Cloud Storage Technology-Assisted Broadcasting Resources Optimization: Postprint

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Abstract

This paper analyzes the problems faced by broadcast program storage, introduces the concept of cloud storage, the construction methods, topological structure, and key technologies employed by cloud storage systems. It elaborates on the issues resolved in broadcast audio program storage through the application of cloud storage systems and the technical advantages thereof, and explores the application of cloud storage technology in broadcast acquisition, editing, and broadcasting management, in conjunction with the practical operations of radio stations.

Full Text

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Cloud Storage Technology for Broadcast Resource Optimization

Abstract: This paper analyzes the challenges facing broadcast program storage, introduces the concept of cloud storage, and examines the construction methods, topology structures, and key technologies employed in cloud storage systems. It elaborates on the problems solved by applying cloud storage systems to broadcast audio program storage and the associated technical advantages. Drawing on practical radio station operations, the paper explores the application of cloud storage technology in broadcast collection, editing, and broadcasting management.

Keywords: cloud storage; broadcasting; cloud computing; network

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Introduction

With the rapid development of cloud computing technology, cloud storage—a derivative of cloud computing—has found extensive application in the broadcasting and television industry. Cloud storage is not merely a storage chip; rather, it is a system comprising servers, network equipment, storage chips, software, and clients. It provides a service capable of unlimited capacity storage for radio stations' vast archives and daily-generated audio programs, establishing a resource-sharing platform for rapid network-based transmission, systematic management, resource sharing, and multi-channel distribution of audio programs. The adoption of cloud storage technology offers effective solutions for the storage, forwarding, supervision, and application of radio station audio programs. The unlimited scalability, stable and reliable performance, ease of management, and robust operation platform of cloud storage systems provide essential support for the long-term development of radio stations.

Broadcast audio program storage currently faces several critical challenges. First, existing storage systems cannot meet the rapid development needs of broadcast collection, editing, and broadcasting. Second, legacy storage systems are bulky and dispersed, making systematic management difficult. Third, storage array maintenance is problematic. Fourth, old storage equipment lacks reserved expansion space, making upgrades difficult. Fifth, these systems cannot accommodate the shared requirements of broadcast and new media platforms. Additionally, cloud storage requires sufficient bandwidth, as users access it through networks and bandwidth must increase progressively to meet usage demands. Cloud storage technology incorporates network peer-to-peer technology, content delivery technology, redundant data elimination, data compression, and data encryption to ensure high-speed and reliable data exchange. Network virtualization technology enables supervision and unified management of geographically distributed storage units, monitoring operational status and performing fault maintenance to ensure stable operation.

Cloud Storage Architecture, Key Technologies, and Functions

Cloud Storage Concept

Cloud storage is a system that provides resource storage and user access through centralized parallel usage, distributed deployment, and grid computing, coordinating various types of storage devices via software. Its workflow involves dividing massive processing programs into numerous small subprograms through networks and software, processing each subprogram separately through software and hardware systems, aggregating the results, and transmitting the final out-

put to customers. Users can upload, download, read, copy, and archive audio programs in the cloud storage system at any time.

Cloud Storage System Structure

The cloud storage architecture consists of four components. The **storage component** is the fundamental part of the system, including fiber channel storage and network storage. All storage devices in the system run a unified management operating system, communicate via the internet, and enable virtualized, centralized management of device status maintenance, supervision, and upgrades. The **management component** is the central hub of the cloud storage system, coordinating multiple storage devices to work on different parts of the same task. Software handles storage task allocation, grid computing, and result aggregation. Data transmission, compression, and task distribution technologies effectively regulate bandwidth usage, reduce data footprint, and improve efficiency, while data encryption ensures confidentiality. Automatic data backup guarantees system security. The **application interface component** provides customized interfaces for different radio channels based on their collection, editing, broadcasting, and new media distribution needs, offering various service types with excellent flexibility and scalability. Authorized departments can connect to the network and access cloud storage resources by entering usernames and passwords. The **system access component** allows authorized radio channels, new media, and internet broadcasting departments to log into the cloud storage service system using credentials, with the system providing tailored services based on departmental requirements. Usage involves accessing services generated by the entire software-hardware system rather than individual storage drives.

Cloud Storage Topology Structure

The cloud storage system comprises two functional modules: front-end control equipment and back-end storage devices. **Control equipment** serves as the application management platform for supervising and querying application data and metadata, using software to control parallel access, data redundancy error correction, and big data management in back-end storage. Administrators manage the entire system operation and user activities in real-time through terminals. **Storage devices** include high-performance, high-capacity disk arrays, built-in access protocol packages, and storage node licenses. After high-performance disk arrays are connected to the network storage pool, software performs audio program backups, saves them across different storage spaces, and intelligently expands storage capacity and bandwidth based on data traffic to enable real-time, dynamic, intelligent adjustment and management, thereby improving system efficiency.

Key Technologies

Storage Load Intelligent Regulation Technology The cloud storage system employs a primary storage server to manage distributed storage nodes. Audio program metadata resides on the primary server, while program data is distributed across other nodes. The primary server assigns unified names to audio programs and monitors other nodes in real-time. When editors upload or download audio programs, the primary server allocates tasks to less-loaded nodes based on traffic and bitrate conditions. If a node fails and goes offline, the primary server automatically copies its unfinished data to other nodes, replaces the failed node's tasks, and shields it from the system to prevent broader impact.

Fast Parallel Access Technology When editors upload or download audio programs, they first access metadata on the primary storage server rather than the actual audio data, which is distributed across other nodes. Since metadata content is minimal, this significantly reduces the primary server's bitrate burden and accelerates program search speed. Audio data uploads and downloads use metadata from the primary server to issue commands via system software to multiple distributed nodes, enabling parallel data transfer across numerous storage servers. Consequently, cloud storage system efficiency is very high—generally, the more distributed storage servers in the system, the faster the overall operation speed.

Problems Solved and Technical Advantages

The transition from analog to digital broadcasting has improved program audio quality and efficiency while transforming audio program editing, production, and storage methods, enabling multi-channel distribution and new business models. The broadcast production process involves frequent audio data exchange, requiring storage systems with high-speed access and responsive performance. Digital broadcast production uses non-linear editing, which demands high bitrate transmission speed and quality from storage systems. Audio program material searches and editing involve very brief access times, with program segments callable in any order—tasks completed through editing software, storage devices, and servers. This approach has become mainstream for audio program editing. Digital broadcasting implementation has not only improved program clarity but also multiplied program bitrates, and with multiple frequencies across stations, total program volume has exploded, rendering previous storage technologies and equipment inadequate.

Cloud storage effectively addresses these issues, improving audio storage and retrieval efficiency. It provides radio broadcasting with a powerful audio program database and robust technical support for program production and broadcasting. Cloud storage offers several technical advantages. First, it enables intelligent management—all management tasks are automatically completed by the primary storage server, which shields faulty nodes to ensure safe, efficient

operation. Second, it provides excellent backward compatibility, supporting both high-performance fiber channel servers and lower-end devices like NAS and iSCSI. Third, it handles large-volume storage with rapid search and preservation capabilities. Fourth, system performance is highly stable, with the cloud architecture providing fault tolerance for different storage nodes and increasing read/write speeds randomly with data volume. Fifth, it offers excellent scalability—grid nodes can be added anytime based on program volume, supporting nearly infinite storage capacity.

Cloud Storage Applications in Broadcasting

Systematic Management of Massive Audio Programs

Radio stations generate enormous audio files daily that consume vast storage space and network resources. Digital broadcasting has caused audio program resources to grow exponentially. Cloud storage leverages its high reliability, performance, capacity, and security to achieve systematic management of massive audio programs.

Program Asset Management

Media asset management involves digital preservation, cataloging, indexing, query, editing, audio transcoding, and distribution of audio files, text manuscripts, and images from various channels. Digital storage has replaced traditional methods, and only cloud storage can handle the massive workloads from rapid media resource growth. Audio materials consist of program data and metadata. Cloud storage technology provides users with a media asset management system integrating digitization, cataloging, storage, search, retrieval, upload, and download functions.

Application in Collection, Editing, and Broadcasting

Current radio collection, editing, and broadcasting systems operate in silos with dispersed resources, low efficiency, and no sharing capabilities. Cloud storage technology enables system software to coordinate dispersed standalone resources and intelligently allocate them based on editors' needs, allowing each node to share tasks, reducing equipment idle rates, and improving overall utilization. Cloud storage is not geographically constrained, enabling remote interviewing, editing, and uploading to improve production efficiency.

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