Postprint: Improving Digital Terrestrial Television Coverage Performance Using 5G Technology

Authors: Tong Ying, Wang Lin, Zhang Yongqiang, Yuan Dayong

Date: 2023-10-08T00:00:00+00:00

Abstract

Digital terrestrial television represents one of the primary transmission modalities for future television broadcasting, offering advantages such as extensive coverage and freedom from bandwidth constraints; however, it is also characterized by several limitations, including the absence of an uplink channel, poor interactivity, and suboptimal actual reception performance. The advancement of 5G technology can effectively remedy the coverage limitations of digital terrestrial television, address reception challenges for end-users, and elevate the overall coverage capabilities of broadcasting and television services. Through a detailed analysis of both 5G and digital terrestrial television technologies, this paper investigates the strategies and prospects for their convergent development.

Full Text

Preamble

Title: Utilizing 5G Technology to Enhance Terrestrial Digital Television Coverage

Abstract: Terrestrial digital television represents one of the primary transmission methods for future broadcasting, offering advantages such as broad coverage and freedom from bandwidth constraints. However, it suffers from numerous deficiencies including the lack of uplink channels, poor interactivity, and suboptimal actual reception performance. The development of 5G technology can effectively compensate for these shortcomings in terrestrial digital television coverage, resolve end-user reception challenges, and elevate the overall broadcasting coverage level. This paper explores the integration and development prospects of 5G and terrestrial digital television technologies through specific technical analysis.

Keywords: 5G; terrestrial digital television; coverage

Authors: Tong Ying, Wang Lin, Zhang Yongqiang, Yuan Dayong

1. Overview

5G, the fifth-generation mobile communication technology, represents the latest cellular mobile communication standard. In the 5G era, the media industry has emerged as a key vertical application domain for "5G+" exploration. On June 6, 2019, the Ministry of Industry and Information Technology issued a 5G license to China Broadcasting Network, providing wings for the takeoff of smart broadcasting. In contrast, terrestrial digital television marks a revolutionary advancement in broadcast transmission and coverage technology, representing the cutting edge of broadcasting science. However, its development in recent years has encountered difficulties. Within broadcasting' s 5G blueprint, whether effective integration with terrestrial digital television can be achieved to create a synergistic effect where 1+1>2 warrants thorough industry examination.

2. Coverage Analysis of Terrestrial Digital Television

Terrestrial digital television planning primarily utilizes existing transmission sites for coverage, which, constrained by actual geographic locations, rarely achieves optimal results. Actual performance often diverges significantly from theoretical models. Taking Anhui Province' s largest central radio and television program wireless digital coverage network as an example, field measurements reveal substantial variation in coverage radius across different regions. With the same 1kW transmission power, signals can reach 40 kilometers in some locations, but typically only about 20 kilometers in most areas, and in many places merely a few kilometers. Since transmission station spacing generally exceeds 40 kilometers, numerous coverage gaps exist throughout the province, making true single-frequency network implementation difficult. Furthermore, even within coverage areas, blind spots are common due to urban buildings and local terrain. While gap-filling stations can partially address these issues, their design is challenging and requires substantial investment.

Additionally, terrestrial digital television remains a one-way channel, relying on third-party networks for bidirectional information transmission. This prevents features such as video-on-demand, catch-up TV, and time-shifting, resulting in an inadequate user experience. The technology employs single-point high-power transmission, meaning a transmitter failure causes complete service interruption —a comprehensive impact unlike communication networks where nearby base stations can immediately provide backup.

3. Prospects for 5G Technology Application in Broadcast Television Wireless Coverage

5G networks feature three key characteristics: extremely high data rates, massive capacity, and ultra-low latency, offering new opportunities for content creation and distribution. These capabilities enable operators to meet the demand for high-quality video on mobile devices in the most efficient and cost-effective manner. Transmitting broadcast television programs via 5G networks is feasible: on May 30, 2019, the BBC used EE' s 5G network to broadcast morning programs live across six UK cities, achieving the country' s first 5G television broadcast and attracting widespread international attention.

However, current 5G deployments utilize very small cells that perform excellently over short distances but cannot provide the extensive coverage of broadcast television transmission sites. Consequently, 5G requires far more transmitters than terrestrial digital television and is better suited as a supplement rather than a replacement. Given China' s vast territory and large population, delivering popular television channels to every household via unicast during prime time "golden hours"would generate enormous traffic volumes likely to overwhelm 5G networks, despite their massive data throughput. Moreover, users must pay for 5G data usage, necessitating careful consideration of the economics of pure 5G applications. In summary, integrating terrestrial digital television with 5G technology is essential.

4. Terrestrial Digital Broadcast Television Networks Based on Future 5G Broadcasting

4.1 5G Broadcasting Concept and Implementation

In the convergence of 5G and broadcasting, the concept of 5G broadcasting has emerged, primarily involving a hybrid network that integrates broadcast networks, 5G networks, and fixed networks to distribute point-to-multipoint (PTM) content, endowing traditional broadcasting with enhanced interactivity. The international mobile communications standards organization 3GPP introduced LTE enTV technology for digital television broadcasting in Release 14, bringing multiple radio access layer enhancements including better coverage for mobile and fixed terminals, greater broadcast capacity, and higher deployment flexibility—undoubtedly laying a solid foundation for 5G broadcasting deployment.

Broadcast services are transitioning to IP networks, shifting from dedicated distribution networks to multi-purpose universal networks, allowing consumers to receive television broadcasts through various networks. 5G spectrum efficiency represents a critical step in this direction, achieving practical network broadcasting effects by eliminating the need to send real-time content separately to each receiver, rather than point-to-point delivery. 3GPP will re-evaluate LTE enTV in the R16 standard and may enhance it to meet 5G broadcasting requirements.

4.2 Integration of Terrestrial Digital Television and 5G Broadcasting

Broadcast television must actively embrace 5G, adopting a "terrestrial digital television broadcast + 5G broadcast" model to achieve transformation and upgrading of traditional media and integrated development with emerging media. Terrestrial digital television broadcast will continue serving large-screen displays and bus mobile screens with 4K or 8K ultra-high-definition wireless network delivery, while 5G broadcast will target small mobile screens with high-quality live television services. Leveraging mobile terminals, broadcasting will upgrade from "village access" and "household access" to "everyone access," "mobile access," and "terminal access," creating an autonomous and reliable mobile network that enhances large-scale production of all-media content, expands public cultural dissemination channels, and realizes an information dissemination paradigm where "terminals follow people and information revolves around people."

Hybrid television broadcast services based on 5G broadcasting will include not only live television but also video-on-demand, user-generated content (UGC) upload, audio broadcasting, audio-on-demand, social media content, interactive advertising, and personalized or localized advertisements. User terminals may include large-screen televisions, various mobile smart devices, or vehicle-mounted terminals, enabling ubiquitous media content consumption in indoor and outdoor environments, whether stationary or mobile. Furthermore, 5G broadcasting can enable augmented/virtual reality broadcasting, providing live and on-demand AR/VR/MR content that users can consume anywhere through smart wearable devices, mobile terminals, and vehicle-mounted systems.

5. Development Strategies

5.1 Promoting R&D Upgrades and Expanding 5G Distribution Channels

Regarding 5G network transmission methods and content, the broadcasting industry should research next-generation wireless broadcasting television technology, promote wireless interactive broadcasting television technology research, establish standards, engage in international exchanges, and lead the industry in building a new-generation wireless interactive broadcasting television network. While advancing R&D, actively expanding 5G distribution channels is imperative. In July 2018, China International Television Corporation (a subsidiary of China Media Group) and China Mobile launched deep cooperation across six domains: 5G technology R&D, 4K ultra-high-definition channel construction, content distribution, big data, and capital. In December, cooperation agreements for 5G new media platforms were also signed with China Telecom and China Unicom. Provincial and municipal broadcasting stations should also plan early and actively prepare. Taking Anhui Province as an example, in July 2019, Anhui Broadcasting Corporation held a signing ceremony with Huawei, ZTE, provincial telecom operators, provincial broadcasting networks, and the Department of Culture and Tourism, initiating multi-domain cooperation in the 5G

era and creating a new integrated development pattern of "5G + Smart Broadcasting + Smart Tourism + Ultra-HD Video."

5.2 Developing Broadcasting Television 5G Networks

The 700MHz frequency band has long been recognized as the golden spectrum for 5G transmission, with the 5G license for this band already obtained by the broadcasting industry for future 5G and other communication applications. However, this golden frequency band has traditionally been used for terrestrial television services, including in the relatively recent central radio and television program wireless digital coverage project where it was incorporated into frequency planning. Once the final frequency usage plan is determined, existing terrestrial digital television systems will undoubtedly require large-scale transformation or replacement. Frequency changes involve numerous considerations and may lead to a nationwide reshuffling of broadcasting television frequencies.

Corresponding to frequency resource integration is network resource integration, primarily involving the national network' s integration of provincial networks to form a nationwide joint-stock company managed under a parent-subsidiary system, with China Broadcasting Network Co., Ltd. as the controlling shareholder and provincial companies as co-investors. This step is crucial for planning the broadcasting 5G network. However, the national network has no direct equity relationship with provincial networks. Although integration has made some progress and strategic investment agreements have been reached with certain provinces, many provinces have not yet participated, and the nine listed companies remain subject to securities market constraints. The journey toward a true "unified national network" has not progressed far.

Even if frequency and network resource integration can be completed smoothly, building broadcasting' s own 5G network remains a long journey. As a network operator transitioning from cable to 5G, the national broadcaster has virtually zero hardware infrastructure and requires massive, continuous capital investment to gradually build the network. This is the fundamental reason why current broadcasting 5G applications still rely on the three major telecom operators. Nevertheless, for broadcasting operators, this is a project that must be undertaken despite the challenges, because once completed, it will not only generate enormous returns but also facilitate deep integration of broadcasting services—a strategic choice focused on the future.

Although national network integration will take time, some provincial broadcasting network companies have begun taking active steps to seize opportunities. For instance, Hunan, Guangdong, and Shandong provincial network companies have successively signed strategic cooperation agreements with Huawei to promote key projects in 5G innovation laboratories and conduct deep cooperation across various 5G industry sectors. Some local governments have also issued strong support policies for broadcasting 5G development.

5.3 Terminal Intelligence Revolution

Beyond network and content development, user terminal intelligence is essential for 5G applications. 5G broadcasting aggregates metadata from various terrestrial digital television broadcast channels and 5G OTT video content, requiring intelligent search and recommendation functions to deliver a "consistent" viewing experience and further enhance video content depth and breadth. Otherwise, users would be forced to constantly switch between various applications and program guides on televisions and other receiving terminals, severely degrading the user experience. Once receiving terminals are intelligently defined, they will deliver unprecedented smooth experiences. For example, on the same terminal, popular programs on hot channels are broadcast in real-time via terrestrial digital television; mobile operators provide catch-up and recording services for television content; users can watch any program on-demand at any time, making viewing schedules more flexible. This approach can significantly reduce pressure on 5G networks and user data costs, with all these functions seamlessly switched on intelligent terminals, enabling users to always obtain maximum experience with minimum resource consumption.

Conclusion

Although 5G has not yet fully entered our lives, we can already deeply sense the tremendous changes it will bring to broadcasting television. The deep integration of 5G and terrestrial digital television will help overcome the drawbacks of both network transmission methods, create complementary effects, expand pathways and scope for broadcasting program coverage, and enhance terrestrial digital television coverage effectiveness. The broadcasting industry should prepare early, actively plan, and develop a 5G-based terrestrial digital television network platform to achieve quality and efficiency improvements in broadcasting television services.

Author Affiliation: Anhui Broadcasting Corporation

Note: Figure translations are in progress. See original paper for figures.