R&D

Flexible Program Production System

Broadcasting operation to produce and store programs has been relied on VCR tapes. However, in recent years, broadcast stations process to introduce program production systems based on hard disks and memories. We have developed a file-based program production system called "Flexible Program Production System", which allows program producers to edit and use program materials anywhere without special hardware and software installed, and which streamlines production workflow (Figure 1).

The current file-based system has issues such that the performance and operation interfaces vary with editing systems, and that it is difficult to expand and update functions after installation of editing systems, and that program producers need to transfer and copy files for management and operation of program materials.

Flexible Program Production System consists of a front-end that provides editing operation interfaces and a back-end that manages distributed editing processes and an amount of material files. All of the servers used for the edit processing and program material storage are connected to a broadband network. We have developed an interface as the front-end which gives users to edit programs on a web browser by pasting material clips on a timeline as a nonlinear editing system (Figure 2). The system allows users to do editing using the same interface from any computer.

To underlie the back-end, we have developed a new distribution technology which distributes the image processes to multiple servers according to edit decisions assigned at the front-ends. By distributing functions of the broadcasting system such as processing servers and editing systems over multiple devices, the technology enables load balancing, efficient use of functions, and failure avoidance when many users access the system simultaneously. For the efficient archiving and sharing of massive amounts of program material files, other technology such as a distributed file system has been developed. It is applied on peer-to-peer technology to virtually handle multiple file servers as a single file server. We have also developed a high-speed file-transfer protocol to transfer only requested video frames bet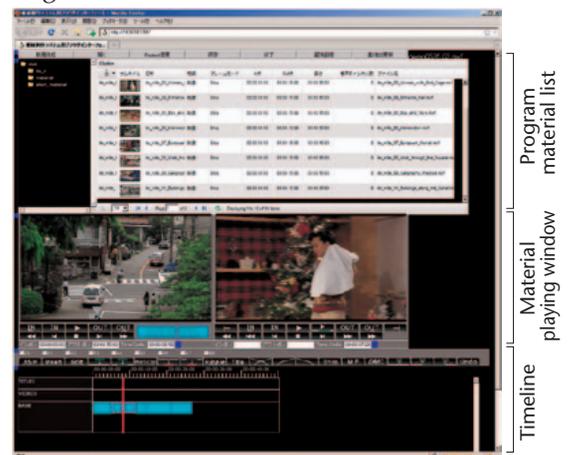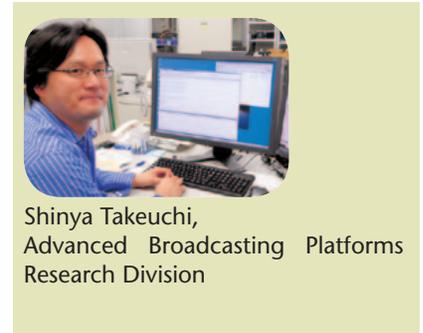ween servers, and a file system that rapidly inserts and deletes program material file data for high-speed edit processing in the back-end.

We are also going to publish the source codes of this system on the Web, and aim to spread as production system for the cloud computing era.
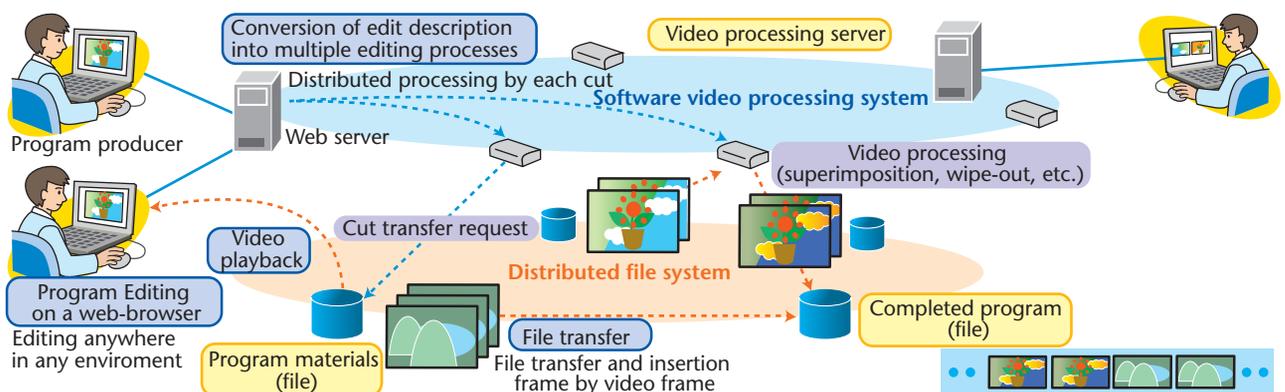
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Figure 2: **Editing interface example**

Program material list
Material playing window
Timeline

Figure 1: **Flexible program production system**

- Program producer
- Conversion of edit description into multiple editing processes
- Video processing server
- Distributed processing by each cut
- Software video processing system
- Web server
- Video processing (superimposition, wipe-out, etc.)
- Program Editing on a web-browser
- Video playback
- Cut transfer request
- Distributed file system
- Editing anywhere in any enviroment
- Program materials (file)
- File transfer
- Completed program (file)
- File transfer and insertion frame by video frame

A P2P Live Streaming system for the NHK School Chorus Contest

We are developing a live streaming system based on peer-to-peer (P2P) technologies to distribute live videos to a large number of viewers over the Internet. The system was used for streaming Shikoku block contest of the NHK school chorus contest, and stably distributed to more than 2,000 users.

A P2P streaming system assists stream delivery between end users' terminals. Hence, it can not only reduce delivery cost but also improve streaming capacity without large-scale investment in facilities (Figure 1).

In a P2P delivery system, the construction strategy of the network greatly affect its stability and streaming capacity. The location of each terminal in the network should be adjusted by considering bandwidth capacity. In addition, it is necessary to take into account the abrupt termination of stream reception and forwarding by the end user. Robust delivery paths are necessary to maintain a stable stream relay.

Our developed P2P system is based on mesh-based network structure and pull-based data transmission. This system builds a terminal status notification network (Figure 2a) in which each terminal notifies its own status information (e.g. reception status, connection type, the number of currently connected peers, etc.) each other. It also builds a stream relay network (Figure 2b) where chunks, which are stream data divided into small segments, are exchanged. In this stream relay network, each terminal exchanges a list of received chunks, checks if any un-received chunks are listed in peer terminals, and requests those un-received chunks to the peers. By repeating this process, each terminal gets a complete set of chunks belongs to the program stream (Figure 2b).

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This system improves distribution stability by locating the terminals with sufficient upload bandwidth capacity near the distribution server in the stream relay network, and improves robustness by performing chunk reception from multiple terminals.

Our future work will enlarge streaming capacity and improve robustness. We also enhance the system so that it can be used as a tool for new Internet/broadcasting services.
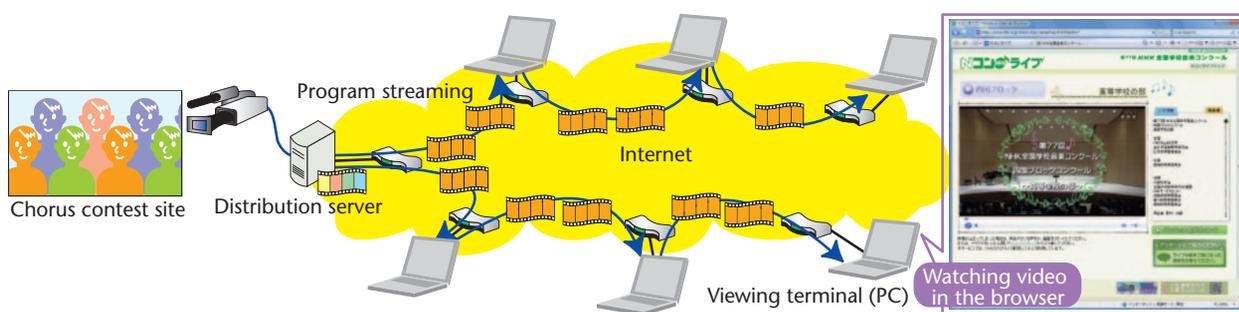

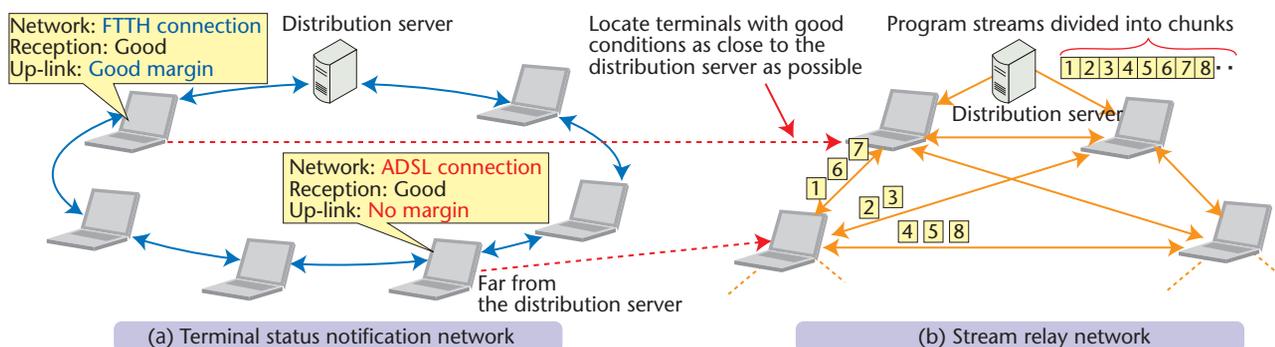Figure 1: P2P live streaming conceptual image

(a) Terminal status notification network

(b) Stream relay network

Figure 2: P2P live streaming scheme overview

teleda: TV Service Platform for Viewer-to-Viewer, Viewer-to-Program Connections

Recently, in additon to broadcast serveces, TV stations offer interactive services between viewers and broadcasting stations, such as video on demand (VoD). We at the Science & Technology Research Laboratories have been developing a new broadcasting station service platform, called "teleda[*1]," that will offer a "public forum" for people to connect with each other and social world (Figure 1).

The basic functions for the teleda service involve program-viewing, posting and browsing program reviews, searching for and recommending programs, and creating viewer-to-viewer and viewer-to-program networks (Figure 2). Displaying viewer opinions and social graph information for programs of interest to other viewers will make it easier for viewers to find new programs that they might be interested in. A viewer's encounters with new programs will also be a way for them to expand their connections with other viewers.

The teleda system consists of databases storing content and viewer information and servers for authentication, content distribution, and social networking. Individual servers are designed to connect to each other via the teleda API server, enabling functional enhancements and new functions to be implemented in response to user requests or by developers easily. Its accessibility via the Internet gives the teleda API the ability to provide client applications to meet the needs of individual viewing styles (Figure 3).

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Our future work will involve the development of program recommendation technology based on program-oriented social graphs, collaboration technologies for other social networks, the introduction of user generated content (UGC) based on TVML (Television markup language), and the incorporation of teleda into the Hybridcast[TM*2] system. We will also use the Internet to conduct verification experiments jointly with the NHK Broadcast Culture Research Institute, with the goal of evaluating the system from a sociological perspective as well as a technological viewpoint.

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*1 teleda: A term coined from television + eda (branch in Japanese). It denotes a human network that expands through TV programs, like tree branches.

*2 Hybridcast: A new broadcasting-communications network collaboration system developed by STRL. Hybridcast is a trademark of NHK Engineering Service Inc.
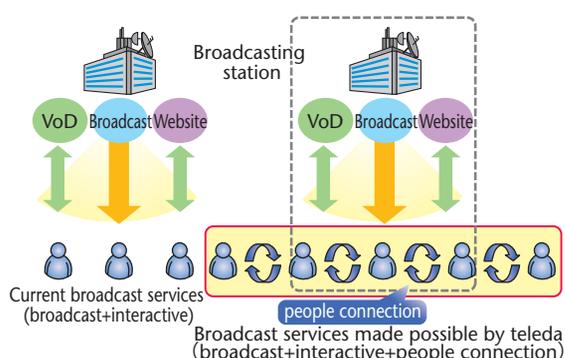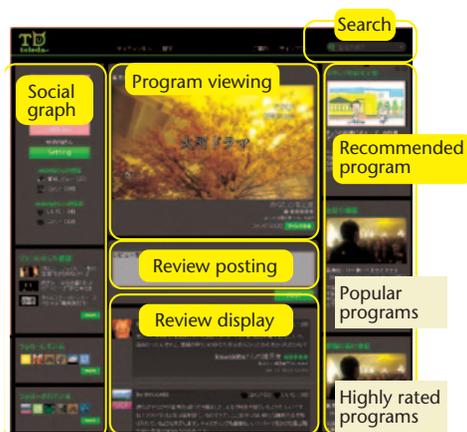

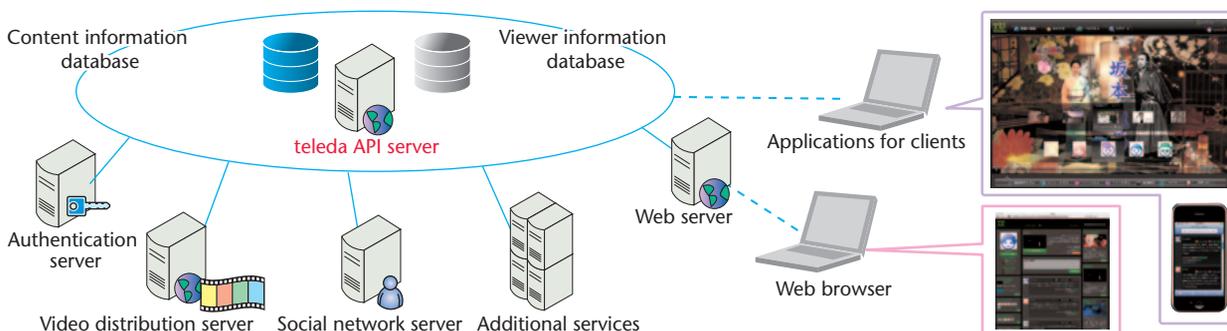**Figure 1: teleda services**

Figure 2: teleda website

Figure 3: teleda system overview

R&D

Connecting Human-to-Human, Human-to-TV Program Verification Experiments on Public Broadcasting Service Model, "teleda"

With the goal of enhancing public broadcasting services, we at the Science & Technology Research Laboratories are developing a service model that aims to create a "public meeting ground" composed of horizontal connections between viewers. We have developed a VOD[*1] service function, a program review-comment posting function, and a platform that also offers an SNS[*2] function called teleda[*3]. These functions were used in a verification experiment that was conducted in collaboration with the NHK Broadcasting Culture Research Institute.

In this experiment, 124 monitored registrants at a research company were allowed to freely use the teleda site for approximately three weeks, after which their use was verified through viewing logs and questionnaires. The teleda site provided a total of 1,264 titles in the catch-up programs category of the NHK on Demand for featured programs, among which 243 programs were actually viewed.

We looked closely at the programs viewed during the experiment (Figure 1) and found that the programs with the most views and/or comments posted using teleda included ones that did not have high audience ratings during the original broadcasts. This indicates that users do not necessarily exclusively view programs that were popular during the original broadcasts when they use teleda, showing the system's potential application as a program discovery tool. There were more comments posted about programs with higher program viewing numbers. The questionnaires indicated that approximately half of those who responded that "other users' reviews were helpful" actually "started to watch a program that he/she had never watched before," showing that postings by others can potentially induce or encourage viewers to expand the

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type of programs being viewed. As both those who answered that teleda "expanded their interest in NHK's programs" and those that said that it "helped them feel closer to NHK's programs" exceeded 50%, we can conclude that a service model like teleda is effective at providing in-depth information about programs (Figure 2).

The verification described above was conducted over a short period, and we will perform a larger-scale, longer-term experiment in the future in order to thoroughly perform multi-lateral verifications on how horizontal connections influence viewers' viewing behavior and awareness. We will also work on making a system with more diverse applications.
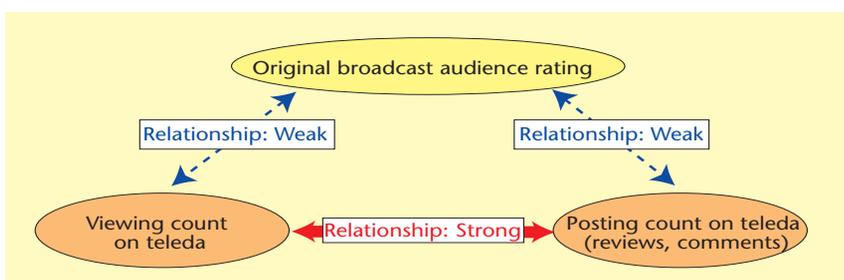
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*1 VOD: Video on Demand, a program streaming service via a network.
*2 SNS: Social networking service, an Internet service for people-to-people connections.
*3 Refer to page 21.

Figure 1: Relationship between program viewing counts, posting count on teleda, and audience ratings
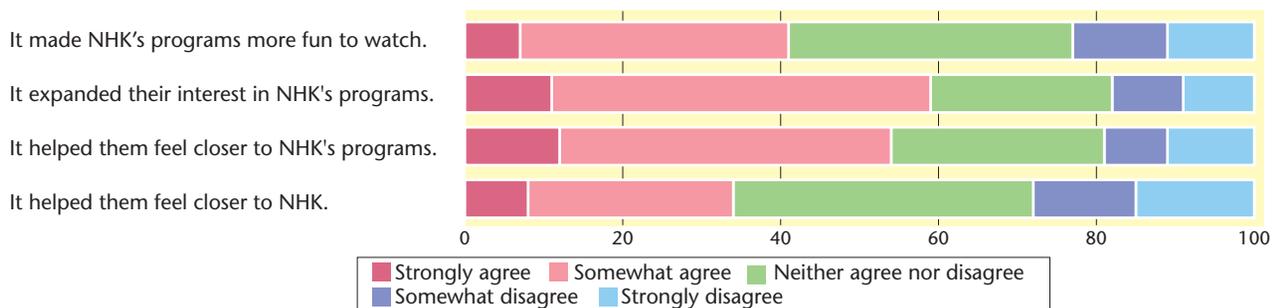

Figure 2: Post experiment changes in viewer awareness (based on questionnaire result)