Discussion on the SRT Transmission Protocol in Broadcast Television Signal Transmission (Post-print)

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Abstract

In the development of converged media technology, public network transmission technology constitutes an important component. The SRT transmission protocol features high security and reliability, along with low latency, and finds extensive application in public network transmission. This paper analyzes the working principles and practical applications of the SRT transmission protocol, addresses rational parameter selection, and clarifies key considerations in public network transmission, thereby enabling full utilization of the SRT transmission protocol in the broadcasting and television domain.

Full Text

Preamble

Title: Exploration of the SRT Transmission Protocol in Radio and Television Signal Transmission
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Abstract: In the development of converged media technology, public network transmission technology constitutes an important component. The SRT transmission protocol offers high security and reliability while maintaining low latency, making it widely applicable in public network transmission scenarios. This paper analyzes the working principles and practical applications of the SRT transmission protocol, provides guidance on optimal parameter selection, and identifies key considerations for public network transmission, thereby enabling full utilization of the SRT protocol in the broadcasting and television domain.

Keywords: converged media technology; public network transmission; radio and television; signal transmission; SRT transmission protocol
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As China' s media industry continues to deepen integration and development, broadcasting professionals are actively embracing the challenges brought by the era of converged media. In the evolution of converged media technology, enhancing public network transmission capabilities has become essential. Particularly in low-bitrate, low-latency environments, ensuring signal transmission quality while improving the reliability and security of internet-based transmission is critical. In this context, leveraging the SRT transmission protocol has become necessary to elevate public network signal transmission standards in broadcasting.

1.1 Overview of Radio and Television Signal Transmission

Radio and television signal transmission technology primarily utilizes wireless data transmission networks to broadcast signals, with receiving terminals capturing various data information and converting it to ensure audiences can watch programs. This technology encompasses microwave transmission, fiber optic transmission, and satellite transmission, among others. With the continuous development of 5G network technology, 5G is also being employed for broadcasting signal transmission. The ongoing advancement of digital information technology has accelerated the development of broadcasting signal transmission technology, delivering high-quality programming to broader audiences and maximizing viewer satisfaction [1].

1.2 Characteristics of Radio and Television Signal Transmission

China has made significant achievements in developing radio and television signal transmission technology, which exhibits several key characteristics. First, it features automation capabilities, enabling automated monitoring of broadcasting system data and real-time transmission of valuable information. The technology also logs operational status data, facilitating supervision of television information. When transmission issues occur, the system can quickly locate problems and restore normal operations, ensuring uninterrupted viewing for audiences. Second, the technology demonstrates high efficiency, requiring minimal time to transmit diverse data types accurately, thereby meeting audience demands for various television information. Third, continuous technological

development has improved transmission stability and program quality. Additionally, the system must possess robust defense capabilities to resist attacks, prevent signal leakage, and protect transmitted content from interception, ensuring secure data transmission [2].

2.1 Microwave Transmission Technology

Microwave transmission technology has been widely adopted in China' s radio and television signal transmission. Following the adoption of semiconductor technology, broadcasting departments began deploying high-capacity microwave repeaters. China has continuously improved its microwave trunk network technology, with rapid development beginning in the 1990s. The emergence of satellite broadcasting and network transmission technologies has increased the difficulty of microwave system upgrades, yet microwave wireless transmission remains critically important. Microwave technology can withstand natural disasters—in harsh environments where many communication methods easily fail, microwave continues to operate normally and adapts to various geographical conditions that limit fiber optic cable deployment. This enables immediate onsite reporting even during emergencies. Moreover, microwave transmission and maintenance costs are relatively low; for instance, in mountainous areas where fiber optic cable installation is expensive, microwave offers an effective solution. However, microwave transmission faces numerous influencing factors that increase electromagnetic wave attenuation and degrade signal quality.

2.2 Satellite Transmission Technology

Satellite transmission is frequently employed in radio and television signal transmission, primarily using satellites to deliver signals. Even over long distances, it ensures stable transmission to designated locations. Satellite technology also enables remote control of broadcasting signals, making it particularly suitable for remote mountainous regions. Many such areas in China have adopted satellite transmission due to its signal stability. When implementing this technology, technicians must thoroughly survey local conditions to determine its suitability [3]. To transmit broadcasting signals via satellite requires adequate broadcast communication satellites for global coverage. As satellite television transmission technology matures, it continues to transform program production methods. Satellites can compress digital program information for widespread distribution, with information technology driving rapid advances in digital compression techniques. Satellite transmission offers strong anti-interference capabilities, as external factors minimally impact the process. Its extensive coverage area and multiple communication lines make it universally adopted in broadcasting signal transmission.

2.3 Fiber Optic Transmission Technology

The choice of signal transmission technology directly affects quality in radio and television broadcasting. While microwave transmission can compromise signal

stability and quality, fiber optic transmission technology addresses these limitations. Fiber optics reduce signal loss, ensuring high-quality reception and meeting audience demands. The technology exhibits strong anti-interference capabilities and immunity to electromagnetic noise, guaranteeing stable and rapid signal transmission. Fiber optic transmission primarily uses optical cables to efficiently convert and transmit optical and electrical signals. This approach reduces bandwidth limitations while ensuring sensitivity, leading to widespread adoption in broadcasting. The technology can integrate compressed and uncompressed techniques to maximize their respective advantages, enabling faster signal transmission. Combining video optical terminals and baseband fiber in different regions enhances transmission flexibility and facilitates signal management and control [4].

3. Overview of SRT Protocol Principles

The SRT (Secure Reliable Transport) protocol is an open-source, low-latency transmission protocol that works across various products. Its main features are security, reliability, and low latency. In terms of security, SRT supports AES encryption for safe video transmission. For reliability, the protocol incorporates error correction technology to maintain signal transmission stability. Regarding low latency, SRT is based on UDP, which reduces network congestion and effectively lowers TCP transmission delays. Built on the UDP platform, SRT enhances data transmission reliability over lossy networks while coordinating packet pacing and decoder reception structures, thereby resolving UDP packet loss and sequencing issues. It also addresses TCP buffer delay problems, enabling efficient low-latency transmission over enhanced UDP in public network environments [5].

4. SRT Protocol Application Scenarios

The Zhejiang Provincial Radio and Television Backbone Transmission Network (hereinafter "Provincial Backbone Network"), established in 1997, was among the earliest provincial backbone transmission networks in China's broadcasting industry. As a crucial platform for Zhejiang Radio and Television Group's program signal transmission, it spans approximately 1,800 kilometers with 2 central stations, 13 node stations across 11 prefecture-level cities, and 8 relay stations along its route. The Zhejiang Guanglian Cable TV Transmission Center (hereinafter "the Center") maintains the Provincial Backbone Network and the national broadcasting trunk network within Zhejiang Province. Its responsibilities include transmitting China Central Television programs within the province, distributing all Zhejiang Radio and Television Group programs domestically and overseas, handling news live broadcasts, and managing data service transmission. The Provincial Backbone Network supports the SRT transmission protocol for several key applications.

4.1 Backup for Major Live Broadcast Satellite and Fiber Channels Annual transmissions of provincial and national "Two Sessions" signals require utmost security and reliability. In addition to maintaining satellite and fiber channels, public network transmission channels serve as an important backup option, offering convenience, efficiency, and cost-effectiveness [6].

4.2 Emergency News Broadcasting In emergency situations requiring live coverage of breaking news, public network transmission demonstrates greater flexibility and mobility compared to satellite news gathering models.

4.3 In-house Broadcast Signals During major event broadcasts, directors and production staff prefer monitoring in-house broadcast signals to prepare adequately for live transmission while maintaining operational agility. Using the SRT transmission protocol enables low-latency solutions [7].

5. SRT Protocol Practical Case Study

This case study demonstrates SRT protocol' s low-latency and reliability advantages in real-world environments. As converged media development involves various platforms and devices, this analysis examines equipment from different manufacturers to verify SRT protocol compatibility across products.

5.1 Overview of Encoding Equipment The encoder used at the encoding end simultaneously supports intranet and public network transmission, multiple transmission methods, and streaming protocols. It enables public network transmission, encoding, and AES encryption for multi-destination streaming. Combined with decoding and streaming devices, it supports multi-signal transmission and multi-destination distribution workflows [8].

5.2 Encoder Parameter Selection When configuring the encoder, several key parameters must be selected. First, for transmission protocol, TS over SRT is chosen; the device also supports RTP and RTMP streaming. Second, for SRT mode and listening port, the encoder SRT mode is set to Listener using port 9010. The SRT protocol requires both communication parties to have fixed public IP addresses, with one end as Listener and the other as Caller. However, the decoding end does not necessarily have to be the Listener—the encoding end with a fixed IP can also serve as Listener. When selecting listening ports, less common ports should be chosen, as popular ports are often blocked [9]. Third, SRT latency parameters are typically set to the default 125ms, though staff can adjust them based on network conditions. After link establishment, staff should observe round-trip time (RTT) between server and client, usually setting latency at four to six times the RTT. Fourth, video encoding parameters should be configured with a GOP length of 15 and IBBP frame format. Data partitioning should be enabled, using entropy coding with context-adaptive binary arithmetic coding for advanced processing. In poor network environments,

IP frame format can be selected with network-adaptive encoding enabled, allowing the encoder to dynamically adjust bitrate based on available bandwidth and reducing dependence on optimal network conditions [10]. Fifth, network port addresses are critical parameters throughout the public network transmission link, as SRT public network transmission requires at least one end of the transceiver to have a public IP address.

5.3 Decoding Equipment In practice, half-rack broadcast-grade professional HD/SD decoders can be used for high-definition and standard-definition decoding. These include IP input interfaces and SDI output interfaces, with IP protocols supporting SRT transmission and requiring compatible SRT encoders.

5.4 Decoder Parameter Selection The encoder SRT mode is set to Listener while the decoder SRT mode is set to Caller, using port 9010 and targeting the encoder' s network port address. SRT latency settings must match the encoding end. Since the decoder operates in Caller mode, it can be used immediately after internet connection without requiring a fixed public IP address.

5.5 Link Status During operations, staff can transmit high-definition audio and video signals using just 6 Mbps network bandwidth while ensuring visual and audio quality meets professional standards with minimal latency.

5.6 Important Considerations Despite SRT protocol' s numerous advantages, broadcasting staff must address several concerns. Public network transmission significantly impacts network environments, requiring thorough contingency planning before SRT implementation. Staff must protect fixed public IP information from leakage, as exposure severely affects signal transmission. On device web control interfaces, the default admin account should be deleted and replaced with new credentials to reduce hacking risks.

6.1 Improving Emergency Response Plans

To promote sustainable development of China' s radio and television industry, the operational system must be adjusted and improved to better adapt to new media impacts. Following the National Radio and Television Administration' s requirements, industry management and standards should be implemented with new technologies and equipment actively introduced and management systems perfected. Comprehensive emergency response plans for broadcast signal transmission security must be established to better address influencing factors. Each work unit needs an emergency response plan enabling staff to handle contingencies according to prescribed methods, improving work standardization and preventing responsibility shifting. Plans should also facilitate advance detection and elimination of potential transmission hazards, addressing issues proactively.

6.2 Regular Equipment Maintenance

To ensure smooth broadcasting, staff must monitor equipment status. Since broadcast signal equipment directly affects transmission quality and program broadcasting, machine maintenance is crucial. As broadcasting signal devices are precision instruments, professional technicians must conduct inspections and maintenance. Pre-operation checks should be performed daily, with routine maintenance conducted afterward to extend equipment lifespan and ensure stable signal transmission.

6.3 Enhancing Staff Comprehensive Quality

Radio and television programs serve broad audiences and undergo strict review processes, requiring high professional standards from staff. For instance, presenters' behavior directly impacts the public, necessitating professional cultivation. In signal transmission, SRT protocol compatibility enables high-quality image transmission in low-bitrate, low-latency conditions, demonstrating that public network transmission can effectively supplement and expand traditional broadcasting methods. During public network transmission, broadcasting staff must ensure network and broadcast security. Using SRT protocol optimizes video streaming performance for safe, reliable audio and video transmission, enabling cross-border news reporting, remote production, and remote interviews. As converged media continues developing, broadcasting professionals must actively respond to era challenges, embrace reform, and fully utilize emerging technologies.

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