the map).

Sometimes repeaters (boosters) are used to exclude gaps ("dead zones") in the network. Boosters are transceiver complexes consisting of receiving and transmitting antennas, broadband amplifiers with filtering units, and feeder lines.

Figure 6 shows the use of the booster for relaying a signal in the Zikh region. Figure 6 shows that the expansion of the service area to the right of Baku Bay can be carried out by using a booster. A highly directional antenna is used to establish communication with the booster. In this case, BS is installed only in the necessary area and there is no need to cover the entire area with a number of BS.

a)



b)

Figure 5.
Map of the Absheron Peninsula showing the location of the main transmitter (a) and its coverage area (b).

The method for determining the distance of direct radio visibility and the effective height of the transmitting antenna is known. A TV station in Baku is defined as for flat and flat-hilly terrain. The tower is at an altitude of h_0 = 134 m above sea level. Therefore, the total height of the transmitting antenna of the MMDS is: $h_1 = h + h_0$ =334 m. For the considered topography, the equivalent height is found by the formula [12]:

$$h_{1eq} = \begin{cases} h_1 - h_{ae}; \text{ when } h_{1eq} \geq 10\,m \\ 10\ m; \text{ when } h_{1eq} \leq 10\,m. \end{cases} \quad (4)$$

where h_{1eq} – is defined as the difference between the height of the electrical center of the transmitting antenna h_1 and the average height of the relief h_{ae} at a distance R of 3 km to 15 km directly from the transmitting antenna to the receiver. Using a digital electron map of the area and the compiled computer program, we get profiles of terrain to the Zikh district direction (Figure 7).

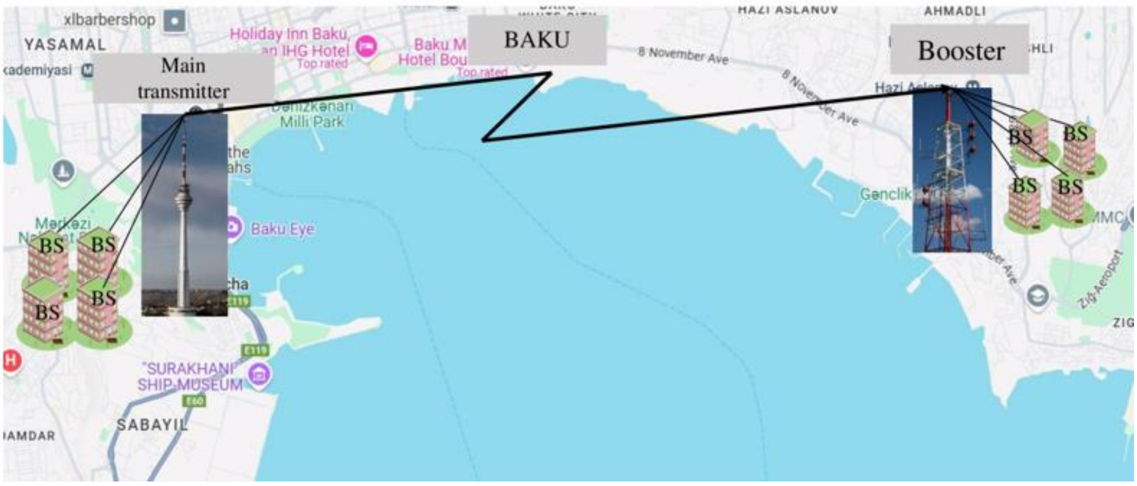


Figure 6.
Location of the main transmitter and repeater on the Absheron Peninsula.

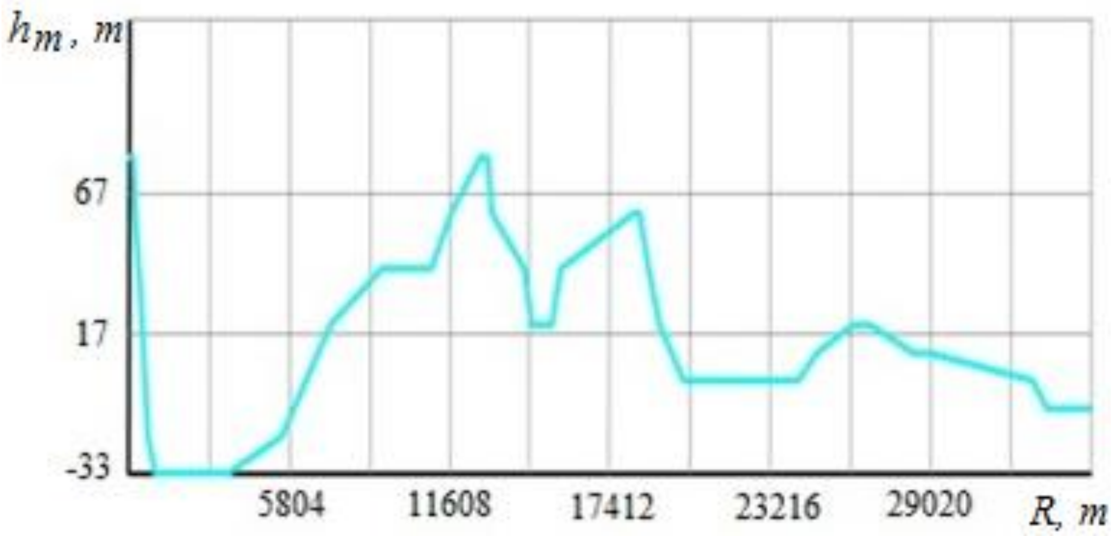


Figure 7.
Profile of the relief in the direction of Zikh.

Also, using computer calculations and a digital map of Azerbaijan, we determined the equivalent height of the transmitting antenna: $h_{1eq} = 287.6\ m$.

Thus, in order to reduce interference in the direct channel, it is proposed and implemented to reduce the power of the main transmitter but to use a booster to ensure reliable reception of the signal in the service area.

6. Conclusion and Recommendation

In the cable television distribution network, wireless broadband radio access technology can be applied to solve the "last mile" problem due to a number of its advantages. In this case, it is necessary to study the method of selecting the modulation type, the power of the multichannel radio transmitter of the base station on the direct channel, as well as the characteristics of the area where the network is built. These issues were studied in the article, and the following new results were obtained:

1. Adaptively changing the modulation method according to the measured value of the signal-to-noise ratio while maintaining the power of the multi-channel radio transmitter of the base station in the direct channel allows for more accurate noise immunity.
2. In the network of integrated telecommunication type MMDS in Baku and on the Absheron Peninsula, the power of the active main transmitter should be reduced, and a booster with appropriate location coordinates should be used to expand the coverage area.
3. The correct selection of the location of the booster and its power allows for reducing 'dead' zones.
4. The construction of the cable television distribution network, taking into account the characteristics of the area, also allows for reducing the number of base stations.

Based on the proposals and applications, a cable TV distribution network was established in the considered area.

References

[1] M. C. Farias, M. M. Carvalho, and M. S. Alencar, "Digital television broadcasting in Brazil," *IEEE Multimedia*, vol. 15, no. 2, pp. 64-70, 2008. https://doi.org/10.1109/MMUL.2008.25

[2] D. Linglong, Z. Wang, and Z. Yang, "Next-generation digital television terrestrial broadcasting systems: Key technologies and research trends," *IEEE Communications Magazine*, vol. 50, no. 6, pp. 150-158, 2012. https://doi.org/10.1109/MCOM.2012.6211497

[3] M. El-Hajjar and L. Hanzo, "A survey of digital television broadcast transmission techniques," *IEEE Communications Surveys & Tutorials*, vol. 15, no. 4, pp. 1924-1949, 2013. https://doi.org/10.1109/SURV.2013.032713.00104

[4] R. Y. Ivanyushkin, K. Razin, and N. Shmakov, "Perspective ways of construction of the tract of amplification of transmitters for digital television broadcasting," in *2018 Systems of Signal Synchronization, Generating and Processing in Telecommunications (SYNCHROINFO)*, 2018: IEEE, pp. 1-5.

[5] V. García-Perdomo, "Re-digitizing television news: The relationship between TV, online media and audiences," in Digital Journalism in Latin America: Routledge. https://doi.org/10.4324/9781003223368-2, 2023, pp. 7-25.

[6] J. E. Håkegård, "Coding and modulation for LMDS and analysis of the LMDS channel," *Journal of Research of the National Institute of Standards and Technology,* vol. 105, no. 5, p. 721, 2000.

[7] G. Li and H. Liu, "Downlink radio resource allocation for multi-cell OFDMA system," *IEEE Transactions on Wireless Communications*, vol. 5, no. 12, pp. 3451-3459, 2006. https://doi.org/10.1109/TWC.2006.256968

[8] T. Pollet, M. Van Bladel, and M. Moeneclaey, "BER sensitivity of OFDM systems to carrier frequency offset and Wiener phase noise," *IEEE Transactions on Communications*, vol. 43, no. 2/3/4, pp. 191-193, 1995. https://doi.org/10.1109/26.380034

[9] Z. Du, J. Cheng, and N. C. Beaulieu, "Accurate error-rate performance analysis of OFDM on frequency-selective Nakagami-m fading channels," *IEEE Transactions on Communications*, vol. 54, no. 2, pp. 319-328, 2006. https://doi.org/10.1109/TCOMM.2005.862978

[10] M. A. Jensen and J. W. Wallace, "A review of antennas and propagation for MIMO wireless communications," *IEEE Transactions on Antennas and Propagation,* vol. 52, no. 11, pp. 2810-2824, 2004. https://doi.org/10.1109/TAP.2004.835272
[11] K. Cho and D. Yoon, "On the general BER expression of one-and two-dimensional amplitude modulations," *IEEE Transactions on Communications,* vol. 50, no. 7, pp. 1074-1080, 2002. https://doi.org/10.1109/TCOMM.2002.800818
[12] G. Mihaylov and E. Ivanova, "Analysis and estimation of the field strength of digital terrestrial television broadcasting," *The Journal of CIEES,* vol. 1, no. 1, pp. 17-22, 2021. https://doi.org/10.xxxx/jciees.2021.01.003
[13] L. Goldfeld, V. Lyandres, and D. Wulich, "Minimum BER power loading for OFDM in fading channel," *IEEE Transactions on Communications,* vol. 50, no. 11, pp. 1729-1733, 2002. https://doi.org/10.1109/TCOMM.2002.805493
[14] J. Lee, H.-L. Lou, D. Toumpakaris, and J. M. Cioffi, "SNR analysis of OFDM systems in the presence of carrier frequency offset for fading channels," *IEEE Transactions on Wireless Communications,* vol. 5, no. 12, pp. 3360-3364, 2006. https://doi.org/10.1109/TWC.2006.256986
[15] B. Hu and N. C. Beaulieu, "Performance of an ultra-wideband communication system in the presence of narrowband BPSK-and QPSK-modulated OFDM interference," *IEEE Transactions on Communications,* vol. 54, no. 10, pp. 1720-1724, 2006. https://doi.org/10.1109/TCOMM.2006.881644
[16] I. R. Mammadov, I. J. Islamov, Z. A. Ismailov, and E. I. Muradzade, "Theoretical and experimental assessment of the noise levels arising at the analog-to-digital conversion of the TV broadcast luminance microwave signals," *International Journal of Microwave & Optical Technology,* vol. 19, no. 5, pp. 1-11, 2024.
[17] P. Banelli, G. Baruffa, and S. Cacopardi, "Effects of HPA nonlinearity on frequency multiplexed OFDM signals," *IEEE Transactions on Broadcasting,* vol. 47, no. 2, pp. 123-136, 2001. https://doi.org/10.1109/11.948265
[18] J. Sanchez-Garcia and D. R. Smith, "Capture probability in Rician fading channels with power control in the transmitters," *IEEE Transactions on Communications,* vol. 50, no. 12, pp. 1889-1891, 2002. https://doi.org/10.1109/TCOMM.2002.806478
[19] N. Y. Ermolova and B. Makarevitch, "Low complexity adaptive power and subcarrier allocation for OFDMA," *IEEE Transactions on Wireless Communications,* vol. 6, no. 2, pp. 433-437, 2007. https://doi.org/10.1109/TWC.2007.05461