“PC on Demand” Architecture and Technologies of Lui

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Abstract

NEC Personal Products, Ltd. has developed the “Remote Screen Technology,” which is an implementation of the “PC on Demand” concept for allowing a home PC to be used anytime, anywhere. This paper introduces the architecture and technologies of the Remote Screen Technology.

Keywords

thin client, compressed coding, VPN, Internet, DSP, LSI

1. Introduction

Dissemination of home networks and public wireless LAN, and the start of HSDPA and WiMAX services, are enabling an environment in which broadband communications are available anytime, anywhere. NEC Personal Products, Ltd. has developed the technology for the concept of using broadband communications to transfer the PC screen in households to other rooms inside the house, and other locations outside the house, to enable PC operation anywhere (PC on Demand), and incorporated it in our Home Server PC and PC Remoters of the pocket and notebook types.

This paper will introduce the architecture and technologies of the Remote Screen Technology, which is the key technology of “PC on Demand”.

2. Remote Screen Technology

As shown in **Fig. 1** , the Remote Screen Technology is composed of the Home Server PC, incorporating the PC Remoter server board, and the PC Remoter that functions as the client.

The PC Remoter server board incorporates an LSI that encodes video and audio in real time using an NEC-original method. The video and audio data encoded by the LSI is transferred to the PC Remoter through the home network or the Internet.

On the other hand, the PC Remoter incorporates an SoC, which is a single chip containing the CPU and DSP. The received video and audio data is decoded by the DSP in the SoC, and output to the screen and speakers of the PC Remoter.

When the user inputs information using the keyboard or pointing device of the PC Remoter, the information is transmitted in the reverse direction, from the PC Remoter to the Home Server PC, and then to the OS through the virtual keyboard or mouse driver. This allows the Remoter to control the Home Server PC.

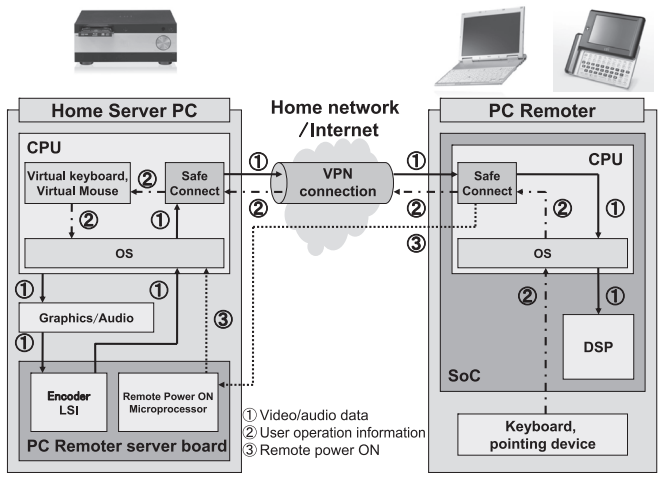

Fig. 1 Operation scheme of Remote Screen Technology.

Both the Home Server PC and the Remoter incorporate the NEC-original VPN connection function (SafeConnect) to secure communications.

In addition, application assist functions are also incorporated to improve usability, even with the small screen of the PC Remoter, or an Internet network with a slow communication rate.

3. Screen Transfer Function

To enable efficient transfer of PC screen images from the Home Server PC to the PC Remoter, we developed an NEC-original video codec system jointly with the Common

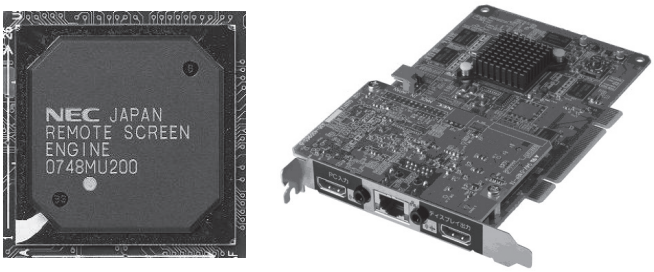

Photo Remote screen engine LSI (Left) and PC Remoter server board (Right).

Platform Software Research Labs, NEC Corporation. This system differs from other image codec systems in that it can encode and decode PC screen images even when characters and natural images are mixed in it. Also, its processing is simpler than other systems, so it can be built more easily into an LSI or embedding CPU [1].

We developed a remote screen engine LSI (**Photo** , left) incorporating this system, and a PC Remoter server board (Photo, right) that transfers the PC screen images using the LSI. For the PC Remoter that receives the PC screen images, we also developed software for decoding the compressed PC screen images in the DSP.

3.1 PC Remoter Server Board

The Home Server PC needs to perform PC screen transfer-related functions such as capturing, encode and encryption in parallel with execution of user applications. Therefore, we decided to implement these functions in the form of this hardware in order to reduce the load on the main CPU(s) of the Home Server PC, as well as to ensure a stable encode performance.

In addition, the PC Remoter server board incorporates the audio encode function, the monitor signal (DVI) switching function and the remote power ON function (see Section 5 for details).

- **DVI Switching Function**

  This function outputs the DVI signal as a through output to the monitor during usual PC operation, but outputs it to the remote screen engine LSI during use of the remote screen function. It makes it possible to align the PC screen resolution to the resolution supported by the PC monitor, regardless of the resolution of the monitor connected to the PC.

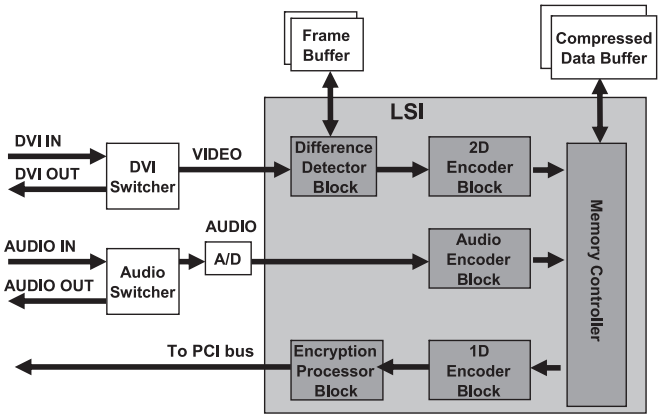

Fig. 2 Function configuration of PC Remoter server board.

3.2 Remote Screen Engine LSI

The remote screen engine LSI is composed of the internal circuit configuration shown in **Fig. 2** . The difference detector block detects the difference between the input image and the previously input image, and outputs the difference to the 2D encoder block. The 2D encoder block performs the compressing, which compresses the image by eliminating redundant data from its 2D configuration, while preserving the character components. The audio encoder block compresses the input audio in parallel with the above operation. The memory controller controls the I/O processing from/to the external large-capacity memory used for temporary storage of the data being compressed. The 1D encoder block performs the final compression of the video and audio data into the target data size. Finally, the encoded data is encrypted into a stream, which is transferred to the main CPU(s) of the PC through the PCI bus.

If the series of operations above were performed with software, the Home Server PC (with 2GHz CPU clock) would be able to provide a encode performance of only 10fps with 100% CPU usage. Use of this LSI can provide a encode performance of 30fps with 5% CPU usage.

3.3 PC Remoter

The PC Remoter incorporates an SoC that mounts the CPU and DSP on a single chip to achieve drastic reduction in components, save power, reduce the cost and decrease the size and weight of the PC Remoter all together.

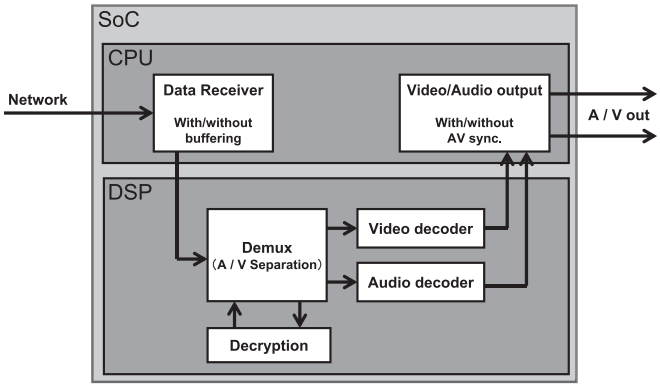

Fig. 3 Function configuration of video/audio decompression of PC Remoter.

(1) Separated Video/Audio Decompression

The CPU of the PC Remoter performs the communication processing, the operation processing of the keyboard and pointing device, and the GUI processing such as OSD. At the same time, the DSP of the PC Remoter performs the decryption processing and the video/audio decode processing. The independent architecture of the CPU and DSP makes it possible to operate the keyboard and display the OSD smoothly even when the decode load is high (**Fig. 3**).

(2) PC Mode and Movie Mode

The operability of the PC Remoter becomes poor if the period from data reception to display (delay time) is long. It is necessary to reduce the processing time for buffering, decode and AV synchronization as much as possible to reduce delay time. However, reducing it may result in unsmooth video or interrupted audio, due to fluctuations in the transmission of the network used.

To solve the inconsistency above, we designed two operation modes: a PC mode, for minimizing delay by eliminating buffering and AV synchronization, and a movie mode, for reducing video unsmoothness and audio interruption by absorbing network fluctuations by means of buffering and AV synchronization.

4. Application Assist Functions

The screen of the pocket-type PC Remoter has lower resolution (WVGA) than the PC screen, so it is hard to control PC applications on the PC Remoter screen. Therefore, we incorporated virtual screen and window fit functions in the PC Remoter server board and PC Remoter to improve usability.

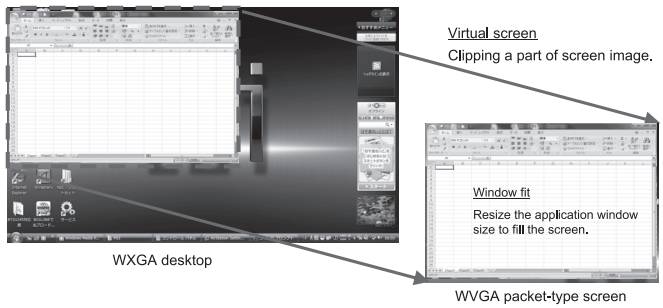

Fig. 4 Virtual screen and window fit functions.

Additionally, to improve usability further, we also incorporated a "function for selection of the bit rate setting according to the speed of the network in use" and a "function for selection of the weighting between video quality, audio quality and motion (frame rate) according to the user's liking or application in use".

(1) Virtual Screen Function

A part of the PC screen is displayed, and the user can freely move the area to be controlled. The PC Remoter screen displays only the magnified image of the area the user selected. This function improves the operability of PC applications.

(2) Window Fit Function

The window of the application used by the user is resized according to the size of the PC Remoter screen, and displayed to fill it. This function allows the user to view only the application in use on the full screen (**Fig. 4**).

5. VPN Connection Function (SafeConnect)

To enable remote connection, Lui uses an NEC-original VPN connection function called SafeConnect. SafeConnect provides Layer 2 VPN functions, and is equipped with AES (128-bit) encryption of communications, the connection destination IP address solution based on mails, mutual certification with remote devices using digital certificates, etc. The Home Server PC also incorporates remote power ON using a microprocessor as a function proper to Lui. **Fig. 5** shows the scheme of the VPN connection operation of Lui, and the following paragraphs summarize its functions.

(1) Mutual Device Certification Function

Mutual device certification using digital certificates adopts

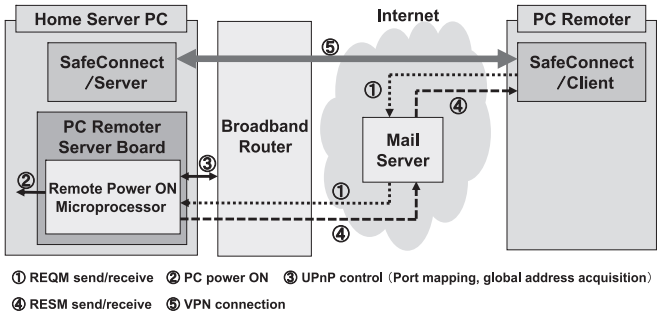

Fig. 5 VPN connection operation scheme.

a characteristic configuration with which, when digital certificates are issued, the Home Server PC and PC Remoter each becomes a certification authority (CA) and signs the digital certificate of the other party. Verification of digital certificates based on the policy of trusting the CA inside the local device makes it possible to prevent impersonations.

(2) Connection Destination IP Address Solution Function

In general, home-oriented ISP services assign global IP addresses dynamically. This function notifies the PC Remoter of the global IP address of the Home Server PC as the connection destination IP address. The IP address notification is done by exchanging the IP address request mail (REQM) and IP address response mail (RESM) between the Home Server PC and PC Remoter. At this time, UPnP port mapping is performed on the broadband router of the Home Server PC so that the PC Remoter can connect to the Home Server PC.

(3) Remote Power ON Microprocessor Function

The remote power ON microprocessor on the PC Remoter server board can function with the standby power of the PCI bus (approx. 1.2W), and actually works at all times, even when the Home Server PC is in power-save mode. This microprocessor also incorporates the IP address solution function of SafeConnect, and continuously monitors for a connection request from the PC Remoter. When a connection request from the PC Remoter is detected (when REQM is received), the microprocessor turns the PC on and returns it to the status in which VPN connection is possible.

6. Conclusion

This paper explained the architecture and technologies implementing the Remote Screen Technology. The image quality and operability of the Remote Screen Technology are affected by communication bandwidth; so, in the future, we will enhance scalability by improving operability in low bit rate environments, such as HSDPA, with high convergence probability, and take measures for assuring high image quality and high resolution in the home network environment.

Reference

1) Takada, M., Senda, S. and Hiroaki, T.: “DOKUJI NO SEISHIGA FUGO-KA GIJUTSU NI YORU GAMEN TENSO SORYUSHON (Screen Transfer Solution Based on Original Still Image Coding Technology),” NEC GIHO, Vol.60, No.2, pp.30-32, May 2007.

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