US 20150106733A1

(19) United States

(12) Patent Application Publication

(10) Pub. No.: US 2015/0106733 A1

(43) Pub. Date: Apr. 16, 2015

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(54) **TERMINAL DEVICE, THIN CLIENT SYSTEM, DISPLAY METHOD, AND RECORDING MEDIUM**

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(21) Appl. No.: **14/466,596**

(22) Filed: **Aug. 22, 2014**

(30) **Foreign Application Priority Data**

Oct. 10, 2013 (JP) 2013-213110

Publication Classification

(51) **Int. Cl.**

H04L 29/08 (2006.01)

G06F 3/0481 (2006.01)

(52) **U.S. Cl.**

CPC ***H04L 67/10*** (2013.01); ***G06F 3/0481*** (2013.01)

(57) **ABSTRACT**

A terminal device includes: a memory; and a processor coupled to the memory. The processor executes a process including: receiving a screen image from a server device connected via a network; storing the screen image received; displaying the screen image stored in a storage; first computing a switching end time based on an amount of one screenful of screen image data that is determined from a screen size of a display and an available band for communications with the server device; second computing a switching start time based on a switching time of the screen image obtained from the screen size and a switching speed of the screen image, and the switching end time; and reading the screen image from the storage and displaying the screen image on the display at the switching speed after the switching start time has elapsed from reception of a user's switching operation.

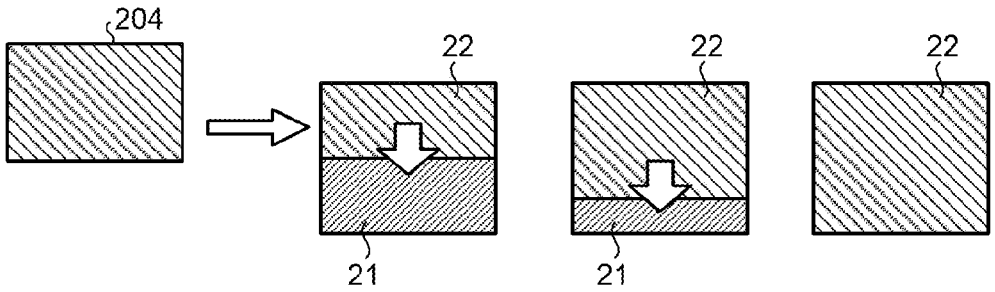


FIG.1

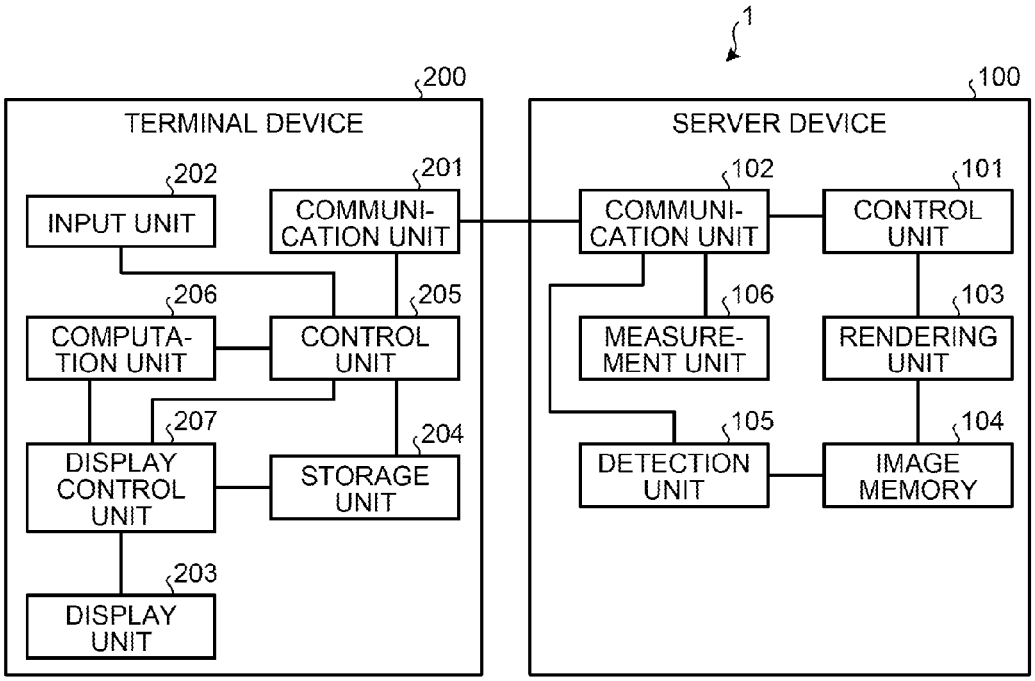

1
200
TERMINAL DEVICE
202
INPUT UNIT
201
COMMUNI-CATION UNIT
206
COMPUTA-TION UNIT
205
CONTROL UNIT
207
DISPLAY CONTROL UNIT
204
STORAGE UNIT
203
DISPLAY UNIT
100
SERVER DEVICE
102
COMMUNI-CATION UNIT
101
CONTROL UNIT
106
MEASURE-MENT UNIT
103
RENDERING UNIT
105
DETECTION UNIT
104
IMAGE MEMORY

FIG.2

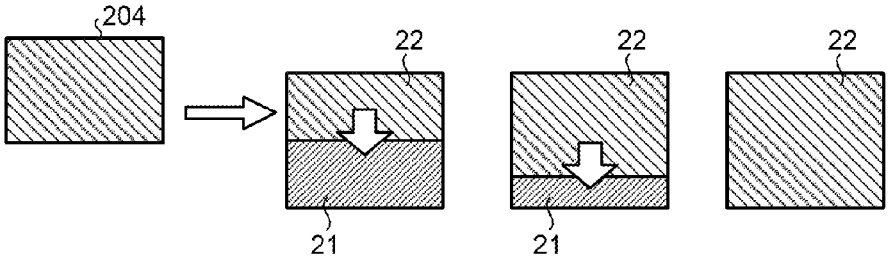

204
22
22
22
21
21

FIG.3

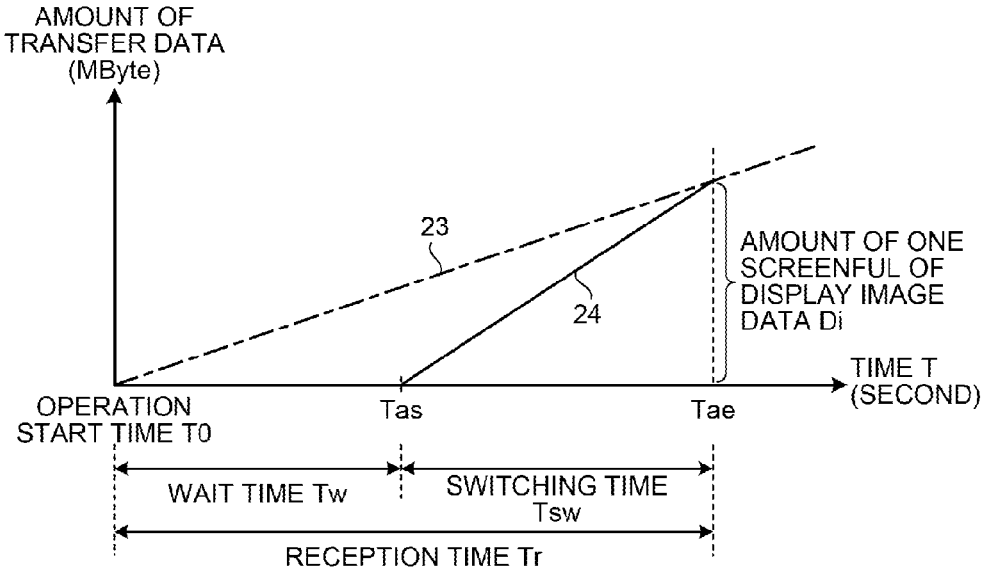

AMOUNT OF TRANSFER DATA (MByte)
23
24
AMOUNT OF ONE SCREENFUL OF DISPLAY IMAGE DATA Di
TIME T (SECOND)
OPERATION START TIME T0
Tas
Tae
WAIT TIME Tw
SWITCHING TIME Tsw
RECEPTION TIME Tr

FIG.4

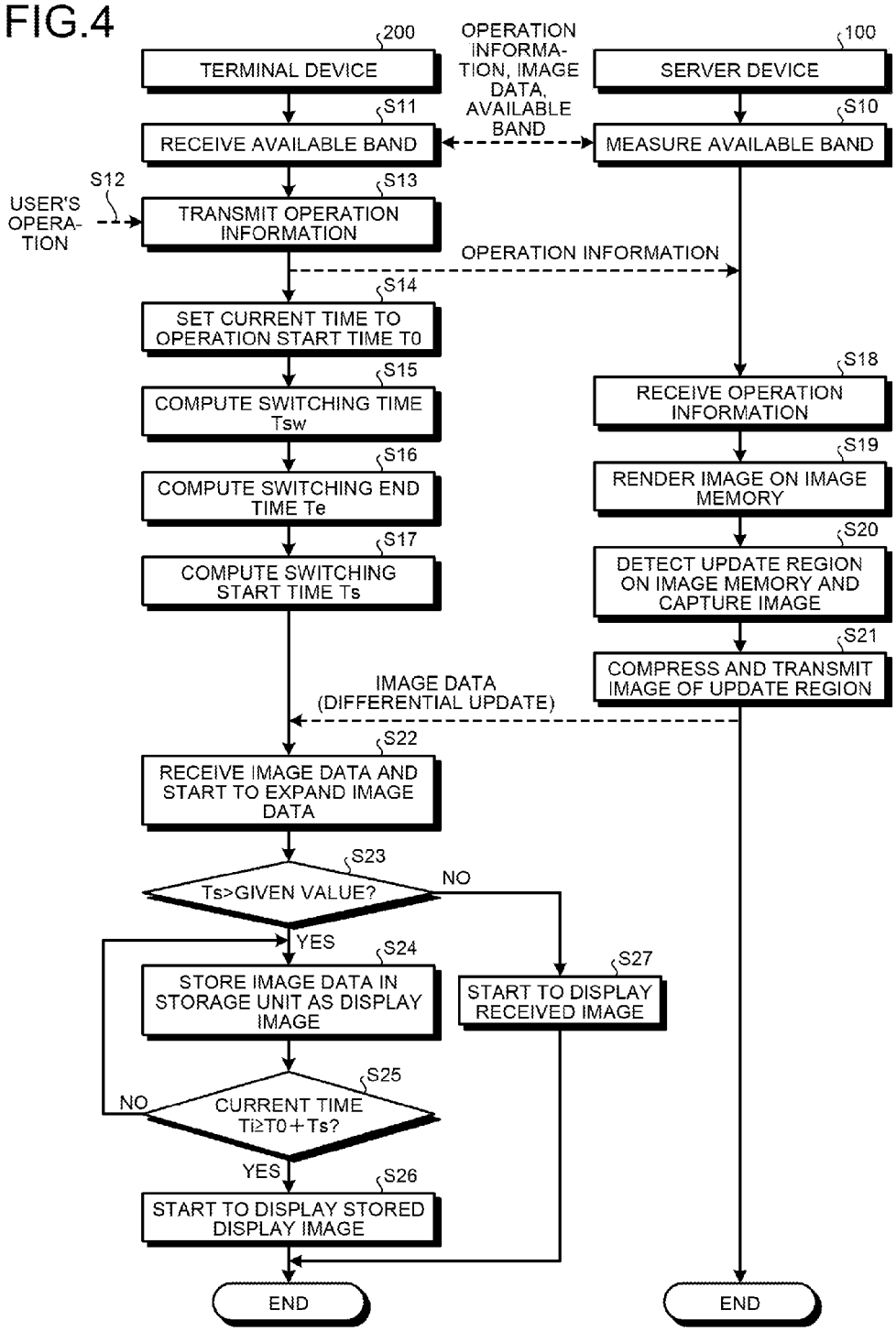

200
TERMINAL DEVICE
OPERATION INFORMATION, IMAGE DATA, AVAILABLE BAND
100
SERVER DEVICE
S11
RECEIVE AVAILABLE BAND
S10
MEASURE AVAILABLE BAND
S12
USER'S OPERATION
S13
TRANSMIT OPERATION INFORMATION
OPERATION INFORMATION
S14
SET CURRENT TIME TO OPERATION START TIME T0
S18
RECEIVE OPERATION INFORMATION
S15
COMPUTE SWITCHING TIME Tsw
S19
RENDER IMAGE ON IMAGE MEMORY
S16
COMPUTE SWITCHING END TIME Te
S20
DETECT UPDATE REGION ON IMAGE MEMORY AND CAPTURE IMAGE
S17
COMPUTE SWITCHING START TIME Ts
S21
COMPRESS AND TRANSMIT IMAGE OF UPDATE REGION
IMAGE DATA (DIFFERENTIAL UPDATE)
S22
RECEIVE IMAGE DATA AND START TO EXPAND IMAGE DATA
S23
Ts>GIVEN VALUE?
NO
YES
S24
STORE IMAGE DATA IN STORAGE UNIT AS DISPLAY IMAGE
S27
START TO DISPLAY RECEIVED IMAGE
S25
NO
CURRENT TIME Ti≥T0+Ts?
YES
S26
START TO DISPLAY STORED DISPLAY IMAGE
END
END

FIG.5

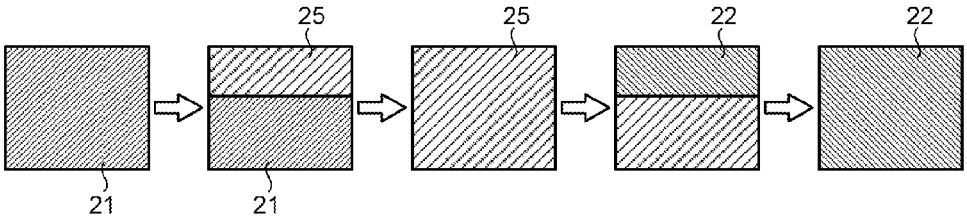

25
25
22
22
21
21

FIG.6

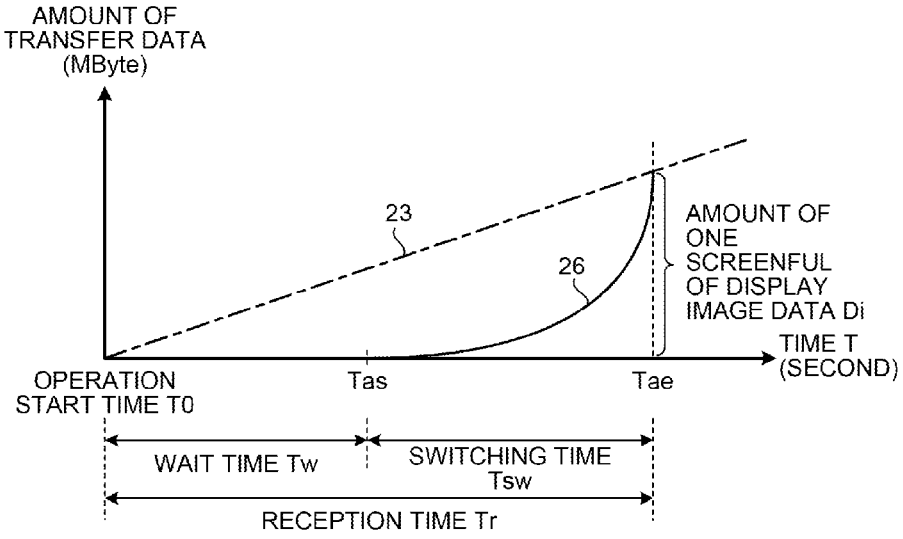
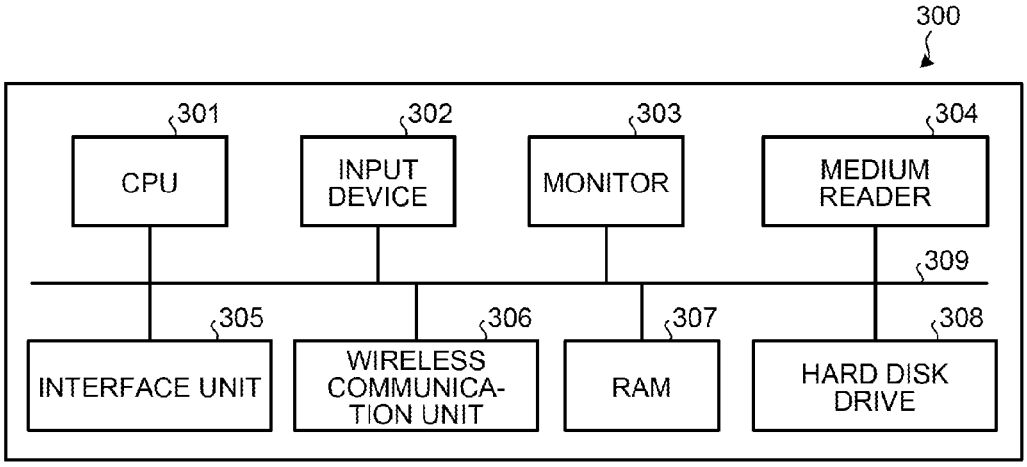

AMOUNT OF TRANSFER DATA (MByte)
23
26
AMOUNT OF ONE SCREENFUL OF DISPLAY IMAGE DATA Di
TIME T (SECOND)
OPERATION START TIME T0
Tas
Tae
WAIT TIME Tw
SWITCHING TIME Tsw
RECEPTION TIME Tr

FIG.7


300
301
CPU
302
INPUT DEVICE
303
MONITOR
304
MEDIUM READER
309
305
INTERFACE UNIT
306
WIRELESS COMMUNICA-TION UNIT
307
RAM
308
HARD DISK DRIVE

TERMINAL DEVICE, THIN CLIENT SYSTEM, DISPLAY METHOD, AND RECORDING MEDIUM

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application is based upon and claims the benefit of priority of the prior Japanese Patent Application No. 2013-213110, filed on Oct. 10, 2013, the entire contents of which are incorporated herein by reference.

FIELD

[0002] The embodiment discussed herein is related to a terminal device, a thin client system, a display method, and recording medium.

BACKGROUND

[0003] Systems referred to as a thin client are known. The thin client system is constructed to provide a client terminal only with a minimum possible function and allow the server to manage resources such as applications and files.

[0004] Such a thin client system behaves as if the client terminal itself executes processing or holds data even though the result of processing executed by the server or the data held by the server is actually displayed on the client terminal.

[0005] When screen data to be displayed on the client terminal is transmitted between the server and the client terminal as described above, screen updates occur along with operations. When a screen update occurs in the thin client system, the server transmits, to the client terminal, differential screen data between before and after the screen update. Here, for example, when a slide show or a performance such as scroll display for screen switching is conducted in a presentation or the like, updates occur on many parts of the screen, and the differential screen data is transmitted to the client terminal.

[0006] Patent Document 1: Japanese Laid-open Patent Publication No. 7-111544

[0007] Patent Document 2: Japanese Laid-open Patent Publication No. 2008-46803

[0008] However, the aforementioned technique may cause a delay in the screen switching due to a delay in transmission.

[0009] For example, when the client terminal is connected to the server in a mobile communication environment, a performance such as scroll display for switching between slides may cause a great deal of differential screen data to be transmitted to the client terminal. In a network between the server and the client terminal, this in turn may cause the amount of transfer to be restricted by a varying available band, leading to a delay in transmission. As a result, since the client terminal may receive and display the differential screen data at unstable speed, the speed may be lower than the screen switching speed by scroll display or the like, so that the screen switching such as scroll display may be performed intermittently with smoothness impaired.

SUMMARY

[0010] According to an aspect of the embodiments, a terminal device includes: a memory; and a processor coupled to the memory. The processor executes a process including: receiving a screen image from a server device connected via a network; storing the screen image received; displaying the screen image stored in a storage; first computing a switching end time, in which switching of the screen image is ended, based on an amount of one screenful of screen image data that is determined from a screen size of a display and an available band for communications with the server device; second computing a switching start time, in which switching of the screen image is started, based on a switching time of the screen image obtained from the screen size and a switching speed of the screen image, and the switching end time; and reading the screen image from the storage and displaying the screen image on the display at the switching speed after the switching start time has elapsed from reception of a user's switching operation.

[0011] The object and advantages of the invention will be realized and attained by means of the elements and combinations particularly pointed out in the claims.

[0012] It is to be understood that both the foregoing general description and the following detailed description are exemplary and explanatory and are not restrictive of the invention.

BRIEF DESCRIPTION OF DRAWINGS

[0013] FIG. **1** is a block diagram illustrating an example of a configuration of a thin client system of an embodiment;

[0014] FIG. **2** is an explanatory view illustrating an example of switching between display images;

[0015] FIG. **3** is an explanatory view illustrating an example of the relation between the reception time and the switching time;

[0016] FIG. **4** is a sequence diagram illustrating an example of the operation of a thin client system of an embodiment;

[0017] FIG. **5** is an explanatory view illustrating another example of switching between display images;

[0018] FIG. **6** is an explanatory view illustrating another example of the relation between the reception time and the switching time; and

[0019] FIG. **7** is an explanatory view illustrating an example of a computer for executing a display program.

DESCRIPTION OF EMBODIMENTS

[0020] Preferred embodiments will be explained with reference to accompanying drawings. Note that these embodiments will not limit the disclosed techniques. Furthermore, the following embodiments may also be combined, as appropriate, without causing inconsistency.

[0021] System Configuration

[0022] First, a description will be made to the configuration of a thin client system according to this embodiment. FIG. **1** is a block diagram illustrating an example of the configuration of the thin client system of this embodiment. The thin client system **1** illustrated in FIG. **1** allows a server device **100** to provide remote control to the display screen of a terminal device **200**. That is, the thin client system **1** behaves as if the terminal device **200** itself executes processing or holds data while in practice, allowing the terminal device **200** to display the result of processing executed or data held by the server device **100**.

[0023] The thin client system **1** illustrated in FIG. **1** has the server device **100** and the terminal device **200**. Note that the example of FIG. **1** illustrates the case where one terminal device **200** is connected to one server device **100**; however, any number of client terminals may also be connected thereto.

[0024] These server device **100** and terminal device **200** are connected communicably to each other over a predetermined network. Such networks, wired or wireless, as can be employed herein may include any types of communication

networks such as the Internet, a Local Area Network (LAN), or a Virtual Private Network (VPN). Note that by way of example, such a case is assumed where the communication protocol to be employed between the server device **100** and the terminal device **200** is the Remote Frame Buffer (RFB) protocol in the Virtual Network Computing (VNC).

[0025] The server device **100** is an example of information processing apparatus and is configured by a computer which provides remote control service to a screen displayed by the terminal device **200**. The server device **100** has a remote screen control application for the server, which is installed or preinstalled. Note that hereinafter, the remote screen control application for the server may also be referred to as the "server-side remote screen control app."

[0026] This server-side remote screen control app functions to provide the remote screen control service as a basic function. In one aspect, the server-side remote screen control app acquires operation information on the terminal device **200** and then allows an application operating on the server to execute the processing requested by the operation. Then, the server-side remote screen control app creates a screen for displaying the result of processing executed by the application and then transmits the resulting screen to the terminal device **200**. At this time, the server-side remote screen control app transmits a rectangular update image, that is, a region with a collection of pixels of changes made from a bit map image that was displayed on the terminal device **200** before the current screen was created. Note that the image of an update is not limited to a rectangular image but may have any shape other than the rectangular one.

[0027] In addition, the server-side remote screen control app also functions to compress data of a significant move between frames into video oriented compression scheme data and then transmit the resulting data to the terminal device **200**. In one aspect, the server-side remote screen control app divides a screen created from the result of processing executed by an application into a plurality of regions, and then monitors the frequency of changes in each divided region. At this time, the server-side remote screen control app transmits, to the terminal device **200**, the attribute information of a region of which frequency of changes has exceeded a threshold value, that is, a high-frequency change region. In addition, the server-side remote screen control app encodes a bit map image of a high-frequency change region to data according to Moving Picture Experts Group (MPEG) scheme such as MPEG-2 or MPEG-4 and then transmits the resulting data to the terminal device **200**. Note that the example here illustrates the case where data is compressed into data according to the MPEG scheme; however, the invention is not limited thereto. For example, any compression encoding scheme such as the Motion-JPEG (Joint Photographic Experts Group) scheme can be employed so long as the scheme is a video oriented compression scheme.

[0028] The server device **100** measures, in a network between the server device **100** and the terminal device **200**, an available band that can be employed, and then transmits the resulting available band to the terminal device **200**. For example, the server device **100** acquires, from the terminal device **200**, a transfer time for image data that has been just transmitted to the terminal device **200**. For example, the server device **100** measures an available band based on the amount of data of the image data having been just transmitted, the transmission time which the server device **100** transmitted, and the transfer time acquired from the terminal device **200**. The server device **100** transmits the measured available band to the terminal device **200**.

[0029] The terminal device **200** is a computer which is provided with remote screen control service by the server device **100**. By way of example, such terminal devices **200** to be employed may include a tablet terminal, a smartphone, a portable personal computer, and the like. Furthermore, other examples of the terminal device **200** to be employed may also include fixed terminals such as stationary personal computers in addition to mobile terminals such as cellular telephones, Personal Handyphone Systems (PHS), or Personal Digital Assistants (PDA). The terminal device **200** may have a client oriented remote screen control application installed or preinstalled. Note that hereinafter, the client oriented remote screen control application may also be referred to as the "client-side remote screen control app."

[0030] This client-side remote screen control app functions to notify the server device **100** of operation information that has been received via various types of input devices such as a touch panel, a mouse, or a keyboard. In one aspect, the client-side remote screen control app notifies, as the operation information, the degree of operation such as tap or flick on a touch panel integrated with a display unit. As other examples, the client-side remote screen control app notifies the operation information such as the right and left clicks of the mouse as well as a double click or drag, or the amount of movement of the mouse cursor that is acquired through a move operation of the mouse. As still other examples, the client-side remote screen control app also notifies the operation information such as the amount of rotation of the mouse wheel or the type of a key on the keyboard that has been depressed.

[0031] Furthermore, the client-side remote screen control app functions to display an image received from the server device **100** on a predetermined display unit. In one aspect, when having received a rectangular update bit map image from the server device **100**, the client-side remote screen control app displays the rectangular update image at the position at which the previous bit map image has been changed. In another aspect, when having received the attribute information of a high-frequency change region from the server device **100**, the client-side remote screen control app employs a region of the display screen, the region being associated with the position included in the attribute information, as a blank region of the bit map image in which nothing is to be displayed. Then, when having received video oriented compression scheme data, the client-side remote screen control app decodes the data and then displays the resulting data in the blank region.

[0032] Furthermore, when a presentation or the like is performed using an application executed on the server device **100**, the terminal device **200** may conduct a performance such as scroll display to slide screens, that is, to switch between screens. The terminal device **200** temporarily saves, i.e., buffers, on a storage unit, the image data of the next slide which has started to be received, and then starts the scroll display of the temporarily saved next slide image so that the completion of the reception takes place at the same time as the end of the scroll display.

[0033] Configuration of Server Device

[0034] Now, a description will be made to the functional structure of the server device **100** according to this embodiment. As illustrated in FIG. **1**, the server device **100** includes a control unit **101**, a communication unit **102**, a rendering unit **103**, an image memory **104**, a detection unit **105**, and a

measurement unit **106**. Note that the example of FIG. **1** may also include, other than those function units illustrated in FIG. **1**, various types of function units which are included in known computers, for example, functions such as various types of input devices or display devices.

[0035] The control unit **101** controls the entire server device **100**, and executes the server-side remote screen control app and various types of applications. Furthermore, the control unit **101** allows the server-side remote screen control app to control the rendering unit **103**, the image memory **104**, and the detection unit **105** so as to provide the remote screen control service. The control unit **101** executes various types of applications, for example, a presentation application. Upon reception of operation information from the communication unit **102**, the control unit **101** executes the server-side remote screen control app and various types of applications depending on the operation information.

[0036] The communication unit **102** is implemented, for example, by a Network Interface Card (NIC). The communication unit **102** is a communication interface which is connected by wire or by radio to the terminal device **200** over a network and serves to communicate information to and from the terminal device **200**. When the terminal device **200** is connected to the Internet, the communication unit **102** can be connected to the terminal device **200**, for example, via a VPN constructed on the Internet as a network. The communication unit **102** receives operation information from the terminal device **200** for output to the control unit **101**. Furthermore, when image data is entered from the detection unit **105**, the communication unit **102** transmits the image data to the terminal device **200**. Furthermore, when an available band is entered from the measurement unit **106**, the communication unit **102** transmits the available band to the terminal device **200**.

[0037] The rendering unit **103** is controlled by the server-side remote screen control app executed in the control unit **101**. The rendering unit **103** renders an image from an application executed on the control unit **101** and stores the image in the image memory **104**. That is, the rendering unit **103** renders a display image (screen image) to be displayed on the terminal device **200** and stores the display image in the image memory **104**.

[0038] The image memory **104** or a so-called frame buffer is a storage device for storing a bit map image or an image corresponding to the entire page rendered by the rendering unit **103**. In one aspect, such an image memory **104** may be a semiconductor memory element such as a Random Access Memory (RAM) including a Video Random Access Memory (VRAM), a Read Only Memory (ROM), or a flash memory. Note that it is also acceptable to employ, as the image memory **104**, storage devices such as the hard disk or the optical disk.

[0039] The detection unit **105** is controlled by the server-side remote screen control app executed by the control unit **101**. The detection unit **105** detects, if any, an update of an image rendered on the image memory **104**, and captures the update and produces the differential image data. The detection unit **105** compresses the produced differential image data. The detection unit **105** employs, as a compression codec, for example, JPEG for still images and MPEG-2 or MPEG-4 for moving images. The detection unit **105** outputs compressed differential image data to the communication unit **102**.

[0040] The measurement unit **106** measures communications at the communication unit **102**. For example, the measurement unit **106** measures the amount of communication data between the communication unit **102** and a communication unit **201** of the terminal device **200**, to be discussed later, every one second, and measures an available band or a band that is available between the communication unit **102** and the communication unit **201**. Furthermore, for example, concerning image data having been just transmitted to the terminal device **200**, the measurement unit **106** acquires the amount of the image data from the communication unit **102**. Furthermore, for example, concerning image data having been just transmitted to the terminal device **200**, the measurement unit **106** acquires the transfer time via the communication unit **102** from the terminal device **200**. For example, the measurement unit **106** measures an available band based on the amount of image data having been just transmitted, the transmission time which the communication unit **102** transmitted, and the transfer time acquired from the terminal device **200**. The measurement unit **106** outputs the resulting available band to the communication unit **102**.

[0041] Configuration of Terminal Device

[0042] Now, a description will be made to the functional structure of the terminal device **200** according to this embodiment. As illustrated in FIG. **1**, the terminal device **200** includes the communication unit **201**, an input unit **202**, a display unit **203**, a storage unit **204**, a control unit **205**, a computation unit **206**, and a display control unit **207**. Note that the example of FIG. **1** may also include, other than those function units illustrated in FIG. **1**, various types of function units which are included in known computers.

[0043] The communication unit **201** is implemented by a wireless communication module which accommodates, for example, a cellular telephone line, a wireless Local Area Network (LAN), Bluetooth (registered trade mark), and the Near Field Communication (NFC). For example, the communication unit **201** is a communication interface which is connected to the Internet over a wireless base station and constructs a VPN between the communication unit **201** and the server device **100** connected to the Internet so as to communicate information therebetween. Note that the communication unit **201** may also be implemented, for example, by a NIC so as to be connected to the server device **100** by wire or by radio over a network. Note that the communication unit **201** may employ, as a cellular telephone line, for example, the third generation (3G) mobile communication system, the Worldwide Interoperability for Microwave Access (WiMAX) communication system, and the Long Term Evolution (LTE) communication system.

[0044] The communication unit **201** receives image data and an available band from the server device **100** for output to the control unit **205**. Furthermore, when operation information is entered from the control unit **205**, the communication unit **201** transmits the operation information to the server device **100**.

[0045] The input unit **202** is an input device for receiving various types of operations from the user. For example, the input unit **202** is implemented by a touch panel, a mouse, or a keyboard. Furthermore, when the touch panel is employed, the input unit **202** is integrated with the display unit **203** which serves as a display device. The input unit **202** outputs operation information depending on a user's operation to the control unit **205**.

[0046] The display unit **203** is a display device for displaying various types of information and implemented, for example, by a liquid crystal display. Furthermore, when the

input unit **202** to be used is a touch panel, the display unit **203** is integrated with the input unit **202**. When image data is entered from the display control unit **207**, the display unit **203** displays a screen corresponding to the image data. Furthermore, in the terminal device **200**, the display unit **203** is implemented, for example, by a projector. For example, when the display unit **203** to be employed is a projector, the same presentation screen can be displayed, for example, on the display unit **203** of a tablet terminal at user's hand and the projector which is separated from the tablet terminal but functionally serves as the display unit **203**.

[0047] The storage unit **204** stores the image data received by the communication unit **201** via the control unit **205**. The storage unit **204** temporarily saves, that is, buffers the image data to be displayed on the display unit **203**, and the temporarily saved image data is read by the display control unit **207**. In one aspect, the storage unit **204** may be a semiconductor memory element such as the RAM including the VRAM, the ROM, and the flash memory. Note that the storage unit **204** to be employed may also be a storage device such as a hard disk or an optical disc. Furthermore, the storage unit **204** stores an alternative image to be temporarily displayed when a switching start time Ts is greater than a predetermined value.

[0048] The control unit **205** controls the entire terminal device **200** and executes the client-side remote screen control app. When image data and an available band are entered from the communication unit **201**, the control unit **205** stores the image data in the storage unit **204**, and outputs the available band to the computation unit **206**. Furthermore, when operation information is entered from the input unit **202**, the control unit **205** outputs the operation information to the communication unit **201** and sets the current time to an operation start time T0 for output to the display control unit **207**. Furthermore, when display information is directly entered from the computation unit **206**, the control unit **205** outputs the image data entered from the communication unit **201** to the display control unit **207** without storing the image data in the storage unit **204**. Note that the control unit **205** decompresses the image data which has been compressed when being stored in the storage unit **204** or outputted to the display control unit **207**. Furthermore, the control unit **205** may also store the image data in the storage unit **204** when no display information is directly entered even after a predetermined time elapsed from the entry of the operation information. Note that the predetermined time can be set to, for example, 100 msec, but may also be changed, as appropriate, depending on the computation speed of the computation unit **206**.

[0049] The computation unit **206** receives the screen size of the display unit **203** from the display control unit **207**. Furthermore, in the computation unit **206**, the switching speed of a display image, that is, a screen image to be displayed on the display unit **203** is set by the user or the administrator of the system, for example, on the server device **100** via the input unit **202** or the communication unit **201**. That is, the computation unit **206** is provided with the setting of a predetermined switching speed as the switching speed at which the display image is switched. Note that the setting of the switching speed can be changed in the same manner as at the time of setting. The computation unit **206** includes a first computation unit for computing a switching end time and a second computation unit for computing a switching start time.

[0050] The computation unit **206** computes a switching time Tsw of a display image based on the screen size of the display unit **203** and the predetermined switching speed of display images. Here, referring to FIG. **2**, a description will be made to the switching of display images. FIG. **2** is an explanatory view illustrating an example of the switching of display images. The example of FIG. **2** illustrates the case where, for example, a next slide **22** is scroll displayed from top to bottom of the screen as the switching of display images. The image data of the next slide **22** temporarily saved in the storage unit **204** is scroll displayed at the switching speed, for example, a constant scroll speed Vs from top to bottom on a current slide **21**. The switching time Tsw of a display image is 780/500=1.56 seconds, where for example, the screen has a horizontal size of 1280 pixels and a vertical size of 780 pixels, and a scroll speed Vs of 500 pixels/second.

[0051] Furthermore, the computation unit **206** computes the amount of one screenful of display image data, that is, the amount of data of the next slide **22** to be scroll displayed based on the screen size of the display unit **203** and an average compression ratio. For example, assuming that the screen has a horizontal size of 1280 pixels and a vertical size of 780 pixels, the computation unit **206** computes the amount of color (RGB) bit map image data as 1280×780×3=2.85 MBytes. For example, assuming that an average compression ratio is, for example, 1/10 to obtain a JPEG image, or a compressed image, the computation unit **206** computes the amount of one screenful of display image data to be 293 KBytes. The computation unit **206** temporarily computes the amount of one screenful of display image data at the time of initial setting, and subsequently employs the value computed at the time of initial setting so long as the screen size of the display unit **203** is not changed.

[0052] Furthermore, the computation unit **206** receives an available band from the control unit **205**. The computation unit **206** computes the switching end time Te, in which the switching of display images is ended, based on the computed amount of one screenful of display image data and the available band. That is, the computation unit **206** computes the time, in which the display image is completely displayed, when the received image data is directly displayed on the display unit **203** without buffering the image data. For example, the computation unit **206** computes the switching end time Te to be (293×1024×8)/(1×1024×1024)=2.29 seconds, where the amount of one screenful of display image data is 293 KBytes and the available band is 1 Mbps. Note that the switching end time Te has the difference of the transmit/receive time of operation information from a reception time Tr in which the image data of the next slide **22** is completely displayed while the image data is received and displayed from the user's operation start time T0. However, since the transmit/receive time is much shorter than the reception time Tr, it is assumed, for simplicity, in the descriptions below that the switching end time Te and the reception time Tr are the same.

[0053] Furthermore, the computation unit **206** computes the switching start time Ts, in which the switching of display images is started, based on the switching time Tsw and the switching end time Te. The computation unit **206** subtracts the switching time Tsw from the switching end time Te to compute the switching start time Ts. The computation unit **206** computes the switching start time Ts to be 2.29−1.56=0.73 seconds, where for example, the switching time Tsw is 1.56 seconds and the switching end time Te is 2.29 seconds. Note that the switching start time Ts has the difference of the transmit/receive time of operation information from a wait time Tw in which the image data of the next slide **22** is received and starts to be displayed from the user's operation

start time T0. However, since the transmit/receive time is much shorter than the wait time Tw, it is assumed, for simplicity, in the descriptions below that the switching start time Ts and the wait time Tw are the same. The computation unit **206** outputs, to the display control unit **207**, the switching start time Ts and the switching speed, which have been computed. Furthermore, when the switching start time Ts is less than a predetermined value, the computation unit **206** outputs display information directly to the control unit **205**. Here, the predetermined value may be, for example, 50 msec.

[0054] Here, referring to FIG. **3**, the relation between the reception time Tr and the switching time Tsw or the like will be described below. FIG. **3** is an explanatory view illustrating an example of the relation between the reception time and the switching time. As illustrated in FIG. **3**, the terminal device **200** starts to receive the image data of the next slide **22** at the operation start time T0. Illustrated by a graph **23** is the amount of transfer data in the case where the received image data is directly displayed on the display unit **203** without buffering the image data. As illustrated by the graph **23**, the terminal device **200** receives the next slide **22**, that is, the amount of one screenful of display image data Di in the reception time Tr and completely displays the image data. In the case of the aforementioned example, the reception time Tr is the same as the switching end time Te, i.e., 2.29 seconds.

[0055] Illustrated by a graph **24** is the amount of transfer data that is needed when the image data of the next slide **22** is scroll displayed at the scroll speed Vs. The graph **24** is drawn in a manner such that the time in which the image data of the next slide **22** for the graph **23** is received and completely displayed coincides with the switching end time Tae that is obtained by adding the switching end time Te to the operation start time T0. In other words, the terminal device **200** starts the scroll display at the switching start time Tas that is obtained by adding the switching start time Is to the operation start time T0. That is, the terminal device **200** starts the scroll display at the time at which the graph **24** intersects the axis of time T after the wait time Tw has elapsed. As illustrated in the aforementioned example, the wait time Tw is the same as the switching start time Ts, i.e., 0.73 seconds. That is, the terminal device **200** starts the scroll display after 0.73 seconds have elapsed from the operation start time T0.

[0056] Referring back to the description of FIG. **1**, the display control unit **207** receives the operation start time T0 from the control unit **205** and receives the switching start time Ts and the switching speed from the computation unit **206**. The display control unit **207** adds the switching start time Ts to the operation start time T0 to compute the switching start time Tas. The display control unit **207** refers, for example, to the Real Time Clock (RTC) to determine whether the current time is after the switching start time Tas. When the current time is after the switching start time Tas, the display control unit **207** reads temporarily saved image data from the storage unit **204** and displays the image data on the display unit **203** at the switching speed. In the aforementioned example of scroll display, the display control unit **207** performs scroll display to switch the current slide **21** to the next slide **22** at the scroll speed Vs. Furthermore, the display control unit **207** detects the screen size of the display unit **203** for output to the computation unit **206**.

[0057] Furthermore, when image data is entered from the control unit **205**, the display control unit **207** determines that the image is to be directly displayed, and then displays the image data at the switching speed on the display unit **203** without temporarily saving the data in the storage unit **204**. Note that the switching speed to be employed in this case is a preset switching speed as in the case of the computation unit **206**.

[0058] Now, a description will be made to the operation of the thin client system **1** of this embodiment.

[0059] FIG. **4** is a sequence diagram illustrating an example of the operation of the thin client system according to the embodiment. For example, concerning image data having been just transmitted to the terminal device **200**, the measurement unit **106** of the server device **100** acquires the amount of the image data from the communication unit **102**. Furthermore, for example, concerning image data having been just transmitted to the terminal device **200**, the measurement unit **106** acquires the transfer time from the terminal device **200** via the communication unit **102**. The measurement unit **106** measures the available band, for example, based on the amount of the image data having been just transmitted, the transmission time which the communication unit **102** transmitted, and the transfer time acquired from the terminal device **200**. Note that for example, to measure the available band, it is also acceptable to measure the amount of communication data between the communication unit **102** of the server device **100** and the communication unit **201** of the terminal device **200** every one second. The measurement unit **106** outputs the resulting available band to the communication unit **102**. The communication unit **102** transmits the available band to the terminal device **200** (Step S**10**). Upon reception of the available band, the communication unit **201** of the terminal device **200** outputs the available band to the control unit **205** (Step S**11**).

[0060] For example, when the user's operation is entered to display the next slide **22** during a presentation, the input unit **202** of the terminal device **200** outputs the operation information to the control unit **205** (Step S**12**). When having received the operation information from the input unit **202**, the control unit **205** outputs the operation information to the communication unit **201** (Step S**13**), and sets the current time to the operation start time T0 and then outputs the operation information to the display control unit **207** (Step S**14**).

[0061] When the available band is entered, the control unit **205** outputs the received available band to the computation unit **206**. Upon reception of the available band, the computation unit **206** computes the switching time Tsw, the switching end time Te, and the switching start time Ts. Note that if no change is made to the setting, the switching time Tsw to be employed may take on a predetermined value. The computation unit **206** computes the switching time Tsw of the display image based on the screen size of the display unit **203** entered from the display control unit **207** and a predetermined switching speed of the display image (Step S**15**).

[0062] Furthermore, the computation unit **206** computes the amount of one screenful of display image data based on the screen size of the display unit **203** and the average compression ratio. Note that if no change is made to the setting, the amount of one screenful of display image data to be employed may also take on a predetermined value as in the case of the switching time Tsw. The computation unit **206** computes the switching end time Te, in which the switching of display image is ended, based on the computed amount of one screenful of display image data and the received available band (Step S**16**). Furthermore, the computation unit **206** computes the switching start time Ts based on the switching time Tsw and the switching end time Te (Step S**17**).

[0063] The communication unit **102** of the server device **100** receives the operation information from the terminal device **200** for output to the control unit **101** (Step S**18**). Upon reception of the operation information, the control unit **101** executes the server-side remote screen control app and various types of applications depending on the operation information. The server-side remote screen control app controls the rendering unit **103** to allow the image of an application executed on the control unit **101** to be rendered and stored on the image memory **104** (Step S**19**).

[0064] The server-side remote screen control app controls the detection unit **105** to detect an update of the image rendered on the image memory **104**, and captures, if any, an update and creates the differential image data (Step S**20**). The detection unit **105** compresses the created differential image data for output to the communication unit **102**. The communication unit **102** transmits the received image data to the terminal device **200** (Step S**21**).

[0065] Upon reception of the image data from the server device **100**, the communication unit **201** of the terminal device **200** outputs the image data to the control unit **205**. Upon reception of the image data from the communication unit **201**, the control unit **205** starts to expand the compressed image data (Step S**22**).

[0066] The computation unit **206** determines whether the computed switching start time Ts exceeds a predetermined value (Step S**23**). If the switching start time Ts exceeds the predetermined value (Step S**23**: YES), the computation unit **206** does not directly output display information to the control unit **205**. For example, the control unit **205** stores the expanded image data in the storage unit **204** as the display image after a predetermined time has elapsed (Step S**24**).

[0067] The display control unit **207** receives the operation start time T0 from the control unit **205** and receives the switching start time Ts and the switching speed from the computation unit **206**. The display control unit **207** adds the switching start time Ts to the operation start time T0 to compute the switching start time Tas. The display control unit **207** determines whether the current time Ti is after the switching start time Tas (T0+Ts) (Step S**25**). When the current time Ti is not after the switching start time Tas (Step S**25**: NO), the process is returned to Step S**24** and the display control unit **207** subsequently receives image data. If the current time Ti is after the switching start time Tas (Step S**25**: YES), the display control unit **207** reads the temporarily saved image data from the storage unit **204** and starts to display the image data on the display unit **203** at a predetermined switching speed (Step S**26**).

[0068] If the switching start time Ts is equal to or less than a predetermined value (Step S**23**: NO), the computation unit **206** directly outputs display information to the control unit **205**. Upon direct reception of the display information, the control unit **205** outputs the image data entered from the communication unit **201** to the display control unit **207**. The display control unit **207** displays the entered image data on the display unit **203** at the switching speed. That is, the display control unit **207** starts to display the received image on the display unit **203** at the predetermined switching speed (Step S**27**). Note that the thin client system **1** repeats the series of the processes of FIG. **4**, thereby allowing the user to control an application operating on the server device **100** via the terminal device **200**. As described above, the terminal device **200** temporarily saves the image data, which has started to be received, in the storage unit, and starts the switching display of the temporarily saved image so that the reception is completed at the same time as the switching display is ended. This allows smooth screen switching without an increase in the amount of image data to be transferred.

[0069] As described above, the terminal device **200** receives a screen image from the server device **100** which is connected thereto via a network. The terminal device **200** stores the received screen image in the storage unit **204** and then displays the screen image stored in the storage unit **204** on the display unit **203**. The terminal device **200** computes the switching end time, in which the switching of the screen image is ended, based on the amount of one screenful of screen image determined from the screen size of the display unit **203** and the available band for communications with the server device **100**. The terminal device **200** computes the switching start time, in which the switching of the screen image is started, based on the switching time of a screen image obtained from the screen size and the switching speed of the screen image, and the switching end time. The terminal device **200** reads the screen image from the storage unit **204** and displays the resulting image at the switching speed on the display unit **203** after the switching start time has elapsed from the reception of a user's switching operation. As a result, the screen switching can be smoothly performed. It is also possible to make a screen transition to the next page (slide) without inducing stress on the user who is watching the presentation.

[0070] Furthermore, when the switching start time is equal to or less than a predetermined value, the terminal device **200** displays a screen image received by the communication unit **201** on the display unit **203** at the switching speed in place of the screen image. As a result, when the data transfer speed is approximately equal to the display speed for switching display, the image can be displayed without buffering, so that the processing of the terminal device **200** can be alleviated.

[0071] Furthermore, the terminal device **200** also receives the available band measured by the server device **100** and computes the switching end time based on the received available band. As a result, the processing related to the measurement of the available band can be alleviated.

[0072] Furthermore, as illustrated in FIG. **2**, in the aforementioned embodiment, the current slide **21** was switched to the next slide **22** by scroll display; however, the invention is not limited thereto. For example, the terminal device **200** can display an alternative image, which is pre-stored in the storage unit **204**, between the current slide **21** and the next slide **22**. FIG. **5** is an explanatory view illustrating another example of the switching of display images. As illustrated in FIG. **5**, for example, when the switching start time Ts is greater than a predetermined value, the display control unit **207** of the terminal device **200** first displays an alternative image **25** pre-stored in the storage unit **204**. The display control unit **207** reads the image data of the alternative image **25** from the storage unit **204** and displays the image data on the display unit **203** at the predetermined switching speed. After having displayed the alternative image **25** on the display unit **203**, the display control unit **207** reads the image data of the next slide **22**, which has been received and temporarily saved, for display at the predetermined switching speed on the display unit **203**. Note that the alternative image to be employed may be, for example, an enterprise logo.

[0073] As described above, the terminal device **200** also stores, in the storage unit **204**, an alternative image to be temporarily displayed on the display unit **203** in place of a

screen image. After having read an alternative image from the storage unit **204** for display at the switching speed on the display unit **203**, the terminal device **200** reads a screen image from the storage unit **204** for display at the switching speed on the display unit **203**. As a result, in the case of a long reception time, it is possible to prevent the screens of a presentation from being stopped.

[0074] Furthermore, in the aforementioned embodiment, as illustrated by the graph **24** of FIG. **3**, the scroll speed Vs that is the switching speed was assumed to be constant; however, the invention is not limited thereto. For example, the terminal device **200** can set the switching speed by using a function that accelerates the scroll display halfway therethrough. FIG. **6** is an explanatory view illustrating another example of the relation between the reception time and the switching time. For example, as illustrated by a graph **26** of FIG. **6**, as the switching speed, the scroll speed can be a function of time as $Vs(t)=\alpha t^2$. Note that a is an arbitrary predetermined value. Furthermore, the function of time, Vs(t), is not limited to the aforementioned one, but may also be any function as long as the function provides performance effects. For example, it is also acceptable to employ a function which allows the scroll speed to be decelerated.

[0075] In this manner, the terminal device **200** computes the switching time using, as the switching speed, a switching speed computed based on a predetermined function, and displays a screen image on the display unit **203** at the switching speed computed based on the predetermined function. As a result, the change in the screen switching speed provides high performance effects and can smoothly perform screen switching.

[0076] Furthermore, in the aforementioned embodiment, the measurement of the available band was performed by the server device **100**; however, the invention is not limited thereto. For example, the terminal device **200** may also measure the available band by the communication unit **201**. In this case, it is possible to alleviate the load of a network between the terminal device **200** and the server device **100** by the amount of communications on the available band.

[0077] Furthermore, in the aforementioned embodiment, an example was described in which illustrated as the screen switching display was the scroll display for overwriting the current screen with the next screen; however, the invention is not limited thereto. The terminal device **200** can also employ, as the screen switching display, the "cutting" in which the screen is instantaneously switched, or the "fading" in which the current screen is gradually faded and the next screen gradually appears, for example. Furthermore, the terminal device **200** may also employ, as the screen switching display, the "pushing" in which the next screen is displayed so as to push out the current screen, or the "wiping" in which the next screen is displayed in a manner such that the screen is wiped from the left or the right, for example.

[0078] Furthermore, each of the component members at each unit illustrated has not to be always constructed physically as illustrated. That is, specific distributed or integrated forms of each unit are not limited to those illustrated, and all or part thereof can be configured by distributing or integrating functionally or physically in an arbitrary unit depending on various types of load or service conditions. For example, the computation unit **206** may also be constructed by two units: a functional unit that computes the switching time Tsw of a display image and the amount of display image data Di and a functional unit that computes the switching end time Te and the switching start time Ts.

[0079] Furthermore, all or any part of various types of processing functions to be performed on each device may also be executed on a Central Processing Unit (CPU) (or microcomputers such as the Micro Processing Unit (MPU) or a Micro Controller Unit (MCU)). Furthermore, needless to say, all or any part of various types of processing functions may also be executed on a program to be analyzed and executed by a CPU (or a microcomputer such as the MPU or MCU), or on hardware wired logics.

[0080] The various types of processing described in the aforementioned embodiment can be implemented by a computer executing a program prepared in advance. In this context, hereinafter, a description will be made to an example of a computer for executing a program which has the same functions as those of the aforementioned embodiment. FIG. **7** is an explanatory view illustrating an example of a computer for executing a display program.

[0081] As illustrated in FIG. **7**, a computer **300** includes a CPU **301** for executing various types of computations, an input device **302** for receiving input data from the user, and a monitor **303**. The computer **300** also includes a medium reader **304** for reading programs or the like on a storage medium, an interface unit **305** for connecting to another device, and a wireless communication unit **306** for connecting by radio to another device. The computer **300** further includes a RAM **307** for temporarily storing various types of information and a hard disk drive **308**. Furthermore, each of the devices **301** to **308** is connected to a bus **309**.

[0082] The hard disk drive **308** stores information processing programs which each have the same function as that of each of the processing units, i.e., the control unit **205**, the computation unit **206**, and the display control unit **207**, which are illustrated in FIG. **1**. The hard disk drive **308** also stores various types of data for implementing the information processing programs. The interface unit **305** and the wireless communication unit **306** include the same function as that of the communication unit **201** illustrated in FIG. **1**. Furthermore, the input device **302** corresponds to the input unit **202**, the monitor **303** to the display unit **203**, and the RAM **307** to the storage unit **204**.

[0083] The CPU **301** performs various types of processing by reading each program stored in the hard disk drive **308** and developing and executing the programs on the RAM **307**. Furthermore, these programs are capable of allowing the computer **300** to function as the control unit **205**, the computation unit **206**, and the display control unit **207**, which are illustrated in FIG. **1**.

[0084] Note that the aforementioned information processing programs do not necessarily have to be stored in the hard disk drive **308**. For example, the computer **300** may also read and execute a program which is stored in a storage medium that can be read by the computer **300**. For example, those storage media that can be read by the computer **300** correspond to portable recording media such as CD-ROMs, DVD disks, and USB (Universal Serial Bus) memory devices, semiconductor memory devices such as flash memory devices, or hard disk drives. On the other hand, these information processing programs may be stored on a device connected to the public line, the Internet, or a Local Area Net-

work (LAN), so that the computer **300** reads these information processing programs therefrom and executes them.

[0085] Screen switching can be smoothly performed.

[0086] All examples and conditional language recited herein are intended for pedagogical purposes of aiding the reader in understanding the invention and the concepts contributed by the inventor to further the art, and are not to be construed as limitations to such specifically recited examples and conditions, nor does the organization of such examples in the specification relate to a showing of the superiority and inferiority of the invention. Although the embodiments of the present invention have been described in detail, it should be understood that the various changes, substitutions, and alterations could be made hereto without departing from the spirit and scope of the invention.

What is claimed is:

1. A terminal device comprising:

a memory; and

a processor coupled to the memory, wherein the processor executes a process including:

receiving a screen image from a server device connected via a network;

storing the screen image received;

displaying the screen image stored in a storage;

first computing a switching end time, in which switching of the screen image is ended, based on an amount of one screenful of screen image data that is determined from a screen size of a display and an available band for communications with the server device;

second computing a switching start time, in which switching of the screen image is started, based on a switching time of the screen image obtained from the screen size and a switching speed of the screen image, and the switching end time; and

reading the screen image from the storage and displaying the screen image on the display at the switching speed after the switching start time has elapsed from reception of a user's switching operation.

2. The terminal device according to claim **1**, wherein when the switching start time is equal to or less than a predetermined value, the displaying includes displaying a screen image at the switching speed on the display in place of the screen image, the screen image having been received at the receiving.

3. The terminal device according to claim **1**, wherein

the receiving further includes receiving the available band measured by the server device and

the first computing includes employing an available band received at the receiving as the available band so as to compute the switching end time.

4. The terminal device according to claim **1**, wherein

the storing further includes storing an alternative image to be temporarily displayed on the display in place of the screen image and

the reading includes reading the alternative image from the storage to display the alternative image at the switching speed on the display, and thereafter reading the screen image from the storage to display the screen image at the switching speed on the display.

5. The terminal device according to claim **1**, wherein

the first computing includes employing, a switching speed computed based on a predetermined function as the switching speed to compute the switching time and

the displaying includes displaying the screen image on the display at a switching speed computed based on the predetermined function.

6. A thin client system comprising a server device and a terminal device, wherein:

the server device includes:

a memory; and

a processor coupled to the memory, wherein the processor executes a process including:

storing a display image to be displayed on the terminal device connected via a network;

rendering a software processed result in an image memory;

detecting an update region which has been updated between frames of an image rendered in the image memory;

measuring an available band for communications with the terminal device; and

transmitting a screen image, which is an image in the update region, and the available band to the terminal device; and

the terminal device includes:

a memory; and

a processor coupled to the memory, wherein the processor executes a process including:

receiving the screen image and the available band;

storing the screen image received at the receiving;

displaying the screen image stored in a storage;

first computing a switching end time, in which switching of the screen image is ended, based on an amount of one screenful of screen image data that is determined from a screen size of a display and an available band for communications with the server device;

second computing a switching start time, in which switching of the screen image is started, based on a switching time of the screen image obtained from the screen size and a switching speed of the screen image, and the switching end time; and

reading the screen image from the storage and displaying the screen image at the switching speed on the display after the switching start time has elapsed from reception of a user's switching operation.

7. A display method to be executed by a terminal device, the display method comprising:

receiving a screen image from a server device connected via a network, using a processor;

storing the received screen image in a storage;

displaying the screen image stored in the storage on a display, using the processor;

first computing a switching end time, in which switching of the screen image is ended, based on an amount of one screenful of screen image data that is determined from a screen size of the display and an available band for communications with the server device, using the processor;

second computing a switching start time, in which switching of the screen image is started, based on a switching time of the screen image obtained from the screen size and a switching speed of the screen image, and the switching end time, using the processor; and

reading the screen image from the storage and displaying the screen image at the switching speed on the display after the switching start time has elapsed from reception of a user's switching operation, using the processor.

8. A non-transitory computer-readable recording medium having stored therein a program that causes a computer to execute a display process comprising:

receiving a screen image from a server device connected via a network;

storing the received screen image in a storage;

displaying the screen image stored in the storage on a display;

first computing a switching end time, in which switching of the screen image is ended, based on an amount of one screenful of screen image data that is determined from a screen size of the display and an available band for communications with the server device;

second computing a switching start time, in which switching of the screen image is started, based on a switching time of the screen image obtained from the screen size and a switching speed of the screen image, and the switching end time; and

reading the screen image from the storage and displaying the screen image at the switching speed on the display after the switching start time has elapsed from reception of a user's switching operation.

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