

Investigation of Technical Solutions for County-level Emergency Broadcasting Systems (Post-print)

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

Abstract

At present, emergency broadcast systems have gradually become a critical component of radio and television service infrastructure. Through such systems, governments can timely disseminate information regarding policies, guidelines, emergency response, and disaster relief to grassroots populations. To satisfy the requirements for timely dissemination of public emergency warning information and to address the construction needs of China's emergency broadcast system, it is imperative to develop more comprehensive technical solutions that enrich and optimize system functionalities. Only through such measures can governments effectively respond to emergencies including natural disasters and public safety incidents, ensure that citizens receive timely information, and safeguard property security. This study conducts an in-depth analysis of technical solution design for emergency broadcast systems, incorporating the current construction status of Suining County's broadcasting system, with the objective of formulating more robust technical solutions.

Full Text

Abstract

Currently, emergency broadcast systems have gradually become a critical component of radio and television service infrastructure. Through these systems, the government can promptly convey policy directives, emergency relief information, and other essential messages to grassroots communities. To meet the demands of timely public emergency warning dissemination and the construction requirements of China's emergency broadcast system, it is imperative to develop more comprehensive technical solutions that enrich and optimize system functionality. Only through such approaches can the government effectively respond to natural disasters, public safety incidents, and other emergencies, ensuring that

the public receives timely information while protecting lives and property. This study analyzes the technical design of emergency broadcast systems in depth, drawing upon the current construction status of Suining County's broadcast system, with the aim of formulating more robust technical solutions.

Keywords: Emergency broadcast system; Broadcast architecture; Technical solution; System functions; System security

2. Emergency Broadcast Technology Solution Design

Broadcasting serves as a crucial tool for government policy dissemination and has become a vital link between the Party and the masses, capable of promptly communicating and implementing various Party policies. It plays an essential role in promoting harmonious social development, disaster prevention, and relief efforts. In particular, broadcast systems offer real-time listening functionality, representing a significant advantage over other media types. In recent years, the Chinese government has attached great importance to emergency broadcast system construction, vigorously promoting county-level emergency broadcast development to enhance emergency response capabilities in county-level cities and rural areas, thereby fully safeguarding people's lives and property. Emergency broadcast systems offer advantages in efficiency and timeliness, with their early warning functions being critical to successful disaster relief operations. This research focuses on county-level emergency broadcast system construction and provides an in-depth analysis of the "Village-to-Village Sound" system, aiming to facilitate smooth implementation and nationwide promotion.

To fully satisfy national emergency rescue and disaster relief requirements as well as county-level broadcast system construction needs, emergency broadcast system development should actively leverage internet technologies and broadcast television networks. This approach enables emergency broadcasts to fulfill critical roles in disaster relief, government policy communication, and public opinion guidance, gradually establishing a new county-township-village coordinated emergency broadcast system capable of timely and effective information transmission. When public safety incidents or natural disasters occur, the system must deliver information to rural populations immediately, achieving comprehensive coverage across all townships and villages. Broadcast control authority should be managed hierarchically: county control center emergency information holds Level 1 priority, township machine rooms Level 2, and village broadcast rooms Level 3. Under normal circumstances, the system primarily broadcasts county control center programming, but can interrupt this content to broadcast emergency information when incidents occur.

Currently, broadcast signals from county-level cities to townships typically utilize television signals or, depending on local conditions, fiber optic transmission. This approach reduces signal transmission costs while providing relatively stable signals and saving maintenance expenses. Additionally, where conditions permit, communication networks may be employed with additional IP network

adapters, though network latency issues during information transmission make this solution a backup option. Signal transmission from the county control center to township control centers can employ automatic addressable encoding broadcast technology, enabling the county control center to control township broadcast systems. Many villages have already access to cable television, allowing township control center signals to reach village broadcast rooms via dual-channel addressable technology—simultaneously using FM radio and cable TV signals. This system enables township-level broadcasts to address and control subordinate administrative village broadcast rooms, offering strong anti-interference capabilities and high stability. For villages with relatively developed communication networks, IP broadcast signals can also be used for information transmission. Under this design scheme, the county control center can control the volume of township and village broadcast equipment and deliver messages to designated townships while controlling device power status. Normally, terminal equipment at all levels remains on standby for immediate activation when needed.

1. County-Level Emergency Broadcast Architecture

Emergency broadcast systems have gradually become a timely and efficient information transmission channel, with county-level emergency broadcast systems playing an increasingly prominent role in rural natural disaster prevention and public emergency response. These systems effectively communicate government policies and disaster information to the masses, enabling them to prepare accordingly, guiding evacuation efforts, minimizing property losses, and protecting lives. In 2018, the National Radio and Television Administration issued the “Technical Specification for County-Level Emergency Broadcast Systems”(GD/J088–2018), which has become the national standard for county-level emergency broadcast system construction, significantly enhancing standardization. With rapid social development and the growing influence of new media, emergency broadcast coverage must become more diversified to improve system reliability and stability during emergencies. Consequently, this proposed county-level emergency broadcast technical solution incorporates new media technologies to enhance design feasibility.[1]

3. County-Level Emergency Broadcast System Functions

3.1 Control Management Function

To meet evolving developmental needs, emergency broadcast systems must feature comprehensive management, timeliness, high efficiency, and stability, enabling regional control management. Typically, system design follows the principle of upper-level equipment priority, though disaster-prone areas often adopt lower-level broadcast equipment priority. Communication command types play a crucial role in emergency broadcast control systems, with information transmission utilizing the 0xB1 encoder serial protocol for data encoding and decod-

ing. The system can encode broadcast terminals for each administrative village and broadcast different content in different regions. Control commands execute from `<paramname= "XXX" >`, with a maximum of 10 messages sent during transmission. If no corresponding acknowledgment is received, the transmission is deemed unsuccessful and returns False; successful transmission with acknowledgment automatically returns a True command. The control management function enables appropriate adjustments to lower-level information transmission systems. For instance, during sudden disasters, GIS network services can significantly improve information dissemination efficiency, with the county control center's management system returning GIS service responses to relevant departments, enabling government agencies to understand disaster conditions promptly and formulate appropriate response measures based on actual conditions.[3]

3.2 Information Dissemination Function

The primary function of emergency broadcast systems is to deliver information to the people in a timely manner, making information dissemination the system's most fundamental capability. County-level emergency broadcast system construction should actively utilize both wired and wireless networks to achieve comprehensive coverage. These systems must not only handle emergency broadcasting during critical situations but also daily content such as emergency knowledge, laws and regulations, and government policies. Government authorities should conduct regular broadcast system drills to verify that the system can complete information dissemination tasks under emergency conditions, ensuring timely transmission of audio and image information.

3.3 Real-Time Monitoring Function

Emergency broadcast systems require real-time monitoring capabilities, necessitating the development of efficient emergency measures. Additionally, data communication timeliness and stability must be ensured. JavaScript and other technologies can enable real-time video monitoring functions, while HTTP communication protocols implemented during system design facilitate video patrol capabilities, helping emergency management departments grasp on-site conditions in real time. The system can transmit acquired information to the platform to correctly assess disaster severity and determine whether to use daily or emergency broadcasting based on actual conditions. Real-time monitoring systems play a vital role in disaster prevention, effectively protecting people's lives and property. During system implementation, emergency events and loss conditions can be input as parameters for the system to classify incident severity levels. Based on processing results, the system determines required emergency services and promptly communicates disaster information to fire departments, hospitals, and emergency management units. Furthermore, emergency broadcast systems help the public guard against natural disasters, guide emergency evacuation, and minimize disaster losses.[4]

4. Implementation of Emergency Broadcast Technology Solution

4.1 County-Level Broadcast System Platform

The county radio and television station establishes an emergency broadcast command center that transmits signals via fiber optic cable to subordinate village broadcast stations, which broadcast daily programming on a regular schedule. When sudden natural disasters or other emergencies occur, the emergency broadcast command center can forcibly interrupt township broadcast station content and relay information from the emergency command center, promptly delivering disaster information to the public. During emergency broadcasting, the county control center can directly terminate township self-produced programs, causing township and village broadcast equipment to play emergency content. When telephone-based remote broadcasting is required, password verification is necessary to confirm broadcast permissions, thereby effectively ensuring the security of telegraph broadcast information.[5]

The county-level emergency broadcast system can employ dual-channel broadcast technology during information transmission. This technology modulates audio signals from the county control center for transmission to township areas, where terminal receiving equipment decodes the information for playback. The county control center room holds the highest priority in the emergency broadcast system and can use microphones or telephones for emergency broadcasting to townships and administrative villages under special circumstances, ensuring that natural disaster or emergency incident information reaches the public promptly to guide timely prevention and minimize losses. The county control center can control the volume of township and village broadcast equipment, deliver messages to designated townships, and control device power status. Normally, terminal equipment at all levels remains on standby for immediate activation when needed. During normal broadcasting periods, lower-level equipment can interrupt upper-level control to broadcast lower-level control room information when necessary; during special periods, upper-level control centers have higher priority and can forcibly interrupt current content to broadcast emergency information. Every township and village must establish broadcast rooms that can normally play self-produced programs, with administrative villages receiving signals via wireless FM to achieve full coverage. To ensure system stability, telephone emergency broadcast channels can be established for emergency broadcasting under special circumstances. When emergencies occur, the emergency management center can use telephones to promptly communicate information to rural populations. Additionally, the system includes an upper-level department emergency broadcast access port.[2]

4.2 Township Broadcast System Platform

When constructing township broadcast system platforms, forwarding and sub-control equipment must be installed separately to transmit information wire-

lessly to village broadcast equipment, primarily including FM speakers or loudspeakers. Simultaneously, townships must establish emergency command centers that can normally play self-produced programs or online resources. When severe natural disasters or emergencies occur, the township command center can release emergency information based on actual disaster conditions to guide timely public response. Township control rooms require the following equipment: addressable encoding controllers, FM equipment, intelligent receiver control devices, and transmitters. For townships without FM signal coverage, IP network adapters must be installed to enable information transmission via IP signals. Township emergency broadcast equipment must remain on standby at all times, responding promptly to broadcast requests from upper-level equipment when emergencies occur. Intelligent FM modulators play a critical role in emergency broadcast systems, mixing and modulating audio signals for transmission via wireless or wired networks to village broadcast terminal equipment. For villages without cable TV signals, townships can utilize IP networks or the Internet for information transmission.[6]

5. System Security

For county-level emergency broadcast systems, ensuring secure broadcasting is essential to fully leverage their functions, making system security critically important. Consequently, this technical solution prioritizes system security in its design, representing a key challenge. To enhance system security, the technical solution implements the following measures: First, firewalls are installed to counter network attacks, monitoring broadcast information data in real time and intercepting attack information. All unused device ports in the broadcast system are closed, and the system only responds to commands from designated IP addresses, promptly intercepting access requests from unknown IPs to prevent hacking. Second, software firewalls monitor all data during system operation, alerting network security administrators to abnormal data and eliminating unsafe communications. Third, virtual networks are constructed to prevent leakage of secure information during communication and isolate critical broadcast equipment. Fourth, digital certificate technology encrypts communication information using complex verification methods, strengthening user authentication management during transmission so only legitimate, protocol-compliant devices can access the system. Fifth, the county emergency broadcast system uses encryption authentication technology to enhance transmission security and integrity, ensuring program information authenticity and legality while preventing malicious tampering. Sixth, digital signature technology ensures information legitimacy, enables source traceability, and prevents terminal broadcast equipment from playing non-compliant content.[7]

In summary, designing county-level emergency broadcast system technical solutions requires adherence to several principles: First, **economy**: system design must meet local practical needs, prioritize existing local networks to save construction costs. Second, **security**: ensure both broadcast information security

and safe, stable system operation, enabling the system to disseminate emergency information during critical periods by equipping devices with UPS power supplies. Third, **compatibility**: the county emergency broadcast system must be able to directly connect with provincial and municipal emergency broadcast systems when needed.

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

Source: ChinaXiv –Machine translation. Verify with original.