Postprint: Application and Exploration of Hard Disk Playout System at Xiaogan Television Station

Authors: Xiaoyi Li, Zhou Zebo

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Abstract

This paper presents the architecture of the hard disk broadcast system at Xiaogan Television Station, elaborating on aspects including subsystem design, primary-backup heartbeat systems, third backup systems, and interconnection methods between production and broadcast networks, and explores the adoption of various novel technologies.

Full Text

Preamble

Title: Application and Exploration of Hard Disk Broadcasting Systems at Xiaogan Television Station

Abstract: This paper introduces the architecture of the hard disk broadcasting system implemented at Xiaogan Television Station, elaborating on its subsystem design, primary-backup heartbeat systems, third-level backup mechanisms, and connectivity between production and broadcasting networks. The system incorporates various innovative technologies to enhance operational capabilities.

Keywords: Hard disk broadcasting; Upload; Heartbeat backup; Secure transmission gateway

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Authors: Li Xiaoyi, Zhou Zebo

1. Overview

With the continuous maturation of digital television and computer network technologies, alongside ongoing advancements in software and hardware platforms, modern television broadcasting systems have evolved into multi-channel, network-controlled digital broadcasting architectures centered on centralized hard disk storage. Critical common challenges in system construction—such as system planning, equipment selection, capacity expansion, and real-time backup —must be carefully addressed.

During the renovation of its four-channel broadcasting project, Xiaogan Television Station adopted various innovative technologies to provide stable technical support for safe and reliable broadcasting operations.

2.1 Overall Network Architecture

The Xiaogan Television Station broadcasting project comprises five major subsystems: program transmission, broadcast control, broadcast upload, business support, and advertising. These subsystems interconnect and interface with one another, providing reliable assurance for safe and efficient broadcasting.

3.1 Program and Program Schedule Transmission Subsystem

Basic Workflow Overview

Broadcast schedules and program materials are produced in the scheduling system and pushed to the broadcasting system and nearline storage according to relevant strategies. Dayang' s scheduling software then synthesizes commercial segments and transmits them to the broadcasting software, migrating materials from nearline storage to broadcast servers.

3.1.1 Program Schedule Transmission Workflow

The chief editorial office' s schedule editing workstation creates broadcast program schedules, selecting program source types based on actual usage requirements for each channel. After verification, schedules are submitted to the Dayang broadcasting system. When upload tasks are required, the scheduling software automatically generates pending upload tasks for HDD signals in the upload manager window of the broadcast upload software. Once the chief editorial office successfully pushes the material and the software refreshes, the pending upload task is automatically canceled.

3.1.2 Broadcast Material Transmission Workflow

After the chief editorial office submits approved program schedules to the broadcast database, strategy software automatically pushes materials to broadcast video servers based on schedule information. If automatic pushing fails, chief

editorial staff can manually transfer programs from secondary cache to designated directories on the broadcast FTP server.

The progress and completion status of transfers from secondary cache to broadcast FTP server directories can be monitored through a service client software, which displays current push tasks and completed transfers. This real-time monitoring enhances broadcasting security. For material safety, a dual-channel review process on broadcast video servers completes secondary material verification. After normal broadcast completion, material management software within the broadcasting system issues deletion commands according to established policies, removing materials from the system.

3.2 Broadcast Control Subsystem

In modern broadcast television systems, the implementation of primary-backup workstations for hot standby and intercommunication between them is critical. Inadequate primary-backup switching or absence of a third-level backup mechanism can introduce unpredictable security risks. To address this, Xiaogan Television Station refined its broadcast control scheme with two key components:

3.2.1 Primary-Backup Heartbeat Mechanism

Primary-backup workstation heartbeat mechanisms are implemented through two approaches: network-based and serial port-based communication. Xiaogan Television Station employs both methods simultaneously to ensure reliable communication between primary and backup broadcast workstations, thereby enhancing broadcast security and primary-backup switching reliability.

3.2.2 Third-Level Backup Mechanism

The broadcast control system represents the core of the entire broadcasting architecture. At Xiaogan Television Station, broadcast workstations control primary and backup video servers, primary and backup switchers, VTRs, and other equipment. Although two control workstations operate in full primary-backup mode, having only two workstations means that if either workstation or video server fails, only a single device remains operational. If the fault cannot be resolved quickly, it poses a significant threat to broadcast security. Consequently, the station implemented a third-level backup mechanism utilizing a third backup workstation to independently control an additional video server. This substantially improves system security during failures and provides adequate time for fault resolution.

In Xiaogan Television Station's hard disk broadcasting system, the signal switching logic for primary, backup, and third-level backup operates as follows: if the primary video server fails, automatic switching occurs; if the backup video server also fails, automatic switching to the third-level backup signal engages.

All switching operations are seamless, significantly enhancing overall system security.

3.3 Security Transmission Gateway and File-based Upload System

External resources obtained by the station fall into two categories: general file ingestion via USB drives/mobile hard disks, and professional media file ingestion, primarily DVD files requiring secure import. Due to substantial differences between these ingestion methods, the system implements two distinct security solutions.

3.4 Production Network and TV Drama File Ingestion

Before implementing the security isolation system, production network and TV drama file ingestion required submitting network access applications to approvers. After approval, network administrators performed virus scanning and manually imported resources. This process is illustrated in [Figure 3: see original paper].

The station adopted the latest USB 3.0 secure ferry technology with a new data interaction workflow, enabling efficient and secure ferrying of general files from office areas. Under the new process, file transfer permissions are fully delegated to editors and journalists. After files are transmitted to the backend, security isolation equipment performs virus scanning and secure ingestion. The secure ferrying process is shown in [Figure 4: see original paper].

In the redesigned workflow, editors can upload files directly from the production network. The system performs file format validation in the backend. After approval, files enter the USB 3.0 security isolation device for mandatory virus scanning and are ferried into the network via a USB 3.0 private transmission protocol along preset paths. The security ferry device replaces traditional TCP/IP Ethernet links with USB links, effectively preventing viruses and hacker attacks. The entire process requires no manual intervention, significantly improving operational efficiency.

To maximize equipment utilization, all external program ingestion adopts a shared backend security transmission gateway design. The security transmission gateway system employs a new USB 3.0 isolation gate, achieving overall transfer speeds up to 100MB/s. File transfers can be controlled through whitelists and blacklists, enabling legitimacy analysis of material files before transmission to prevent unauthorized files from entering the production network.

3.5 Business Support Subsystem

The business support subsystem consists of two parts: a server cluster support system (including database servers, application servers, and technical review

servers) and a material management and scheduling subsystem.

3.5.1 Core Server Cluster Backup Mechanism

To enhance database security, Xiaogan Television Station' s broadcast project employs primary-backup hot standby (implemented through AUTOSTART software) plus a third-level backup approach. For additional security, the system publishes database files to a separate third backup database through SQL-specific methods, with complete daily backups generated automatically.

3.5.2 Material Scheduling Mechanism

With limited storage capacity at Xiaogan Television Station, a comprehensive scheduling scheme was developed to ensure material scheduling security and efficiency. The overall principle follows the program schedule lifecycle—once a schedule expires, the corresponding materials no longer require retention. Materials stored locally are scheduled to secondary storage and video servers, with synchronization maintained between video servers.

Xiaogan Television Station's broadcasting system is now fully operational. Both system design and equipment selection prioritize broadcast security and structural innovation. The system incorporates advanced technologies including Omneon video servers, AutoStart hot backup database services, Dayang secondary storage, and Dayang' s advanced broadcasting, scheduling, and transmission systems. These innovations have substantially enhanced broadcast security and reliability while significantly improving broadcast quality, establishing a solid foundation for Xiaogan Television Station' s business development.

(Author Affiliation: Hubei Xiaogan Radio and Television Station)

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