Terrestrial Wireless Digital Television Coverage Single Frequency Network SFN Networking Mode and Poor Reception Handling Postprint

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Abstract

Wireless digital television is a novel television reception method that has emerged based on cable digital television, with the two employing substantially different coverage approaches. At present, the promotion of terrestrial wireless digital television in China remains in its nascent stage, where coverage areas require expansion and various issues such as poor reception persist, thereby constraining the broader adoption of wireless digital television. Accordingly, this paper first briefly analyzes the principles and advantages of single-frequency networks, then expounds upon the networking architecture of Single-Frequency Network (SFN) for terrestrial wireless digital television coverage, and finally explores effective mitigation measures for poor reception in SFN-based terrestrial wireless digital television coverage.

Full Text

Terrestrial Wireless Digital TV Single Frequency Network (SFN) Coverage: Network Configuration Modes and Poor Reception Handling

Abstract: Terrestrial wireless digital TV represents a novel reception method derived from cable digital TV, with significantly different coverage approaches. Currently, the promotion of terrestrial wireless digital TV in China remains in its initial stages, with coverage scope requiring expansion and various issues such as poor reception limiting its broader adoption. This paper briefly analyzes the principles and advantages of SFN, elaborates on network configuration modes for terrestrial wireless digital TV SFN coverage, and finally explores effective measures for addressing poor reception in SFN deployments.

Keywords: wireless digital TV; single frequency network SFN; network configuration mode; poor reception handling

2. SFN Network Configuration Modes for Terrestrial Wireless Digital TV Coverage

Terrestrial wireless digital TV coverage employs three primary networking approaches: single frequency networks, dual-frequency networks, and multi-frequency networks. Among these, SFN is most widely adopted due to its high frequency resource utilization efficiency and extensive coverage area. SFN performance is influenced by various system parameters including modulation coding schemes, guard intervals, and error correction code rates, making the selection of appropriate SFN configuration modes contingent upon careful consideration of these parameters and actual requirements.

2.1 Configuration Principles

The structure of terrestrial digital TV SFN constitutes a network topology. When substantial coverage overlap exists within an SFN, the signal carrier-to-noise ratio decreases, leading to reception failures in certain areas—manifesting as poor SFN reception. Therefore, to ensure optimal SFN performance, network configuration modes must be selected judiciously during SFN construction to minimize overlapping coverage areas and ensure all transmission points within the coverage zone emit TV signals at identical frequencies with reduced interference, thereby guaranteeing signal transmission quality.

The selection of SFN configuration modes should adhere to specific principles: the distance between transmitters within SFN coverage should be less than yet approach the theoretical coverage radius of the SFN; configuration modes with low carrier-to-noise ratio thresholds should be employed; transmission modes with high payload rates should be selected; and system parameters should be calculated accurately to achieve effective control of terrestrial digital TV transmitter power and maximize TS stream transmission.

2.2 SFN Network Mode Analysis

SFN networking includes two structural implementations: open network architecture and closed network architecture. The open network structure consists of individual transmitters, which helps reduce radiation level restrictions on areas outside SFN coverage caused by the overall network structure. The closed network architecture, meanwhile, facilitates lowering radiation levels outside the SFN coverage area without affecting service conditions.

Based on the determined SFN structure and varying practical requirements, SFN configuration modes can be divided into two types: hexagonal network mode (Figure 1 [Figure 1: see original paper]) and triangular SFN mode (Figure 2 [Figure 2: see original paper]). The hexagonal SFN mode is primarily suitable for large-area coverage, while the triangular SFN mode covers relatively smaller areas, demonstrating distinct characteristics of each approach.

Analysis of the hexagonal SFN mode reveals that it consists of seven transmission stations. The periphery comprises six stations with identical transmission power, transmitting directionally toward the seventh central station. The hexagonal SFN offers larger coverage area with strong adjustability, enabling expansion of terrestrial digital TV SFN coverage through combinatorial assembly in a honeycomb structure.

The triangular SFN mode involves constructing three transmission stations in a triangular configuration to achieve closed SFN networking. With identical transmitter power, coverage area expansion can be accomplished by assembling three such triangular units.

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3. Effective Measures for Handling Poor Reception in Terrestrial Wireless Digital TV SFN

3.1 Transmitter-Side Adjustments

The transmitter side includes transmission stations and digital TV repeaters. Poor reception issues in SFN arising from large overlapping coverage areas and low carrier-to-noise ratios can be addressed through scientific transmitter-side adjustments, such as increasing transmission station output power, using digital TV repeaters to supplement SFN coverage, and employing leaky cable to augment underground space coverage.

Transmission stations constitute the primary entities for receiving and emitting signals in terrestrial digital TV SFN, with their output power determining coverage area size. Compared to areas near the SFN core, remote regions receive poorer TV signal quality and are prone to reception problems. Therefore, to better address SFN reception issues, transmission station output power can be increased and antenna heights raised according to actual requirements and operational conditions, thereby enhancing field strength within SFN coverage and expanding coverage range while maintaining signal transmission quality.

Digital TV repeaters, as wireless relay signal enhancement devices, represent an effective solution for poor TV signal reception. Based on different transmission methods, digital TV repeaters include three types: optical fiber, co-frequency, and frequency-shifting repeaters. By selecting appropriate repeater types according to actual terrestrial wireless digital TV signal transmission requirements and SFN coverage conditions, SFN coverage can be effectively supplemented. Repeater power is limited, and interference caused to SFN transmission signals is negligible. Furthermore, repeater operation timing need not be synchronized with transmitters within SFN coverage, which helps ensure signal transmission quality.

Terrestrial wireless digital TV transmitter output connections primarily include two methods: transmitter antenna connection and leaky cable connection. Antenna connections are mainly effective above ground, with limited impact on underground spaces, resulting in coverage blind spots in underground parking garages, tunnels, and similar areas. To address this, leaky cable connections can supplement antenna connections. As a type of coaxial antenna, leaky cable proves more effective in underground spaces. Through leaky cable supplementation, the cable's outer conductor generates high-frequency energy via multiple slots, radiating this energy uniformly and forwarding it through repeaters to improve TV signal transmission quality in underground spaces.

3.2 Receiver-Side Improvements

The receiver side refers to the terminal equipment receiving TV signals transmitted by wireless digital TV SFN. Poor reception issues in SFN can be resolved through receiver-side improvements to ensure signal transmission quality. In terrestrial digital TV SFN construction, selecting higher-performance, higher-gain receiving antennas and corresponding equipment enhances receiver-side anti-interference capability and sensitivity, strengthening reception capacity and ensuring better handling of signal reception problems.

Additionally, diversity reception technology represents an ideal solution for addressing poor reception in terrestrial digital TV SFN in China. The application principle involves combining dual-tuner receiver design with dual-space diversity technology to ensure received signal levels are improved under identical transmitter power conditions, thereby enhancing signal transmission quality and resolving reception issues.

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4. Conclusion

In summary, terrestrial wireless digital TV represents a core development direction for the broadcasting industry. SFN coverage scope and signal transmission quality directly influence the development pace of terrestrial wireless digital TV. To address current signal reception problems in terrestrial digital TV transmission, employing SFN technology and rationally selecting SFN configuration modes while adjusting transmitter-side parameters and improving receiver-side equipment can enhance signal transmission quality, expand SFN coverage area, ensure effective signal reception, and promote the broader adoption of terrestrial wireless digital TV.

References

[1] Yang Junhua, Gu Xiaohui. Terrestrial Wireless Digital TV SFN Configuration Modes and Poor Reception Handling[J]. West China Broadcasting TV, 2014(2).

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