IP Broadcast Systems for Cable Television

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In the cable television (CATV) industry, an all-IP transition is expected to improve infrastructure efficiency and enable new services. CATV operators provide both broadcasting and communications services to subscribers in their service areas. The proliferation of broadband networks via Fiber to the Home (FTTH) has led to the implementation of communications infrastructure that enable high-speed Internet connections, making it possible to transmit large volumes of video traffic using IP protocols. FTTH's Passive Optical Network (PON) systems compatible with IP broadcasting are also being provided[1].

To convert broadcasts that were previously transmitted using radio frequency (RF) technology to IP, efficient transmission using IP multicast and reliability of IP networks to deliver stable quality are essential. Japan Cable Laboratories (JLabs) has established operational specifications using IP multicast for the IP retransmission of terrestrial digital, BS digital, and advanced BS digital broadcasts, as well as independent broadcasting of specialty and community channels[2]. The Ministry of Internal Affairs and Communications has also revised the ministerial ordinance regarding the quality of general cable broadcasting to include technical standards for IP broadcasting[3].

OKI has developed an IP broadcast server that complies with the operational specifications for IP broadcasting, and an IP broadcast monitoring system that can measure the technical quality standards specified by the ministerial ordinance. This article explains products that support CATV IP broadcast systems from its implementation to operation.

IP Broadcast System Configuration

Figure 1 shows an example configuration of a CATV IP broadcast system using a server developed by OKI. Terrestrial digital, BS digital, and advanced BS digital broadcasts are received by a broadcast receiving equipment at the CATV station headend. Signals for multi-channel broadcasts are received from platform operators via dedicated lines. Signals for community channels produced within the CATV station are generated by an on-site encoder. Using these signals as input, the IP broadcast server processes them in accordance with operational specifications for IP broadcasting and transmits IP multicast packets. The transmitted packets are transmitted via the FTTH system's optical line terminal (OLT) and optical network unit (ONU), and broadcasts are viewed at subscriber homes using an IP set-top box (IP-STB).

Packets transmitted from the IP broadcast server are also continuously received by the IP broadcast monitoring server installed in the headend to monitor signal integrity.

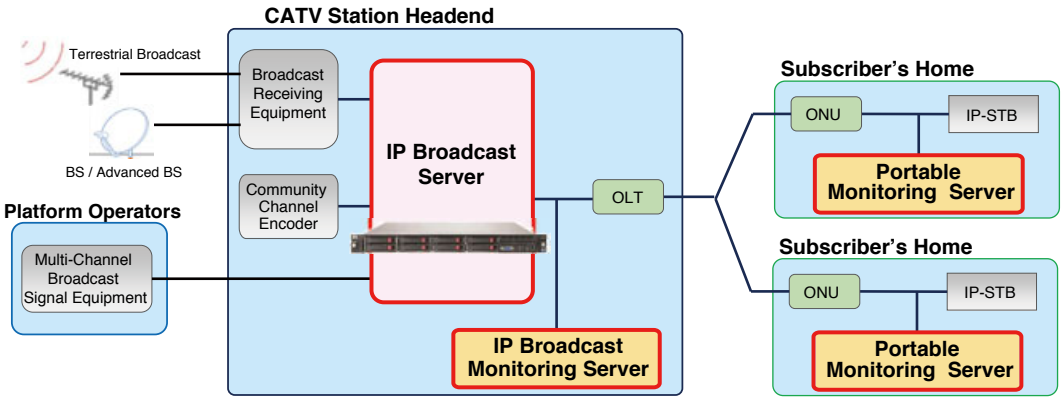

Figure 1. Configuration Example of CATV IP Broadcast System

Additionally, portable monitoring servers can be placed in subscriber homes and other locations as needed to measure the quality of the received signals, enabling the provision of stable broadcasting services that comply with quality standards.

Operational Specifications for CATV IP Broadcasting

The operational specifications for CATV IP broadcasting were established by JLabs. Among these, terrestrial digital, BS digital, and advanced BS digital retransmissions are required to reference the IP retransmission specifications (IP pass-through method) of the IPTV Forum. Furthermore, for multi-channel broadcasting, in addition to the conventional method using Marlin as a conditional access system (CAS), two specifications have been established that support the advanced CAS (ACAS) method in accordance with the signal format provided by platform operators. **Table 1** lists the established operational specifications for IP broadcasting.

Table 1. Operational Specifications for IP Broadcasting

Broadcast Type	JLabs Specifications
Terrestial Digital	Operational Specifications for IP Retransmission (IP Passthrough Method) JLabs SPEC-045 (in Japanese)
BS Digital	
Advanced BS Digital	
Multi-Channel	Operational Specifications for IP Broadcasting (Independent Broadcasting) JLabs SPEC-028 Part 1 Marlin Method
	Operational Specifications for IP Broadcasting (Independent Broadcasting) JLabs SPEC-028 Part 2 ACAS Compliant
	Operational Guidelines for Advanced Cable Independent Broadcasting (ACAS Compliant) JLabs SPEC-035 Part 2 IP Broadcasting Specifications

OKI has been providing IPTV service platform products for telecommunications carriers and CATV operators for many years, with a proven track record of stable, long-term operation without rebooting for several years[4]. Based on the software components that support this platform, OKI has now developed software that supports the newly established CATV operational specifications. The software runs on OKI's if Server, which is a 1U-sized (1.75 inch) general-purpose Intel Architecture server, and supports all broadcasting services on this single server. Additionally, a second server can be implemented to form a redundant configuration that will automatically detect an equipment failure and make a switchover, minimizing interruptions to broadcasting services. This allows for the efficient installation of a multifunctional, cost-effective system that saves space and energy at the CATV station headend.

Figure 2 shows an example screenshot of the IP broadcast server's configuration display. The operator accesses the IP broadcast server using a web browser and enters information such as the IP addresses to be used by the streamed channels for each broadcasting type. The server then performs operations such as service information (SI) specific stream generation, timestamped transport stream (TTS) conversion, and forward error correction (FEC), as specified in the operational specifications for IP broadcasting, before transmitting packets via IP multicast. It also has a function to generate channel selection control information to be provided to terminals such as IP-STBs, making it possible to provide IP broadcasting services with a single IP broadcast server.

IP Broadcasting Quality

(1) Quality-Related Technical Standards

Traditional CATV broadcasting is provided using RF

Figure 2. Example of IP Broadcast Server's Configuration Display

technology, and services provide by IP CATV broadcasting must also be of equal quality. Networks managed by CATV operators enable stable IP broadcasting services with minimal quality degradation and delays.

Regarding the quality of cable broadcasting, “The Ministerial Ordinance on Technical Standards for the Quality of General Cable Broadcasting” was partially revised in 2019 with the addition of requirements for IP broadcasting. The major additions are listed in **Table 2**. CATV operators offering IP broadcasting are required to measure these values and submit the results to their respective Regional Bureau of Telecommunications.

Table 2. Technical Standards Related to IP Broadcasting Quality

Added Item	Requirement
Packet IP Address	IP multicast address
Packet Loss Rate	$1X10^{-7}$ or less (after error correction)
Packet Delay Time	1 second or less
Packet Jitter	100 milliseconds or less
Quality Stability	IP broadcast packet priority control, etc. Ensure transmission capacity for IP broadcast packets

The method for measuring the values of the ministerial technical standards on CATV operator networks has been established by JLabs and is specified in the “Operational Specifications for IP Broadcasting Quality Measurement” (JLabs SPEC-040). The measurement range is from the headend to the receiver terminal (input point of an IP-STB, etc.), and measurements are recommended during network construction, topology changes, terminal installation work, and operation.

The measurement time varies depending on the item being measured. For packet loss rate measurements, at least 8.3 hours is required for a 12Mbps bitrate stream, and for delay and jitter, 10-minute measurements are required to be taken several times (about two or three times). Measurement equipment includes dedicated devices that generate and measure IP packets, and general-purpose measuring devices that measure using multicast packets of video signals used for service.

(2) Quality Measurement and Monitoring

OKI’s IP broadcast monitoring system functions as a general-purpose measuring device for IP broadcasting quality measurement. It can measure items specified in technical standards using an IP broadcast monitoring server installed at the headend and a portable monitoring server installed at subscriber homes.

The IP broadcast monitoring server continuously receives IP multicast packets sent from the IP broadcast server and monitors conditions such as bit rate and packet loss. Additionally, the packet recording function can be used to save packets streamed during service, which can later be retransmitted with the same timing to be reviewed and analyzed for determining the cause of abnormalities such as video distortion.

Figure 3 shows a screen example of the IP broadcast monitoring server. The left side displays a list of locations and servers installed at each location. When a server is selected, information such as the bit rate of received packets and error logs are displayed. The time series graph is updated in real time, making it easy to check changes in streaming status. Various information for each channel received by the server can also be displayed. Furthermore, by installing IP broadcast monitoring servers at network relay points, transmission quality for each transmission leg, such as packet delays and jitters between locations, can be checked.

Figure 3. Screen Example of IP Broadcast Monitoring Server

Figure 4. Screen Example of Portable Broadcast Monitoring Server

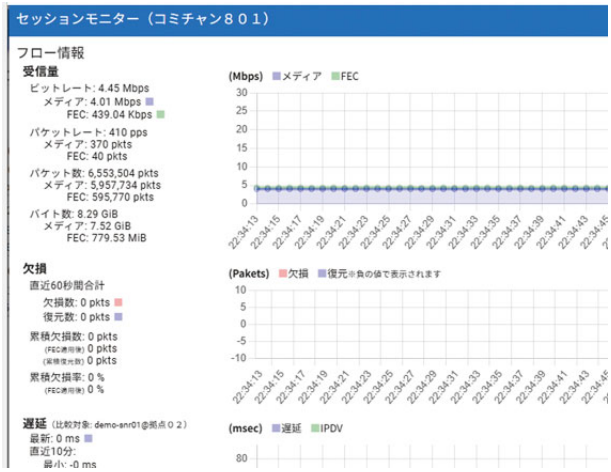

Figure 5. Screen Example of Quality Measurement Session (partially enlarged)

The portable monitoring server is a compact device that can be hand-carried and used for measurements at IP broadcast receiving locations such as subscriber homes. Similar to viewing devices such as IP-STBs, the desired channel is selected to request IP multicast packets. It then receives the packets and begins measurement. Simultaneous measurement of multiple channels is also possible, enabling efficient quality measurement and analysis if viewing issues occur.

Figure 4 shows a screen example of the portable monitoring server. The operator selects the IP broadcast monitoring server at the target location and the channel to measure, and the session begins. Measurement values for bitrate, delay, and jitter are displayed in real time. As shown in **Figure 5**, a graph of the latest status of each session is updated in real time, and the left side of the screen displays the results of each measurement item specified in the IP broadcasting quality measurement. The main quality measurements displayed for each session are:

- **Bitrate**
  Media packets and FEC packets are displayed separately
- **Loss**
  Actual number of lost packets and the number of FEC recovered packets are displayed
- **Delay**
  Minimum, average, maximum, and IP Delay Variation (IPDV) for the last 10 minutes are displayed

Measurement values as required by the JLabs' specifications are easily obtained.

Conclusion and Future Developments

This article described the IP broadcast server and IP broadcast monitoring system required for CATV IP broadcasting services. They enable the realization of a highly integrated and compact IP broadcast system that meets the operational specifications and quality technical standards of IP broadcasting.

Future development will include promoting the implementation of the IP broadcast systems, and continuing the functionality expansion and operability improvement of related products. ◆◆

References

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