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Military Audio-Visual Data Management Cloud Platform Architecture Design: Postprint

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Abstract

[Purpose] With the rapid development of big data from concept to implementation, data collection, data storage, data mining, and data analysis have been applied in an increasing number of industries. Data acquisition channels continue to expand, and data storage and computing capabilities are increasingly enhanced. Big data, which began influencing the military domain from the Internet industry, has been elevated to a national strategy. In the field of military big data, there exists a substantial amount of multimodal data, such as image, video, and voice-based audio-visual data, which have yet to be effectively mined and utilized.

[Method] This paper proposes systematic design recommendations on how audio-visual data in the military domain can provide services for upper-layer big data platforms within a big data environment.

[Results] Through in-depth analysis of technologies such as big data, cloud computing, and distributed data governance, a system design scheme for an audio-visual data management cloud platform suitable for military domain construction and utilization is proposed.

[Conclusion] By summarizing experience from relevant project implementations, this paper provides a comprehensive exposition from the perspectives of platform system composition, system architecture, functional logic, system interaction, and other aspects.

Full Text

Preamble

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Design of a Cloud Platform Architecture for Audio-Visual Data Management in the Military Domain

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Abstract

Objective: As big data rapidly evolves from concept to implementation, technologies such as data acquisition, storage, mining, and analysis have found applications across an increasing number of industries. With expanding data acquisition channels and growing storage and computing capabilities, big data—originating in the internet sector and gradually influencing the military domain—has officially become a national strategy. Within military big data, there exists a wealth of multimodal data, including images, videos, and audio-visual information, that remains underutilized and inadequately exploited.

Methods: This paper proposes a systematic design framework for how audio-visual data in the military domain can provide services to upper-level big data platforms within a big data environment.

Results: Through in-depth analysis of big data, cloud computing, and distributed data governance technologies, we propose a design scheme for an audio-visual data management cloud platform architecture suitable for military domain construction.

Conclusion: Drawing on experience from related project implementations, this paper provides a comprehensive exposition covering platform system composition, system architecture, functional logic, and system interaction.

Keywords: Military domain; audio-visual data; management; architecture; services

1. Requirements Analysis for Audio-Visual Data Management in the Military Domain in the New Era

In recent years, big data technology has been deeply integrated into military domains worldwide, gradually demonstrating its technological advantages in effectiveness and precision for applications such as intelligence and decision support. Military big data is characterized by large volume, broad domain coverage, diverse types, and spatiotemporal complexity. Particularly challenging are spatiotemporal data correlation and consistent data management, making precise hybrid utilization of big data extremely difficult. This paper proposes a design scheme for an audio-visual data management cloud platform architecture suitable for military construction through in-depth analysis of big data, cloud computing, and distributed data governance technologies. By summarizing experience from related projects, we provide a comprehensive exposition from the perspectives of platform system composition, architecture, functional logic, and system interaction, offering certain guiding significance.

The audio-visual data management cloud platform can be designed with three hierarchical layers: infrastructure resource management, foundational service

management, and application service management.

The infrastructure resource management layer, Infrastructure as a Service (IaaS), provides a unified foundational environment for both the foundational service management and application service management layers. Aligned with current cloud architecture data center construction concepts, it centrally manages hardware infrastructure resources including servers, storage, and network equipment through cloud management approaches. During construction planning, this layer should be integrated into the upper-level big data platform's infrastructure resource construction based on actual conditions; this paper does not address its specific design.

The foundational service management layer, Platform as a Service (PaaS), serves as an intermediate service layer providing support capabilities including system authentication, management, public capability services, and interface management. It can adapt to private, dedicated, and public cloud services. The platform should be standardized and open, enabling unified scheduling of computing, storage, and network services. Design considerations must fully account for serviceability and scalability to provide available tools and services for new business requirements and to satisfy subsequent development and functional expansion needs. Simultaneously, as the foundational management layer for audio-visual data, it should deliver essential capability services required for audio-visual data operations such as transcoding, technical review, and composition.

The application service management layer, Software as a Service (SaaS), functions as the user-facing product output layer, primarily deploying various application software customized according to user requirements. Its foundational data resources, management services, and service support originate from the application service management layer itself, with emphasis on deploying functional service tools such as audio-visual data acquisition software, data governance software, and data distribution software tailored to actual user needs. Through a unified portal, it provides product services and data interaction services to external users, thereby achieving secondary platform service support.

2. Overall Architecture of the Military Audio-Visual Data Management Cloud Platform

The military audio-visual data management cloud platform is a foundational data governance platform that integrates cloud computing, big data, wide interconnection, and intelligentization. It includes specialized processing technologies for text, images, audio-video, and telemetry data, as well as fundamental data analysis technologies based on big data. The platform implements governance, screening, classification, and basic relational operations on audio-visual data. Serving as a secondary data governance platform, it performs refined governance and processing of audio-visual data to produce an efficient and massive audio-visual data resource pool, laying a data foundation for the analysis and management of various data services on the top-level multi-source data

platform.

Based on relevant cloud computing theories and technologies, the military audio-visual data management cloud platform can be designed with three hierarchical layers: infrastructure resource management, foundational service management, and application service management.

[Figure 1: see original paper]

In accordance with the characteristics of audio-visual data services, various system software and tool software within the application service layer can be integrated and consolidated through portal integration technology to achieve single sign-on, identity authentication, and centralized display of multiple system software interfaces. Through a unified portal system, relevant system software is integrated and consolidated, with the system software subsequently invoking various services from the platform service layer (PaaS) and calling upon various tool software.

3. Design of the Foundational Service Management Layer for the Military Audio-Visual Data Management Cloud Platform

The foundational service management layer serves as the core of service management, representing the abstraction and unified control of audio-visual data governance-related capability services. It provides various business interfaces for the upper application service management layer, simplifying business logic complexity through integrated service models, and enabling the provision of unified API and SDK interfaces to external parties. Design considerations should fully account for requirements for business capability integration and functional expansion.

[Figure 2: see original paper]

The portal system can rely on the unified user authentication service provided by the cloud platform service layer (PaaS) to complete user information management at the business level, implementing user legitimacy and uniqueness authentication while allowing third-party vendor access. It can provide personalized customization and achieve aggregation and presentation of key data information from various business modules on the portal through efficient technical means.

Within the foundational service management layer, public capability services constitute the core of audio-visual data capabilities, representing the abstraction and control of audio-visual data governance capabilities and forming an important component of the audio-visual data management cloud platform. These services should include essential functions for audio-visual data governance such as transcoding, migration, technical review, packaging, and splicing, while providing standard interface specifications that allow heterogeneous capability systems to connect.

[Figure 3: see original paper]

Each production capability component and data management system serves as a loosely coupled component of the data. Although logically belonging to part of the data production system, they can be deployed and operated independently in actual operation. Functions such as ingest, quick editing, transcoding, and distribution can all be deployed and used separately.

It should be specifically noted that the technical review module design should fully incorporate military domain business characteristics and integrate intelligent technical review processes to reduce operational steps and enhance efficiency. The transcoding module design should fully consider non-standard video data processing capabilities. For hardware selection, X86 architecture equipment is currently recommended, supporting cloud deployment methods that can be flexibly scheduled according to user needs, adaptable to different network bandwidths and terminal processing capabilities, thereby increasing controllability and security.

It should also be noted that cataloging of audio-visual data is the most critical step in the audio-visual data governance process, directly affecting subsequent data utilization efficiency. Therefore, data standards adopted during project design should strictly follow upper-level big data platform data standards. Platform metadata must be described in a standardized manner according to unified metadata cataloging standards. Audio-visual data cataloging design should incorporate intelligent and visual customization, enabling flexible and customizable cataloging templates as needed, and supporting XML data exchange to facilitate inter-system data exchange.

4. Design of the Application Service Management Layer for the Military Audio-Visual Data Management Cloud Platform

The application service management layer serves as the operational core of various software services for the audio-visual data management cloud platform, covering all aspects of the audio-visual data generation process and providing integrated production capabilities for the upper-level big data platform. It can flexibly schedule public services and tools from the PaaS layer through API interfaces. The layer can be divided into system software applications and tool software applications, capable of completing audio-visual data acquisition, processing, cataloging, CP/SP management, data retrieval, data review, data distribution, data monitoring, and other business functions.

[Figure 4: see original paper]

The data acquisition and aggregation subsystem can achieve unified collection and aggregation of real-time audio-visual data, original standard-format audio-visual data, and non-standard audio-visual data from specialized equipment such as telemetry devices. It supports ingest from various media, disk file im-

port, IP ingest, and other platform processes that can be customized according to actual user requirements for convenient and flexible configuration implementation. During material ingest, automatic technical review functions can be invoked to automatically analyze data attributes, simplifying the data cataloging process and enhancing intelligent application.

The intelligent data production management subsystem serves as the platform's foundational business system, enabling functions such as production scheduling, data cataloging, review, storage, retrieval, process definition, and user management.

The intelligent data distribution subsystem functions as the platform's external data service port, operating as an independent system within the overall audio-visual data management cloud platform. It is responsible for distributing audio-visual data produced by the intelligent data production management subsystem to various sub-platforms as needed, and achieving interactive interfacing with the upper-level data platform. It can perform statistical analysis on produced and distributed audio-visual data to enable intuitive and precise grasp of platform operational status.

[Figure 5: see original paper]

5. Extensibility Planning and Design for the Military Audio-Visual Data Management Cloud Platform

The audio-visual data management cloud platform is built upon a three-tier cloud architecture to construct a PaaS platform with military attributes, aiming to adapt to more SaaS services. It targets not only the military audio-visual professional domain but also strives to gradually develop a mature and complete PaaS layer service system to better provide public capabilities and platform services for the upper-level big data platform and other technical platforms.

The foundational capability of the PaaS layer is the management service of basic toolsets, which should uphold an open philosophy by providing an open, stable, and operable management platform. Subsequent planning and expansion should fully consider hybrid cloud management capabilities and elastic scalability for the PaaS layer. It should enable rapid integration of third-party tool products and provide simple calling interfaces for SaaS product development. As business continues to evolve, an increasing number of tool services will be incorporated into the foundational capability management services, enabling SaaS product developers to more conveniently develop specialized software. Through clustered deployment and high-availability technical means, SaaS products can be ensured to operate stably and persistently.

For the data acquisition and aggregation subsystem, consideration should be given to accessing more data content aggregation services, such as CP/SP access capabilities based on dedicated networks, which can enable operations including

data upload, submission, query, statistics, and management through a dedicated CP/SP service portal.

[Figure 6: see original paper]

Due to their particularity and security requirements, military domain audio-visual data cannot rely on public network resources and processing technologies. Such data features large volume, complex storage formats, specialized data governance requirements, and high network resource consumption for data transmission, making it difficult for upper-level big data platforms to encompass professional audio-visual data processing technologies. As an important component of military big data, audio-visual data platforms should be planned and constructed as relatively independent foundational platforms during military big data platform development, which is conducive to fully leveraging the unique value and utility of audio-visual data.

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