A Preliminary Discussion on the Design Scheme of SD/HD Simulcast Systems for County-Level Television Stations (Postprint)

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Abstract

This article introduces two different technical solutions for simultaneous HD/SD broadcasting and the respective advantages and disadvantages of these two broadcasting modes, and conducts a brief analysis combined with the practice of constructing simultaneous HD/SD broadcasting systems at county-level stations, hoping to provide reference for research on the construction of simultaneous HD/SD broadcasting systems at county-level stations.

Full Text

Preamble

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A Brief Discussion on Design Schemes for Simultaneous HD/SD Broadcasting in County-Level Television Stations

Abstract: This paper introduces two distinct technical solutions for simultaneous high-definition (HD) and standard-definition (SD) broadcasting, analyzing the respective advantages and disadvantages of each broadcast mode. Drawing upon practical experience in constructing HD/SD simulcast systems at county-level stations, this analysis aims to provide a reference for similar initiatives in county-level television stations.

Keywords: county-level station; HD/SD simulcast; design scheme

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1. Current Status of Broadcasting Equipment and Practical Requirements for HD/SD Simulcast

Currently, most county-level television stations operate analog hard-disk broadcast systems or video server systems that have been in service for considerable time. These aging systems experience frequent failures and significant signal quality degradation, failing to meet modern safety broadcast requirements. With rapid advances in computer technology, networking, cloud computing, big data, digital signal processing, and information technology—coupled with the digitization of cable and wireless transmission—broadcast television urgently requires digital transformation. This transformation must encompass digitalization, high-definition upgrading, and IP-based integration across the entire workflow from acquisition, production, and storage to management and playout, ultimately achieving automation and intelligence in television signal production and broadcasting.

Consequently, county-level stations must adopt forward-looking design schemes for HD/SD simulcast systems when planning their digital transformation to avoid detours and meet escalating safety broadcast demands from local party committees and governments. A practical HD/SD simulcast system typically comprises one SD channel and one HD channel, integrating program schedule editing systems, playout control systems, video broadcast servers, clock systems, and other essential components.

2.1 Overall System Architecture Design

When designing HD/SD simulcast solutions for county-level broadcast stations, two primary architectural approaches are employed:

First, Independent HD/SD Broadcast Mode (Figure 1): HD and SD programs are broadcast simultaneously through two completely independent broadcast systems. Each system uses separate boards to output HD and SD signals respectively.

Second, Integrated HD/SD Broadcast Mode (Figure 2): HD and SD programs are broadcast simultaneously through a single integrated system. One board outputs both signals—when configured for HD output, one port delivers the HD signal while the other provides a down-converted SD signal through the board' s built-in down-converter; when configured for SD output, both ports deliver SD signals, with the SD signal being derived from HD source material via down-conversion.

These two modes differ significantly in workflow and requirements. Considering personnel, financial resources, and other practical constraints at county-level stations, the integrated broadcast system is recommended. A detailed comparison of the two schemes reveals that the independent mode offers higher reliability and security due to its separate, non-interfering systems, with format conversion completed before broadcast, thereby improving operational efficiency. The integrated mode, while slightly less secure and reliable, presents a more practical solution for resource-constrained county-level stations.

[Figure 1: see original paper] Block Diagram of Independent HD/SD Broadcast System

2.2 Video Server Playout System Design

The primary function of this system is to manage diverse video files and external program sources, perform real-time switching according to broadcast schedules, and integrate station logos, subtitles, and other graphic elements. Given the complexity of audio-visual source materials, the system must be equipped with appropriate transcoding hardware and software to generate unified HD program signals. For the main channel, HD signal quality can be ensured by adding key mixers for logo and subtitle insertion. Playout control equipment should employ primary-backup hot standby configurations.

HD/SD Simulcast Board Implementation: Our approach utilizes a single playout system to achieve simultaneous HD/SD signal broadcasting—one board with two output channels. When configured for HD program output, one channel delivers the HD signal while the other outputs a down-converted SD signal through the board's integrated down-converter. When configured for SD output, both channels deliver SD signals derived from HD sources via down-conversion.

HD Signal Switcher: This component switches between signal sources from different broadcast devices and lines. The broadcast program material file-based delivery platform handles comprehensive material processing tasks including upload, migration, high-capacity storage, transcoding, up/down conversion, format conversion, transmission verification, manual review, material management, scheduling, and program distribution—preparing all necessary materials for the playout control system.

Nearline Storage System: To ensure the security of self-produced programs such as news, specials, and advertisements, these files must be automatically migrated to the broadcast video server after review through the delivery platform. A nearline storage system is therefore essential.

[Figure 2: see original paper] Block Diagram of Integrated HD/SD Broadcast System

2.3 System Security and Reliability

Beyond the core systems described above, a digital clock system is required to ensure time synchronization across all playout control systems. The video broadcast system should employ redundant backup designs throughout, with core systems utilizing primary-backup hot standby configurations (e.g., video broadcast servers, gigabit switches, power supplies, and fans all feature redundant designs) or mirroring mechanisms. The system must have no single point of failure and no data islands, incorporating proper down-conversion mechanisms to ensure safe, compliant transformation of different program types. System design and equipment selection must comply with relevant national and industry standards, incorporate data fault-tolerance technologies, and include contingency plans to guarantee broadcast security and stability.

As broadcast television technology continues to evolve, HD/SD simulcast systems will become increasingly widespread at county-level stations. While resources and capabilities vary significantly among stations, leading to different implementation choices, the overall design philosophy remains consistent: accelerate digitalization, improve broadcast quality, ensure broadcast security, and meet the people' s growing cultural needs. County-level stations must therefore base their designs on local realities to implement scientifically sound and rational digital broadcast systems that elevate their broadcasting capabilities to new levels.

2.4 Main Components of the Playout System

Broadcast Video Server: The system employs a primary-backup-hot backup distributed heterogeneous architecture with multi-level redundancy (primary-backup redundancy, machine redundancy, channel redundancy). Each video broadcast server handles two channels, ensuring file compatibility and functional mutual backup during emergencies. Server storage may use internal arrays (or external arrays for larger capacity requirements), with capacity sufficient for at least 20 days of programming across two HD channels. Playout boards must support HD-to-SD down-conversion to enable mixed HD/SD material broadcasting. While the system can accommodate separate HD and SD versions of the same material, it is recommended to use unified HD files for both channels to conserve system resources and improve efficiency. All critical equipment in the signal chain must be equipped with redundant power supplies.

Playout Control Workstation: The control system must achieve complete separation of playout and control functions to ensure greater security and stability. In the integrated broadcast system, which we have designed with HD broadcasting as the backbone, only one HD program schedule needs to be created. During HD signal broadcast, the built-in down-converter on the playout board enables compatible SD broadcasting, thereby simplifying operations.

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