The i-Visto Gateway XG—Uncompressed HDTV Multiple Transmission Technology for 10-Gbit/s Networks

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Abstract

The i-Visto gateway XG is a new product for the i-Visto (Internet video studio system for high-definition television (HDTV) production) system developed by NTT Laboratories. It can transmit multiple HDTV streams using a 10-Gbit/s network interface. We used the i-Visto gateway XG in two field tests: multiple HDTV transmission between Osaka and Tokyo over the JGNII network and a local demonstration at an NTT Group exhibition. This article describes the new functions of the i-Visto gateway XG, the results of the field tests, and our future plans.

1. Development background

The i-Visto (Internet video studio system for high-definition television (HDTV) production) is an Internet-based video production-support system for professional use developed by NTT Laboratories. It consists of six main products (**Fig. 1**). (1) The i-Visto gateway performs conversion between digital video signals and Internet protocol (IP) streams. (2) The i-Visto HDTV camera is an HDTV camera that can be directly connected to an IP network. (3) The i-Visto media server is a network-attached video server that

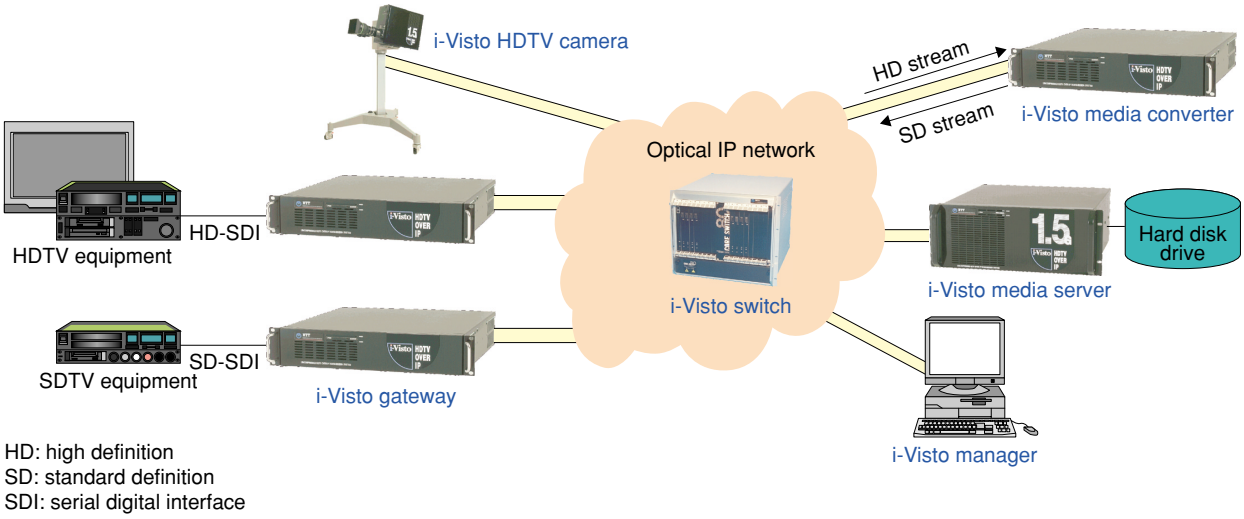

Fig. 1. The i-Visto product lineup.

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can handle uncompressed HDTV streams. (4) The i-Visto media converter converts video from one format to another in real time (e.g., from HDTV to SDTV (high definition to standard definition television)). (5) The i-Visto switch is an OC-48-based layer-2 switch. (6) The i-Visto manager manages and controls i-Visto products via an IP network.

Field tests have shown that these products can provide quality sufficient for commercial broadcasting. However, various transmission technologies that reduce the cost of video transmission services have recently been making their appearance (e.g., coarse wavelength division multiplexing (CWDM)). Consequently, finding ways to make i-Visto a more economical system have become important. In response, we have developed the i-Visto gateway XG (**Fig. 2**), which is an upgraded version of the previous i-Visto gateway. It reduces network-related costs in the following ways.

(1) The i-Visto gateway XG supports Ethernet. This lets us use wide-area Ethernet services, which are cheaper than transmission services based on asynchronous transfer mode (ATM) or synchronous transfer mode (STM). The previous i-Visto gateway supported only STM.

(2) The i-Visto gateway XG can handle multiple HD-SDI or SD-SDI (high/standard definition serial digital interface) signals. The previous i-Visto gateway could handle only one digital video signal.

2. Functions

The i-Visto gateway XG guarantees backward compatibility with the previous i-Visto gateway. **Table 1** shows how the functions of the i-Visto gateway have been enhanced in the i-Visto gateway XG. These enhancements are described in more detail below.

2.1 Multiplexed transmission of video streams

The i-Visto gateway XG can transmit multiple video streams over an IP network. It can convert HD-SDI and SD-SDI video streams input from multiple video interfaces to IP packets in real time, then multiplex and transmit these packets via a network interface (**Fig. 3**). The destination i-Visto gateway XG of

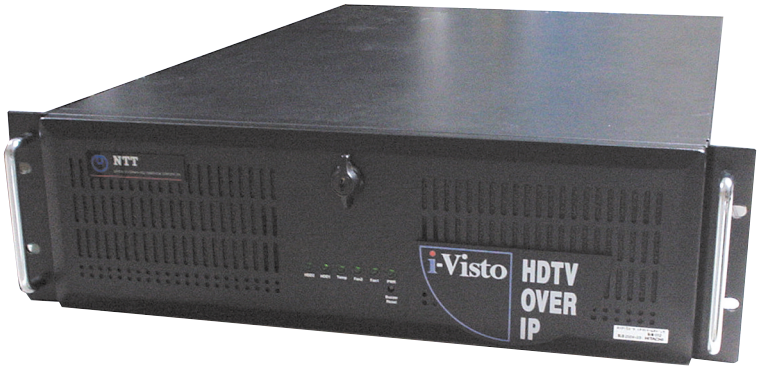

Fig. 2. External view of i-Visto gateway XG.

Table 1. Main functions of i-Visto gateway XG.

	i-Visto gateway XG	i-Visto gateway
Network interfaces	10-Gbit/s Ethernet, 1-Gbit/s Ethernet, POS/POS++ (max. 10 Gbit/s)	POS/POS++ (max. 2.4 Gbit/s)
Maximum number of video streams (multiplicity)	3	1
IP packet length	1500 bytes to 64 KB	64 KB
Supported data (other than video)	RS232c (for control), IP tunneling	RS232c (for control)

POS: packet over SONET/SDH
POS++: multiple access protocol over SONET/SDH
SONET: synchronous optical network
SDH: synchronous digital hierarchy

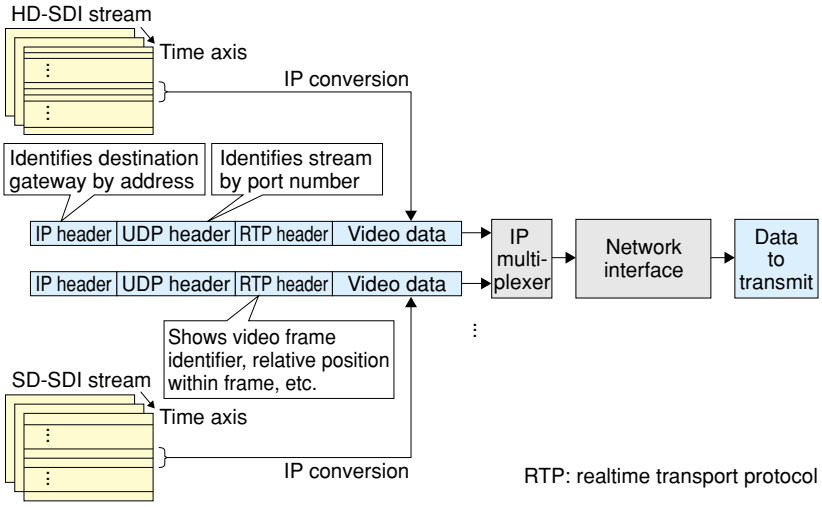

Fig. 3. Example of IP conversion and IP multiplexing of HD-SDI and SD-SDI video streams.

each of the video streams is specified by the destination IP address.

In reverse, it can also receive IP packets from a network interface and reconfigure individual digital video streams from them, then output them from corresponding video interfaces. According to the video-stream identification data included in IP packets, it identifies the corresponding video stream for each arriving IP packet. Specifically, a destination port number of UDP (user datagram protocol) is used.

The i-Visto gateway XG supports both IPv4[*1] and IPv6[*2]. It also supports 1-to-N video distribution using IP multicasting.

In handling multiple video streams, i-Visto gateway XG can separately initiate or halt the transmission of each video stream and can separately monitor its transmission status.

Information attributed to each video stream such as the source/destination IP address, video format, and other control data can be managed in an integrated fashion using configuration files within the i-Visto gateway XG. This makes it easy to refer to and modify this information.

2.2 Support for 10-Gbit/s and 1-Gbit/s Ethernet interfaces

While the previous i-Visto gateway supported network interfaces up to 2.4-Gbit/s (OC-48), i-Visto gateway XG supports 10-Gbit/s Ethernet. Moreover, the previous one transmitted HDTV streams using only 64-KB IP packets, while the latter can additionally transmit HDTV streams over networks using a 1500-byte MTU (maximum transfer unit) because its higher IP-SDI conversion performance lets it handle such short MTUs. Needless to say, it supports Ethernet networks with larger MTUs such as 9 KB commonly referred to as a “jumbo frame”.

The i-Visto gateway XG also supports the trunking transmission[*3] scheme. It can transmit an HD-SDI signal requiring a bandwidth of about 1.6 Gbit/s by using two 1-Gbit/s Ethernet interfaces.

2.3 General-purpose-data transmission mode

In addition to video streams themselves, the IP conversion function used by this system supports the transmission of data related to the streams and general-purpose data as well. This is an extension of the previous i-Visto gateway function that allows IP multiplexing of an i-Visto HDTV-camera remote-control signal with a video stream.

In more detail, the i-Visto gateway XG has a function for encapsulating Ethernet frames input from an Ethernet interface or a POS (packet over SONET/SDH) interface plus IP or control signals input from a serial port to achieve tunneling-type transmission. It also has a function for routing IP. In any case, IP-multiplexed transmission can be performed using the

*1 IPv4: The current IP standard (version 4) used by the Internet featuring an address length of 32 bits.

*2 IPv6: Next-generation IP standard (version 6) featuring an address length of 128 bits.

*3 trunking transmission: A transmission system that treats multiple network interfaces as a single virtual interface.

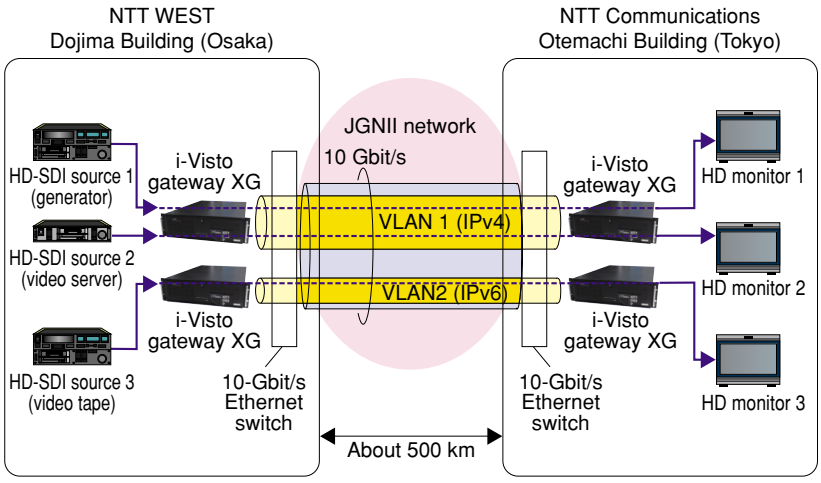

Fig. 4. System configuration for long-distance transmission field tests.

same network interface as used for the IP-converted video-stream data.

2.4 Maximum number of installed interfaces

An i-Visto gateway XG can house up to six cards for video and network interfaces. This provides flexibility in configuring the relationship between video streams and IP such as when multiple video streams are being transmitted and received from corresponding network interfaces.

3. Long-distance transmission field tests

To evaluate the performance of the i-Visto gateway XG, field tests of HDTV uncompressed video transmission were conducted by NTT Communications, NTT West, and Asahi Broadcasting Corporation in collaboration with CKP[*5] on the JGNII[*6] 10-Gbit/s Ethernet network. As shown in **Fig. 4**, an IPv4 virtual local area network (VLAN) and an IPv6 VLAN were constructed on JGNII 10-Gbit/s Ethernet lines between Tokyo and Osaka, a distance of about 500 km. In each VLAN, a total of three uncompressed HDTV streams including commercial broadcasting material were IP multiplexed and transmitted. During the transmission, video quality and operation stability were examined.

The test was conducted for a period of five days. During the test we monitored HDTV video quality, the number of lost IP-packets, and transmission delay. We did not observe any video-frame or packet loss in any of the video streams. We also found that the transmission delay was at most equal to the time taken to display two HDTV video-frames, which does not present any problems in practical use. From these results, we conclude that the i-Visto gateway XG achieves stable high-speed uncompressed video transmission between widely separated locations.

4. Demonstrations at NTT Group exhibition

As part of an effort to promote business for the i-Visto gateway XG, demonstrations were performed at the R&D booth at an NTT exhibition called NTT Group Collection in West 2004 held sequentially at exhibition halls in Fukuoka, Nagoya, and Osaka. As shown in **Fig. 5**, the network configuration of this demonstration system connected three locations within the exhibition hall by a 10-Gbit/s Ethernet LAN. In contrast to the long-distance transmission field test described above, the objective of this demonstration was to let users experience for themselves the sensation of high-quality remote communication in bidirectional HDTV transmission using the i-Visto gateway XG.

In the demonstration, a satellite studio set up inside the exhibition hall was first connected to the exhibition booth by a 10-Gbit/s Ethernet line, and HDTV streams including audio were transmitted in both

*5 CKP: Cyber Kansai Project; Chairman: Hideo Miyahara (President, Osaka University)

*6 JGNII: An extension of the JGN (Japan Gigabit Network) testbed network for R&D featuring ultrahigh transmission speeds and advanced functions. It began operating in April 2004 under the supervision of the National Institute of Information and Communications Technology (NiCT, President: Makoto Nagao).

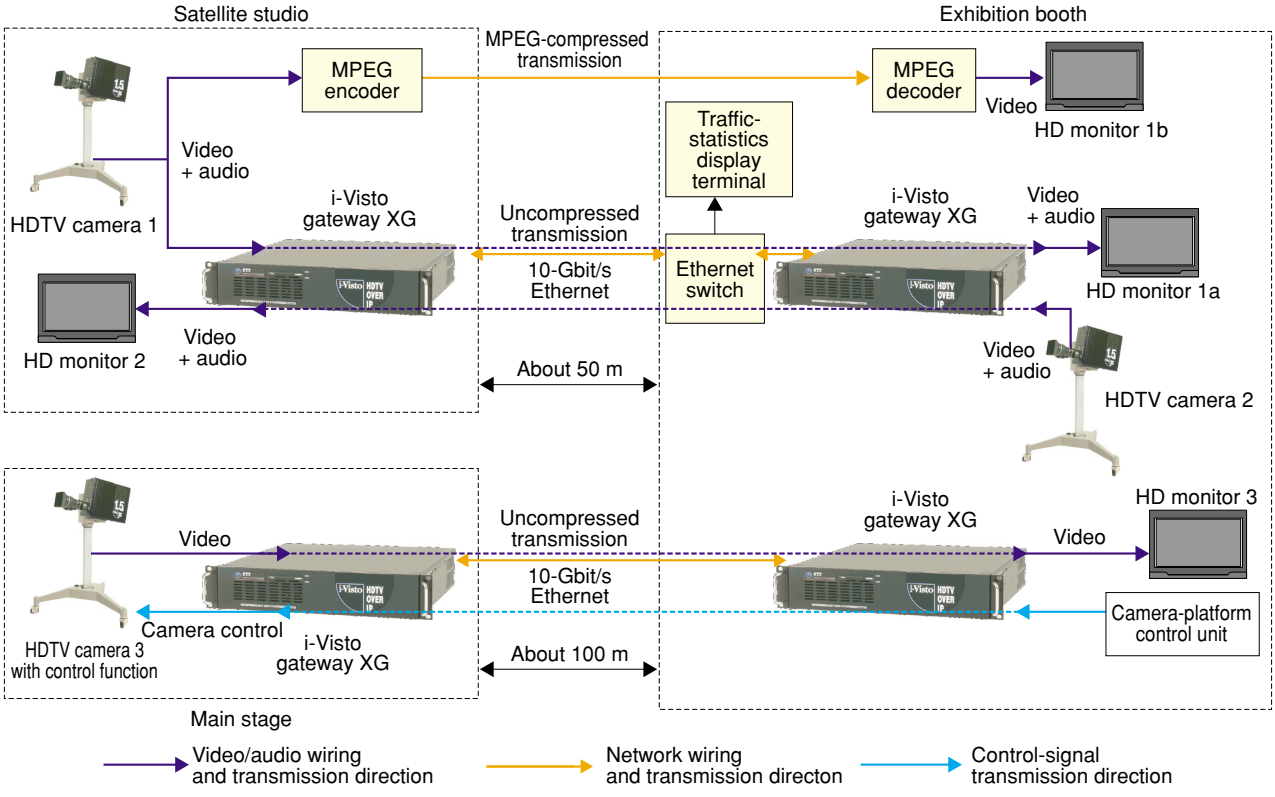

Fig. 5. Demonstration system at an NTT Group exhibition (NTT Group Collection in West 2004).

directions. A narrator in the satellite studio could converse with people visiting the booth. For comparison purposes, an HDTV video transmission system consisting of an MPEG-2 encoder and decoder was set up in parallel. It was found that most visitors participating in the demonstration could sense little delay in uncompressed video transmission by the i-Visto gateway XG and that they could understand the need for such a system.

A parallel demonstration was also held in which i-Visto gateway XG was used to remotely control an HDTV camera on the main stage from the exhibition booth in order to relay happenings there in real time. No problems were experienced in operating this system even for visitors that were familiar only with ordinary broadcast cameras.

5. Future plans

The i-Visto gateway XG is scheduled to go on the market in March 2005 to meet the demand for HDTV distribution networks generated by the spread of digital terrestrial broadcasting. In the future, we plan to expand its scope of application by making further functional improvements such as adding a video-clock synchronization function and a video interface for broadcasting use.

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