Video Delivery Technology with QoE Control

Takafumi Okuyama, Hiroyuki Kitada, Arifumi Matsumoto, Toshihito Fujiwara, Daisuke Kobayashi, Hiroshi Inoue, Ken-ichi Endo, Yasunobu Kasahara, and Ken Nakamura

Abstract

The amount of high-definition content has been increasing significantly lately, and there is also growing demand for video delivery services. This article introduces technology intended to address these issues. It achieves this by delivering high-definition and high-presence video content with high quality in an economical manner by optimizing the server deployment and communication network of content delivery providers and communication providers and by implementing new delivery control techniques.

Keywords: CDN, QoE control, multicast conversion

1. Introduction

To enable a large number of customers to enjoy high-definition video over the network, it is essential that no phenomena occur that can degrade quality within the communication network, or more specifically, that can lower the customer's quality of experience (QoE). To this end, we propose video delivery technology consisting of two component technologies—technology for controlling QoE and technology for efficiently delivering video data—that are implemented in an end-to-end manner from the video delivery server to the viewing terminal (**Fig. 1**).

2. Technology for controlling QoE

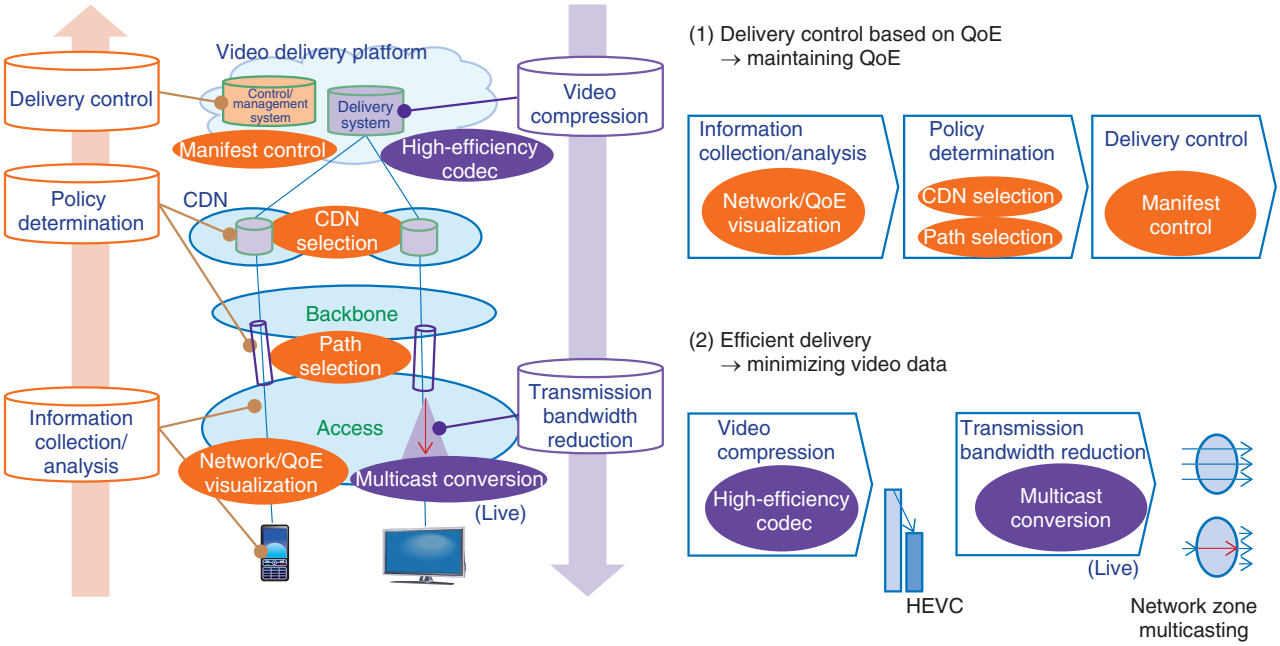
The technology for controlling QoE consists of three phases: namely, information collection/analysis, policy determination, and delivery control, as summarized below.

The information collection/analysis phase uses network/QoE visualization technology to determine whether it is possible to provide QoE that satisfies the customer, and if not, to clarify the phenomena such as network congestion that prevents this. This is accomplished by collecting and analyzing network conditions and server load status from the network as well as information related to customer viewing quality and content from the customer's viewing terminal.

The policy determination phase determines the delivery policy governing the delivery server and content delivery network (CDN) to be selected, the resolution that can be provided, advertising content, and other data in order to provide the appropriate QoE for each customer and gain the customer's satisfaction. This policy can be set according to the customer's service, the viewing location, or other factors.

The delivery control phase uses the policy established in the policy determination phase to decide on specific delivery conditions such as video resolution and bandwidth that can satisfy the QoE, advertising content, and other information, and which delivery server to use and to perform manifest control for notification to the viewing terminal.

Executing these three phases in a linked manner enables the provision of good quality video while avoiding congestion in the network.



CDN: content delivery network
HEVC: High Efficiency Video Coding

Fig. 1. Video delivery technology for controlling QoE.

This technology for controlling QoE was demonstrated at the NTT R&D Forum held in November 2018 in the form of a delivery experiment that connected a server group on the NTT laboratories' network with a test bed at NTT Communications over the Internet.

3. Technology for efficiently delivering video data

The technology for efficiently delivering video data encompasses two independent technologies. One is high-efficiency codec technology, which encodes high-definition 4K video in real time based on the HEVC (High Efficiency Video Coding) standard. Its proprietary variable-bit-rate control technology can compress video to an amount less than half that of conventional H.264 encoding technology.

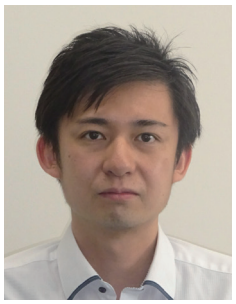
The other is multicast conversion technology, which converts traffic from unicast to multicast within the network zone while having the delivery provider and viewer use a general-purpose web interface (HTTP (Hypertext Transfer Protocol)-based unicast) device. This scheme makes it possible for a delivery provider or network provider to reduce the facility resources needed for data transfer of one item of content by a factor equal to the number of simultaneous viewers. It also enables stable delivery to an individual viewer regardless of the number of simultaneous viewers.

In short, the application of these technologies enables the delivery of video at a level of quality that can satisfy many viewers.

This technology for efficiently delivering video data was demonstrated at the NTT R&D Forum.

4. Future work

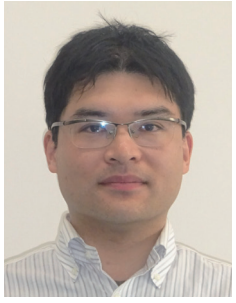
In addition to enhancing the video delivery function in the access network, we plan to develop the all-in-one system architecture from the streaming platform to the viewing terminal for the video distribution business.



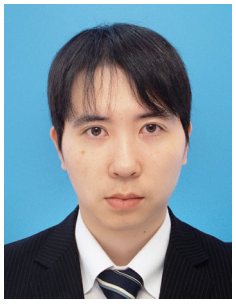
Takafumi Okuyama
Senior Research Engineer, NTT Network Technology Laboratories.
He received a B.E. and M.E. in information and computer sciences from Tokyo Institute of Technology in 2005 and 2007. He joined NTT Service Integration Laboratories in 2007. From 2010 to 2014, he was temporarily transferred to NTT Communications, where he worked as a mobile application engineer. He is currently engaged in research and development (R&D) of video streaming and communication quality analysis/control of video services.

Hiroyuki Kitada
Research Engineer, Network Architecture Design and Promotion Project, NTT Network Technology Laboratories.
He received a B.E. and M.S. in engineering from Shibaura Institute of Technology, Saitama, in 2008 and 2010. Since joining NTT in 2010, he has been studying energy efficient network architecture and network virtualization technology. He is currently researching a content delivery network for video streaming. He is a member of the Institute of Electronics, Information and Communication Engineers (IEICE).

Arifumi Matsumoto
Senior Research Engineer, Communication Quality Group, Communication Traffic & Service Quality Project, NTT Network Technology Laboratories.
He received a B.E. and M.E. in information sciences from Kyoto University in 2002 and 2004. His research interests are emerging network technologies such as IPv6 (Internet protocol version 6), multihoming, and mobility. He is currently researching communication quality control.



Toshihito Fujiwara
Senior Research Engineer, Access Network Service Systems Project, NTT Access Network Service Systems Laboratories.
He received a B.E., M.S., and Ph.D. in engineering from University of Tsukuba in 2002, 2004, and 2011. He joined NTT Access Network Service Systems Laboratories in 2004, where he has been engaged in R&D of video delivery and video transmission systems.



Daisuke Kobayashi
Research Engineer, Visual Media Project, NTT Media Intelligence Laboratories.
He received a B.E. and M.E. in information and communication engineering from the University of Electro-Communications, Tokyo, in 2007 and 2009. He joined NTT Cyber Space Laboratories in 2009 and since then has been researching high-quality image coding and transmission. He is a member of the Institute of Electrical and Electronics Engineers and IEICE.

Hiroshi Inoue
Senior Research Engineer, NTT Network Technology Laboratories.
He received a B.E. in electrical engineering from Kyoto Institute of Technology in 1999 and an M.E. in information sciences from Nara Institute of Science and Technology in 2002. He joined Lifestyle and Environmental Technology Laboratories in 2002. From 2005 to 2009, he was temporarily transferred to NTT EAST and worked as a communication control engineer. He is currently researching and developing a content delivery network for video streaming.

Ken-ichi Endo
Senior Research Engineer, Network Architecture Innovation Project, NTT Network Technology Laboratories.
He received a B.E. and M.S. in electronic engineering from the University of Yamanashi in 1984 and 1986. He joined NTT LSI Laboratories in 1986. He has been with NTT Network Technology Laboratories since 2012 and is studying distribution of next-generation video content.

Yasunobu Kasahara
Senior Research Engineer, Access Network Service Innovation Group, Access Network Service Systems Project, NTT Access Network Service Systems Laboratories.
He received a B.E. and M.E. in electronic engineering from Nihon University, Chiba, in 1996 and 1998. He joined NTT in 1998 and worked on the development of optical access systems such as asynchronous transfer mode systems, passive optical networks, and Layer-2 switches. He is currently engaged in R&D of content distribution technologies for emerging services.

Ken Nakamura
Senior Research Engineer, Visual Media Project, NTT Media Intelligence Laboratories.
He received a Master's degree in science and technology from Keio University, Kanagawa, in 1997. He joined NTT Human Interface Laboratories in 1997 and has since been engaged in R&D related to video coding and processing. He is a member of IEICE and the Institute of Image Information and Television Engineers.