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Postprint: Technical Solution for HD/SD Simulcast System at Beijing Television Station

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Abstract

This paper introduces the HD/SD simulcast system solution for Beijing Television Station, proposes new application concepts and adopts innovative technical means to address emerging issues in development, and elaborates on the overall design, implementation of various subsystems, and system application status.

Full Text

Preamble

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Technical Solution for Beijing TV Station's HD/SD Simulcast System

Abstract: This paper presents the technical solution for Beijing TV Station's high-definition and standard-definition (HD/SD) simulcast system. To address emerging challenges in broadcast development, the system introduces innovative application concepts and employs new technical approaches, elaborating on the overall design, implementation of various subsystems, and operational application.

Keywords: HD/SD simulcast; broadcast center; broadcast server

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1. Overall Design

The overall system design comprises two primary components: the broadcast network and video server system, and the broadcast center system. The system architecture is illustrated in [Figure 1: see original paper]-1. The design also incorporates three loop broadcast servers to generate independent loop broadcast signals for each channel. Each server provides effective storage capacity exceeding 6TB, satisfying seven days of new program storage requirements (with daily new program volume calculated at 12 hours). The FTP backplane bandwidth of 40MBps meets daily new program transmission demands (12 hours of new programs transmitted within 4 hours). Each server is equipped with four channels for broadcast, emergency upload, file head/tail detection, and backup purposes. The video server system design is shown in [Figure 3: see original paper].

Centered on broadcast backup storage, the system interfaces with the station-wide HD production and broadcast backbone network, establishing an efficient program data transmission chain from the media asset backup library to broadcast backup storage, and then to broadcast servers. By receiving station-wide transformation playlists containing Active Format Description (AFD) information, the system achieves automatic down-conversion control for HD/SD broadcast systems—representing both an innovative feature and technical challenge of this solution. Additionally, the system implements functions including automatic technical review, emergency upload, and content management. The architecture employs a channel-independent approach to build six sets of simulcast systems, with each channel functioning as a separate module. The channel input consists of HD signal program sources for conventional HD broadcasting, while SD simulcast is achieved through matrix-switching-based automatic aspect ratio conversion, making Beijing TV Station the first in the national industry to successfully implement HD/SD simulcast functionality.

2. System Implementation—Broadcast Network and Video Server System

Based on actual operational requirements, the broadcast network and video server system can be divided into several components: video servers, broadcast backup library, content storage management, network platform, broadcast control, and network system monitoring. The system structure is shown in [Figure 2: see original paper].

2.1 Video Server

The video servers employ a single-machine architecture with local storage design, required to support broadcasting for five HD/SD channels plus one HD/SD backup channel. Within each channel, video servers utilize a 1+1 backup configuration. The video server system design is shown in [Figure 3: see original paper].

2.2 Broadcast Secondary Storage

The broadcast secondary storage is designed as two independent primary and backup groups, with specific configurations detailed in . The system employs six migration servers, six file technical review servers, and six FTP servers in a clustered configuration. When any single migration server or multiple servers fail, tasks from the faulty servers automatically redistribute to other servers to ensure no task loss. If transmission links are damaged, materials and metadata files can be manually copied to designated paths, with the system automatically importing the materials into the broadcast system.

The media link network structure is shown in [Figure 5: see original paper]. Program file transmission utilizes primary and backup independent links: the primary storage reads program files once from the media asset system, and the backup storage reads the same files again. Mirror servers perform verification between the two storage systems, with only verified-consistent files showing successful migration, ensuring transmission security. The system can automatically switch between primary and backup during failures without manual intervention.

For external interfaces, external system services are isolated through antivirus firewalls, with switch ports monitored. FTP servers connect directly to core switches, with ACL (Access Control List) restrictions binding specific internal migration servers for access. Internally, the core switch employs VLAN partitioning to separate control information from material data, with IP routing enabled for free inter-VLAN access.

3. Network Application and Security Design

The network system is functionally divided into information domain and media domain.

(1) Information Network: As the core of broadcast network business data, the information network design is critical. Two core switches operate in load-balanced mode. All access switches feature dual uplinks to core switches to prevent service interruption from single-device failures. Servers and workstations in this zone use single network cards with separate primary and backup connections to access core switches, ensuring backup mechanisms. The database employs dual hot-standby mode, with data stored in real-time mirror copies on primary/backup server local disks. When the primary database service stops, the system automatically switches database operations to the backup within 90 seconds, ensuring no data loss. The information link network system is shown in [Figure 4: see original paper].

(2) Media Data: As core data for the broadcast network, media data requires high security. The system is equipped with six migration servers, six file technical review servers, and six FTP servers operating in cluster mode. When any

server fails, tasks automatically redistribute to other servers to ensure continuity.

4. Broadcast Control System and Global Transformation Playlist

The broadcast control system manages HD and SD channel equipment within each simulcast channel. After loading the program playlist, the broadcast software controls various devices—including switching equipment, selector switches, and servers—to achieve punctual program broadcasting. The global transformation playlist represents a technical innovation in this project, solving the difficult problem of down-conversion method selection.

5. AFD Information Implementation for Down-Conversion in Global Playlist

The global transformation playlist contains not only conventional information such as program codes, video sources, duration, broadcast time, broadcast type, and program type, but also embeds AFD (Active Format Description) information. Starting from the station-wide production domain, AFD information is carried in program code bits, passes through the backup domain, and finally reaches the broadcast domain, where it is decoded and entered into the down-conversion information fields of the broadcast playlist. The broadcast control software controls SD selector switches to output the required SD signal aspect ratio, which then has SD station logos and subtitles added before being output as the SD channel signal. By embedding AFD information in the global playlist, the system overcomes the challenge that the existing network production-broadcast workflow does not support embedding AFD information in video/audio signals, avoiding the massive workload of re-embedding AFD information in existing materials and providing an innovative approach for integrating the simulcast system into the station's backbone system. The workflow of the global transformation playlist is shown in [Figure 6: see original paper].

6. Broadcast System Control Method

The system adopts a “main control primary-backup, backup control primary-backup” design philosophy. Under normal operation, all equipment—including primary and backup video servers, switchers, selector switches, emergency function keys, and VTRs—operates under main control, managed directly by the primary industrial computer through 422 switchover control. The backup industrial computer remains in hot standby, periodically detecting equipment status through VDCP commands. When the primary broadcast channel or primary server experiences control issues, the broadcast software can switch online to the backup server's broadcast channel. If both primary and backup broadcast server controls fail, the broadcast software automatically switches to filler signal sources to ensure uninterrupted broadcasting. Dual time synchronization

safeguards are implemented for broadcast industrial computers: first through network time service from a clock server, and second through precise timekeeping via BB sync signals. This dual guarantee ensures that either method's failure does not affect local client clock accuracy.

7. System Implementation—Broadcast Center System

The video/audio and peripheral systems receive control signals from the automatic broadcast control system to correctly select and switch program signal sources, process or adjust broadcast signals as needed, and provide program signals in required formats for transmission systems. Primary equipment includes switchers, frame synchronizers, video distribution amplifiers, down-converters, and keyers.

8. Down-Conversion Aspect Ratio Selection

HD baseband signals can be directly routed to broadcast. For SD live signals requiring broadcast, up-conversion by upstream systems is necessary before transmission. For media files, since up-conversion by control servers is difficult, HD version program files must be provided. If existing SD files need broadcasting, the program production department must perform HD re-production before transmission. Meanwhile, the chief editor's office must describe the down-conversion method in the broadcast playlist, with broadcast control software selecting the correct down-conversion method for the broadcast link. The signal flow is shown in [Figure 7: see original paper].

8.1 Simulcast Link Implementation

Based on our station's actual broadcast conditions, we chose to implement HD down-conversion simulcast. The system contains six simulcast channels, each operating as an independent module. The HD channel portion follows conventional single-format broadcast links, with the main path using a production switcher for logo and subtitle overlay, passing through primary-backup 2x1 selection and final distribution to downstream HD transmission systems. The backup path uses a clean switch, with an HD keyer handling logo and subtitle overlay, distributed as the HD backup output signal. The clean outputs from HD primary and backup channels are sent to SD primary and backup channels respectively. Each SD primary and backup channel connects to two down-converters performing two fixed aspect ratio conversions. AFD information in the broadcast software controls SD primary-backup selectors to choose the correct aspect ratio output. After adding SD logos and subtitles, the signal is sent to downstream SD transmission systems. The HD down-conversion simulcast approach requires minimal equipment, space, and personnel investment, while program production departments only need to provide HD program versions to broadcast. The technical challenge lies in safely and reliably implementing correct aspect ratio selection for down-conversion. The video/audio path structure

for a single channel is shown in [Figure 8: see original paper].

8.2 Optimized Emergency Handling

Although the system simulcast links employ mature and reliable technologies, they increase broadcast link complexity to some extent. Through optimization, operators can quickly handle faults. When HD channel problems occur, operators only need to switch the HD channel's 2x1 selector, with the SD channel's 2x1 selector 联动 (linked) simultaneously. When SD channel problems occur, only the SD 2x1 selector needs switching, leaving the HD channel unchanged. This emergency mechanism ensures operators can perform "one-key emergency" handling when problems arise, solving the complexity of separately managing HD and SD paths and shortening fault emergency response time. The GPI-linked primary-backup 2x1 control is shown in [Figure 9: see original paper].

8.3 Synchronization System Structure

The synchronization system provides reference sync signals to all equipment, enabling accurate signal processing timing and frame-accurate broadcast control. To ensure channel independence and safety, each channel uses an independent sync switchover system.

8.4 Clock System

The clock system provides timing signals to control and management equipment (including logo inserters, keyers, character generators, and multi-viewers), and displays accurate time information through sub-clocks in the monitoring area. Each channel in the equipment rack area is configured with one 1U sub-clock.

9. Conclusion

Since its official launch in December 2010, the system has operated 24/7 with stable and reliable performance. The system meets user requirements in improving broadcast quality, ensuring broadcast safety, achieving resource sharing, enhancing work efficiency, and clarifying management workflows. After years of operation, the system has experienced no technical issues, greatly ensuring safe and high-quality synchronized HD/SD broadcast for our station's multiple channels, fully achieving our original design objectives.

References

- [1] Weng Zhiqing, Chen Weiping. *Digital TV Production and Broadcast Systems* [J]. Shanghai University Press, 2008(10).
- [2] Zhang Qi, Yang Yingyun. *Digital TV Production and Broadcast Technology* [J]. China Radio & Television Press, 2002(10).
- [3] Chris McNab O'Reilly. *Network Security Assessment* [J]. 2010(5).

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

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