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Broadcast Control System Architecture and Applications at the New Anhui Radio and Television Center (Postprint)

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Abstract

This paper primarily introduces the basic architecture of the broadcast control system of Anhui Radio and Television Station, including the system's design philosophy, overall architecture, and strategies, focuses on elaborating the construction characteristics of the broadcast control system, and introduces the broadcast software, channel broadcast architecture, and HD/SD simulcast strategy.

Full Text

Abstract

This paper introduces the fundamental architecture of the broadcast control system at Anhui Broadcasting Station, encompassing its design philosophy, overall framework, and operational strategies. The discussion emphasizes the distinctive features of the system's construction, detailing the broadcast software, channel architecture, and high-definition/standard-definition (HD/SD) simulcast strategy.

Keywords: broadcast control system; channel broadcast mode; HD/SD simulcast strategy

Introduction

In recent years, provincial satellite television stations across China have successively upgraded to HD/SD simulcast systems, ushering in a new era of high-definition television development in the country. The HD/SD simulcast model represents a significant initiative proposed by the State Administration of Radio, Film, and Television in 2009 based on contemporary development needs, offering a novel approach for transitioning from standard-definition to high-definition

television. The new television broadcast control system at Anhui Broadcasting Station's center aligns with this initiative. The system comprises 16 HD/SD compatible broadcast channels (currently operating as 14 SD channels and 2 HD channels). System construction began in October 2012, with installation and commissioning completed for trial operation in July 2013, followed by official launch in October 2013. Through multiple rounds of strategic debugging and operation, the system has gradually matured and stabilized, robustly ensuring the safe and high-quality broadcast of programs across all Anhui TV channels.

System Overview

The broadcast control system employs online hot-backup for all primary equipment. The hardware infrastructure includes domain control servers, interface servers, database servers, Media Director System (MDS) servers, synchronous migration servers, automatic technical review systems, ingest and primary/backup broadcast video servers, primary/backup broadcast workstations, ingest, playlist editing, and review workstations, Ethernet core switches, and associated background service software. Business processes encompass material ingest, backup broadcasting, review, playlist editing, material transmission, automatic technical review, manual re-examination, on-air broadcasting, and delayed broadcasting.

Hardware Architecture

Channel Hardware Configuration

The channel broadcast architecture utilizes a primary-backup switcher configuration. The system is designed with 16 channel broadcast workstations—comprising 14 standard-definition and 2 high-definition broadcast workstations—along with 4 broadcast review workstations, 4 HD/SD software delay-broadcast workstations, 2 manual technical review workstations, 2 domain control servers, 2 database servers, 2 MDS servers, 8 synchronous migration servers, 6 migration servers, 2 interface servers, and 5 Ethernet core switches.

The system employs a 1+1 redundancy configuration for control systems, switching mechanisms, and channel broadcasting, enabling real-time takeover of all device controls by the backup system should the primary system fail. Broadcast control utilizes a hybrid primary-backup mode with 422 switchers for cross-control—"primary controls primary, backup controls backup." This hybrid approach employs two 422 switchers: Switcher 1 manages control switching for the primary broadcast video servers and primary broadcast switchers, while Switcher 2 handles channel control switching for backup broadcast servers, with the backup controller as primary and primary controller as backup. Consequently, even if the primary broadcast control workstation crashes at the instant it issues a Play command, only the primary video server will freeze; the backup video server remains under control of the backup broadcast workstation and is

unaffected. Manual switching to the backup video server signal path restores normal broadcast immediately. This design facilitates straightforward, easily mastered emergency operations, saving critical time during incidents.

Video Servers and Storage

The system incorporates ten video server sets using OMNEON Media Director for material ingest, review, and broadcast. Video servers support HD/SD compatible encoding/decoding with MPEG2 compression at 12Mbps for SD and 50Mbps for HD. Storage employs RAID3 technology with capacities of 7.2TB per broadcast disk array, 3.6TB per ingest array, and 43TB for each primary and backup secondary storage system.

HD/SD Simulcast Strategy

Standard-definition channels utilize clean signals from high-definition channels, employing squeeze mode for down-conversion. Down-conversion transforms television pictures from high to standard definition through decimation and wavelet transformation of the original HD signal to obtain lower-resolution SD signals. Three down-conversion modes exist: letterbox, edge-crop, and squeeze. Letterbox mode adds black bars to the top and bottom to achieve a 4:3 aspect ratio, preserving original content and proportions. Edge-crop mode cuts both sides of the HD signal to obtain 4:3 framing, sacrificing some image content but yielding clearer signals. Squeeze mode horizontally compresses the HD signal, causing picture distortion. However, with CRT televisions now replaced by flat-panel displays, squeeze mode was selected to satisfy 16:9 SD television users' preference for full-screen viewing.

Software System Architecture

The broadcast control software system comprises several modules: database services, broadcast management, strategy services, material management, broadcast control, ingest/playlist editing/review, software delay-broadcast, automatic technical review, software time correction, and master control scheduling.

The database module runs on the Microsoft SQL Server platform with EMC AutoStart software managing dual-server hot backup. The strategy service generates material transmission tasks based on playlist schedules and executes specific point-to-point transfers. Synchronization servers retrieve and distribute material transmission tasks (including synchronization, copying, and deletion). The automatic technical review module analyzes every video and audio frame, comparing extracted data against relevant standards to detect technical issues such as black fields, color bars, and silence, marking problematic points for manual re-examination. Manual re-examination software can review playlist items flagged as "automatic technical review failed," locate problem points via timecode, display images at the current timecode, and allow operators to confirm whether issues are genuine errors, marking materials as "manual re-examination passed"

or "manual re-examination failed." Material management includes archiving and deletion functions.

The broadcast control software features comprehensive device control plugins supporting multiple switchers, video servers, matrix routers, and keying controls. The ingest software enables precise recording with signal quality detection during acquisition. The delay-broadcast system supports delays of at least 30 seconds and operations including delayed broadcast, delayed deletion, delayed insertion, and delayed overlay.

Key Technical Features

Material Migration with MD5 Verification

Material files may become corrupted or altered during migration. MD5 verification technology increases the accuracy of audio-visual file migration across video servers to 99.9999%, effectively achieving "fail-safe" material migration.

Playlist Import Flexibility

Broadcast playlists can be created and edited manually or imported from external systems such as advertising and programming departments, supporting multiple file formats. This capability significantly improves playlist editing efficiency and reduces labor costs.

Conclusion

Since its official launch in October 2013, the Anhui Broadcasting Station broadcast control system has consistently and stably handled program ingest, automatic technical review, manual re-examination, migration and copying, playlist editing, on-air broadcasting, advertisement material backup broadcasting, and background storage and database modules. The HD/SD simulcast system has achieved 100% simultaneous broadcasting. Although the transformed SD signal quality remains inconsistent due to not all source materials being originally HD, the system's security, practicality, stability, and reliability meet all design requirements and have passed functional, performance, and security tests conducted by the former State Administration of Radio, Film, and Television's Radio and Television Information Security Evaluation Center and Planning Institute. The system provides robust technical support for safe broadcasting across all Anhui TV channels.

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

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