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(54) **RECORDING MEDIUM, DATA COLLECTION DEVICE, AND DATA COLLECTION METHOD**

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(57) **ABSTRACT**

A non-transitory computer-readable recording medium storing a program that causes a computer to execute a process, the process includes comparing first data previously acquired from a data transmission source device and second data currently acquired from the device to specify a difference portion of the second data as compared with the first data; determining a dividing position of the second data so that the difference portion is made into a single block; dividing the second data into first blocks at the dividing position; transmitting, to the device, a first hash value for each of the first blocks and information on the dividing position; and receiving, from the device, the second block corresponding to a second hash value different from the first hash value for each of the first blocks, among second blocks obtained by dividing third data held by the device based on the information on the dividing position.

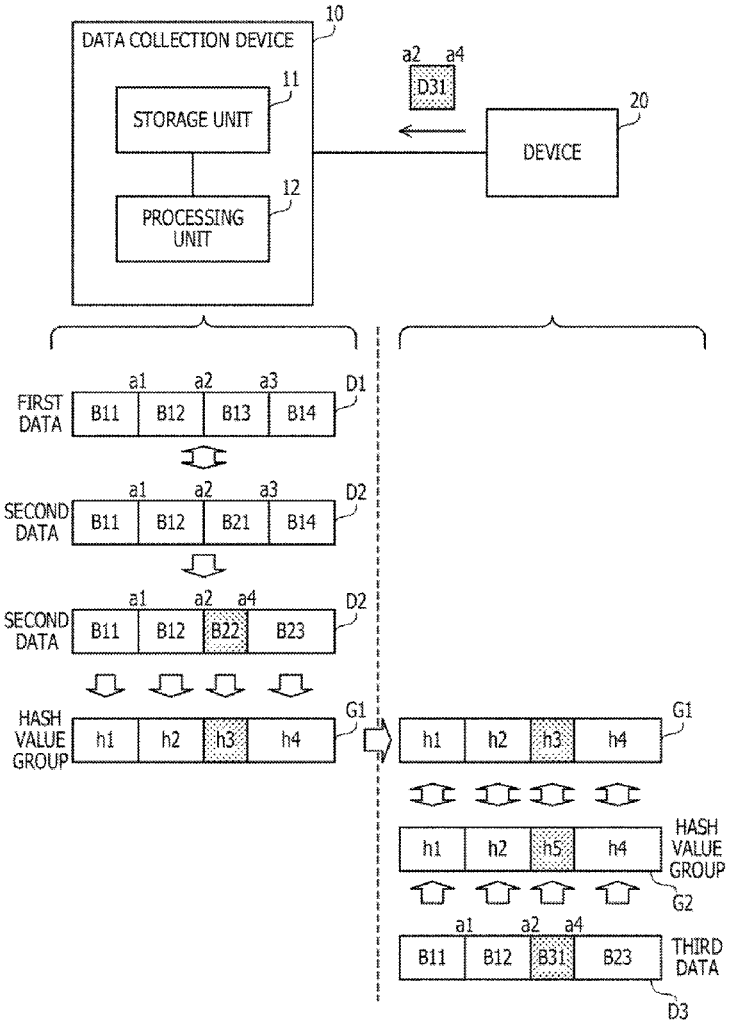


FIG. 1

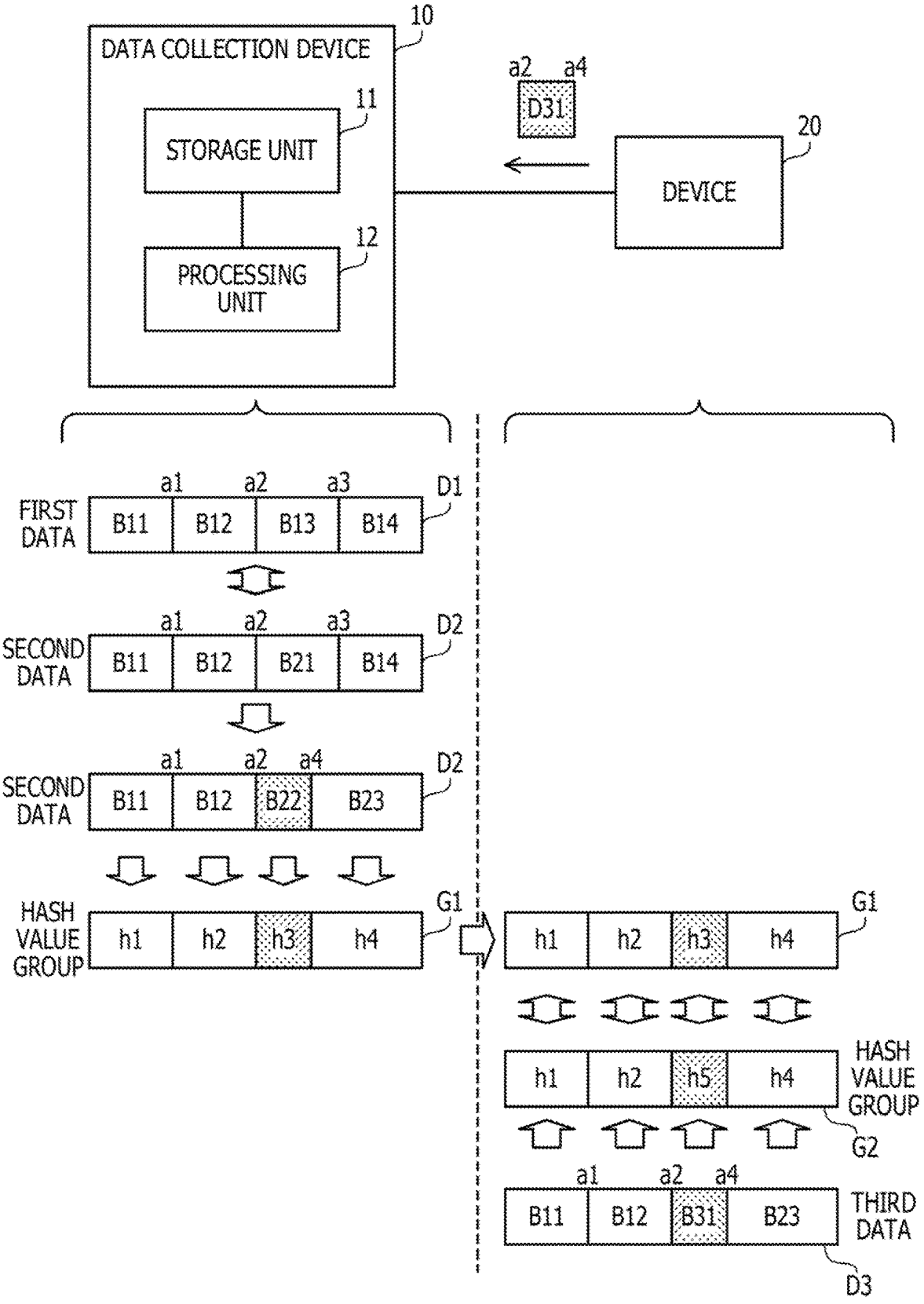

10
DATA COLLECTION DEVICE
11
STORAGE UNIT
12
PROCESSING UNIT
a2 a4
D31
20
DEVICE
a1 a2 a3
D1
FIRST DATA
B11 B12 B13 B14
a1 a2 a3
D2
SECOND DATA
B11 B12 B21 B14
a1 a2 a4
D2
SECOND DATA
B11 B12 B22 B23
HASH VALUE GROUP
G1
h1 h2 h3 h4
G1
h1 h2 h3 h4
h1 h2 h5 h4
HASH VALUE GROUP
G2
a1 a2 a4
B11 B12 B31 B23
THIRD DATA
D3

FIG. 2

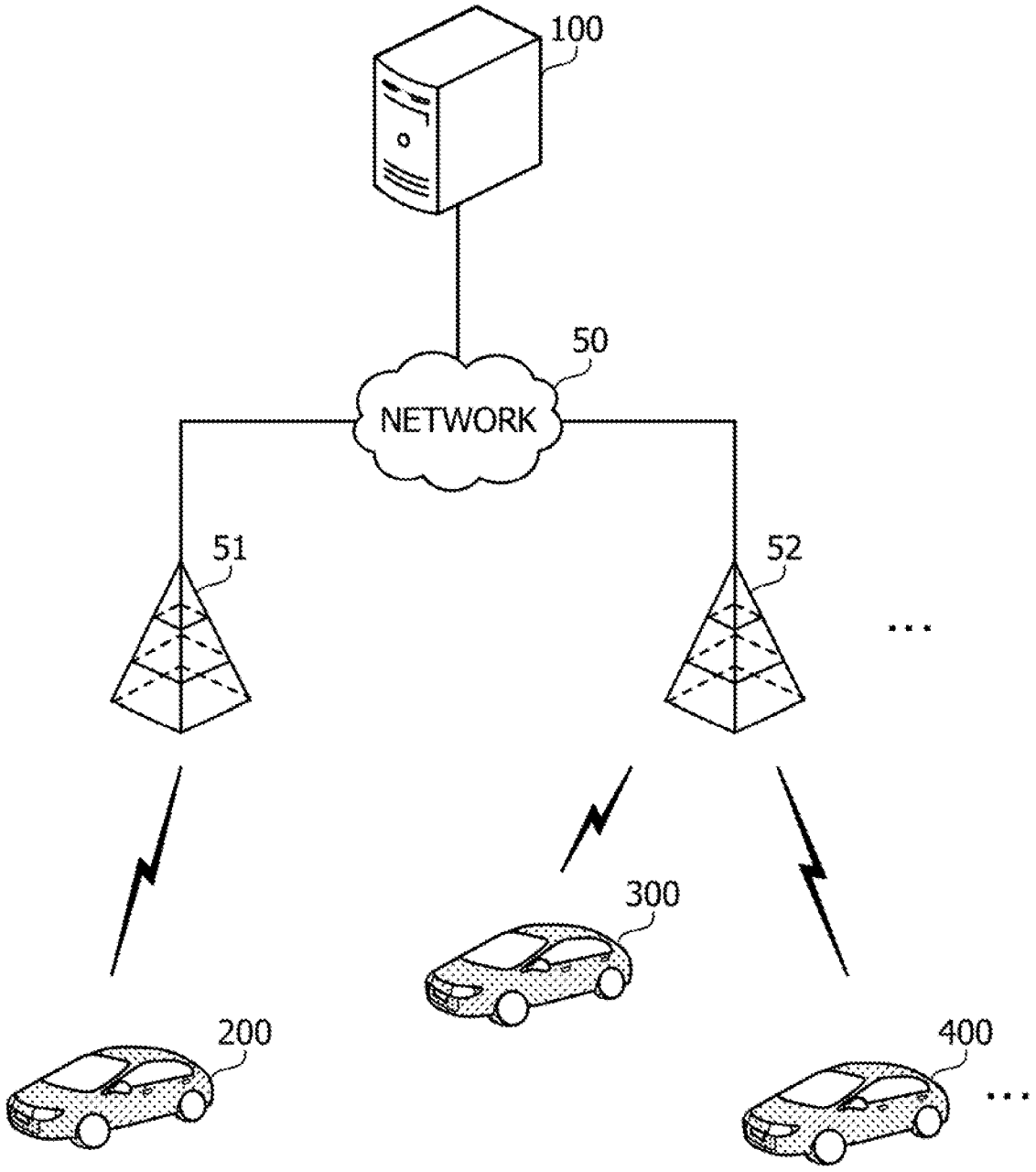


FIG. 3

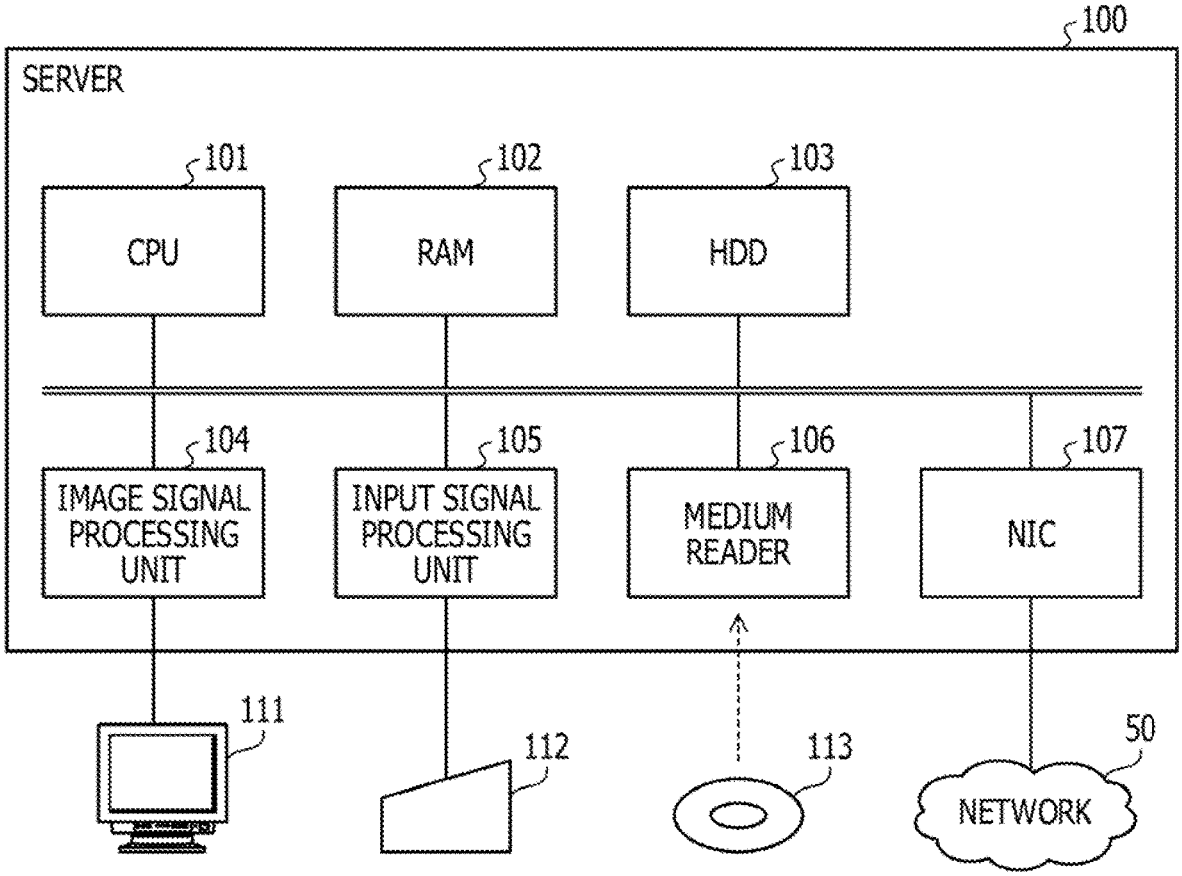

100
SERVER
101
CPU
102
RAM
103
HDD
104
IMAGE SIGNAL PROCESSING UNIT
105
INPUT SIGNAL PROCESSING UNIT
106
MEDIUM READER
107
NIC
111
112
113
50
NETWORK

FIG. 4

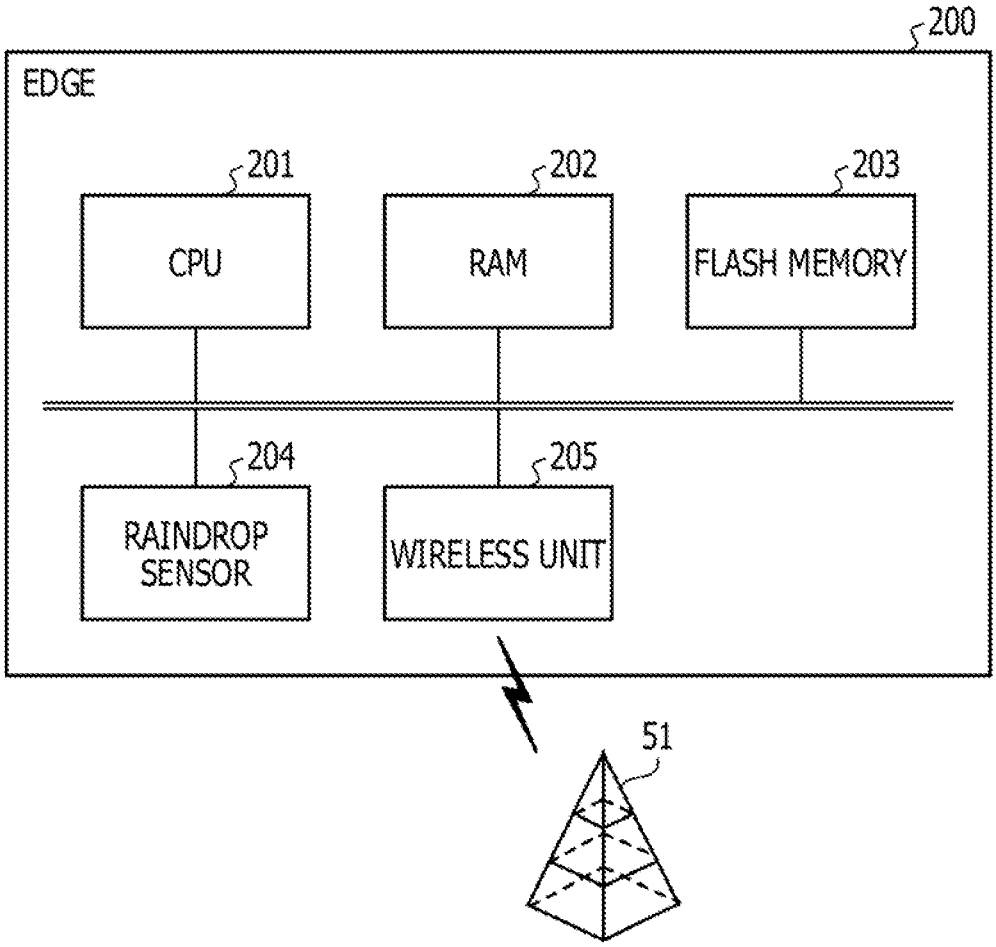

200
EDGE
201
CPU
202
RAM
203
FLASH MEMORY
204
RAINDROP SENSOR
205
WIRELESS UNIT
51

FIG. 5

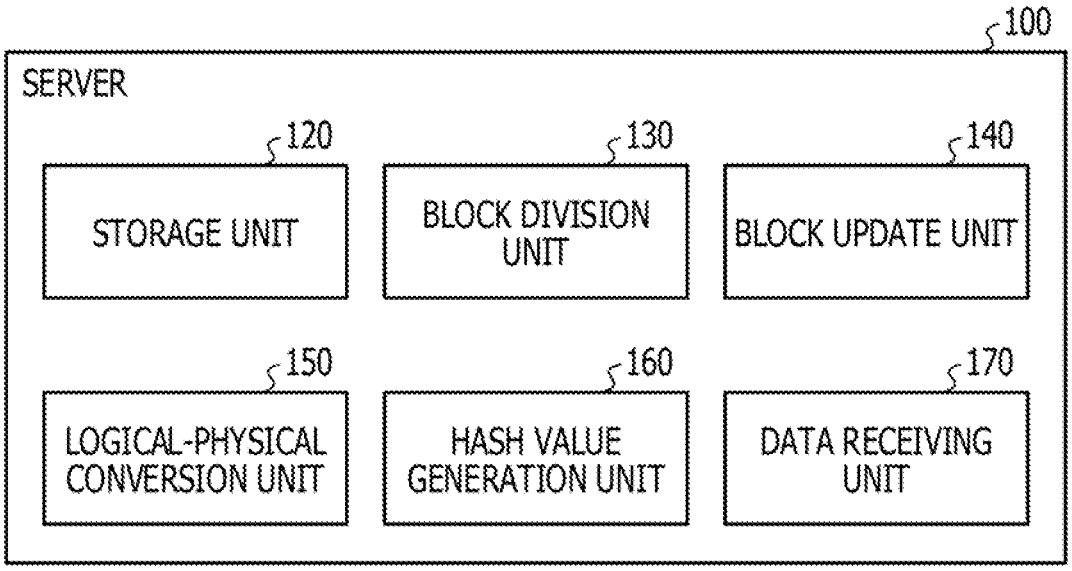

100
SERVER
120
STORAGE UNIT
130
BLOCK DIVISION UNIT
140
BLOCK UPDATE UNIT
150
LOGICAL-PHYSICAL CONVERSION UNIT
160
HASH VALUE GENERATION UNIT
170
DATA RECEIVING UNIT

FIG. 6

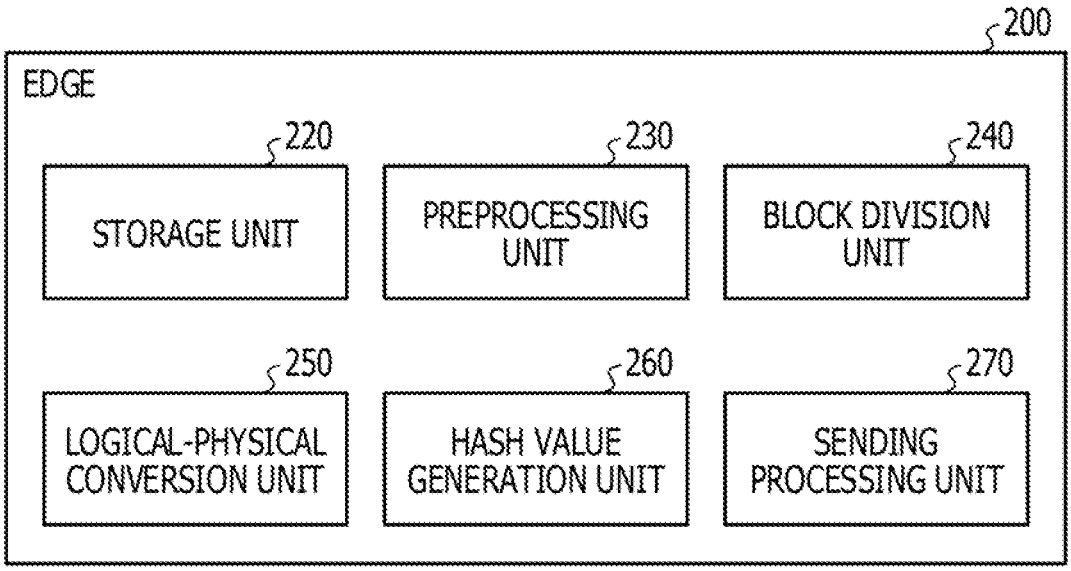

200
EDGE
220
STORAGE UNIT
230
PREPROCESSING UNIT
240
BLOCK DIVISION UNIT
250
LOGICAL-PHYSICAL CONVERSION UNIT
260
HASH VALUE GENERATION UNIT
270
SENDING PROCESSING UNIT

FIG. 7A

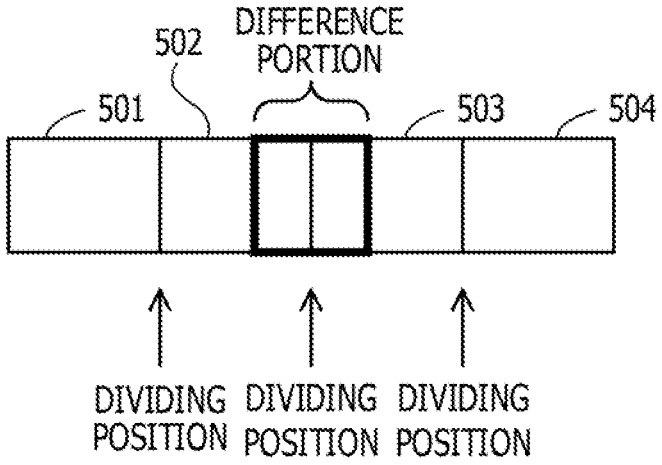

DIFFERENCE PORTION
502
501
503
504
DIVIDING POSITION
DIVIDING POSITION
DIVIDING POSITION

FIG. 7B

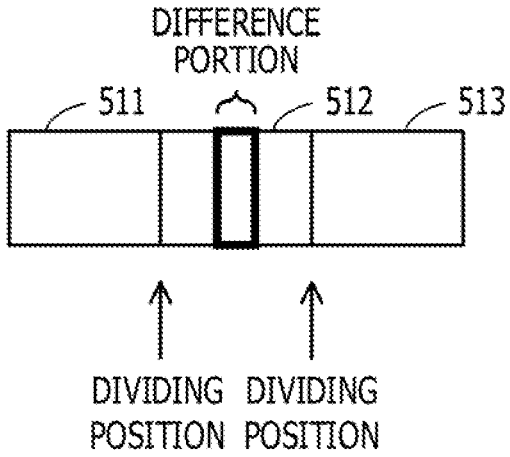

DIFFERENCE PORTION
511
512
513
DIVIDING POSITION
DIVIDING POSITION

FIG. 8A

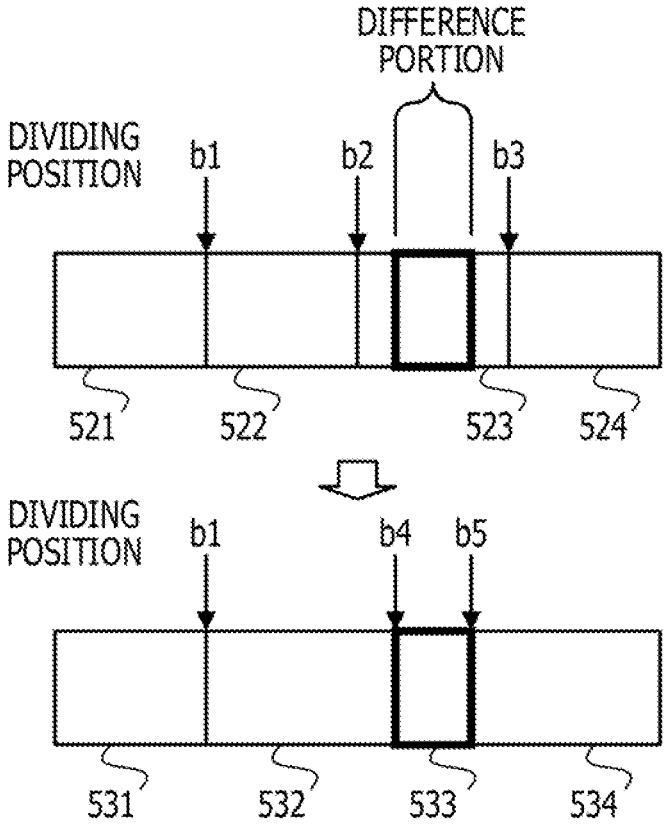

DIFFERENCE PORTION
DIVIDING POSITION
b1
b2
b3
521
522
523
524
DIVIDING POSITION
b1
b4
b5
531
532
533
534

FIG. 8B

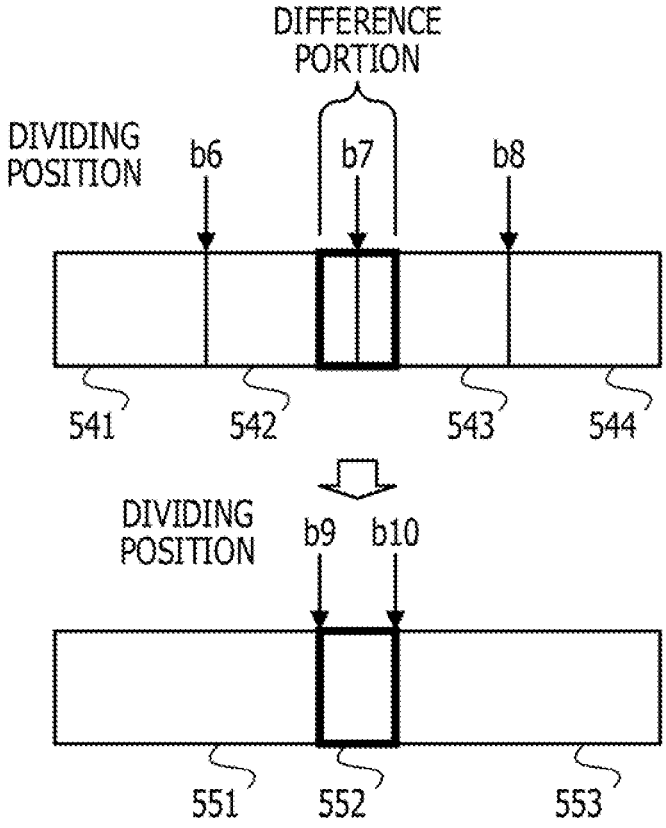

DIFFERENCE PORTION
DIVIDING POSITION
b6
b7
b8
541
542
543
544
DIVIDING POSITION
b9
b10
551
552
553

FIG. 9

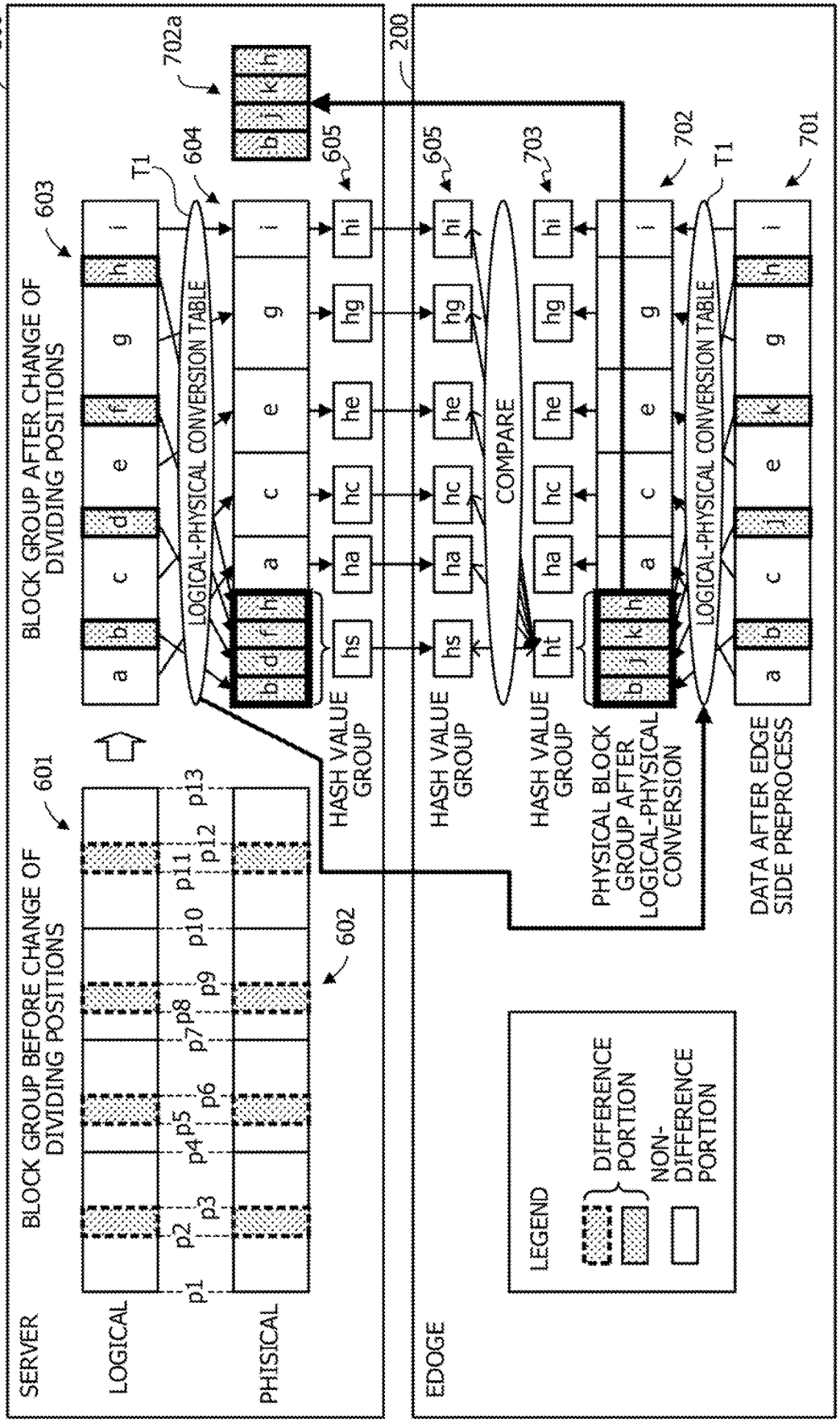

100
SERVER
BLOCK GROUP BEFORE CHANGE OF DIVIDING POSITIONS
601
602
LOGICAL
PHISICAL
p1
p2
p3
p4
p5
p6
p7
p8
p9
p10
p11
p12
p13
BLOCK GROUP AFTER CHANGE OF DIVIDING POSITIONS
603
T1
LOGICAL-PHYSICAL CONVERSION TABLE
604
605
HASH VALUE GROUP
hs
ha
hc
he
hg
hi
200
EDOGE
COMPARE
ht
703
PHYSICAL BLOCK GROUP AFTER LOGICAL-PHYSICAL CONVERSION
702
702a
701
DATA AFTER EDGE SIDE PREPROCESS
LEGEND
DIFFERENCE PORTION
NON-DIFFERENCE PORTION

FIG. 10

T1

LOGICAL-PHYSICAL CONVERSION TABLE				
PHYSICAL BLOCK ID	LOGICAL BLOCK ID	LOGICAL ADDRESS	PHYSICAL ADDRESS	SIZE (Bytes)
0	b	0xaaaabbbb	0x00000000	16
	j	0xbbbbcccc	0x00000010	16
	k	0xccccdddd	0x00000020	16
	h	0xccccdddd	0x00000030	16
1	a	0xddddeeee	0x00000040	32
2	c	0xeeee0000	0x00000060	48
...	...	...	...	...

FIG. 11

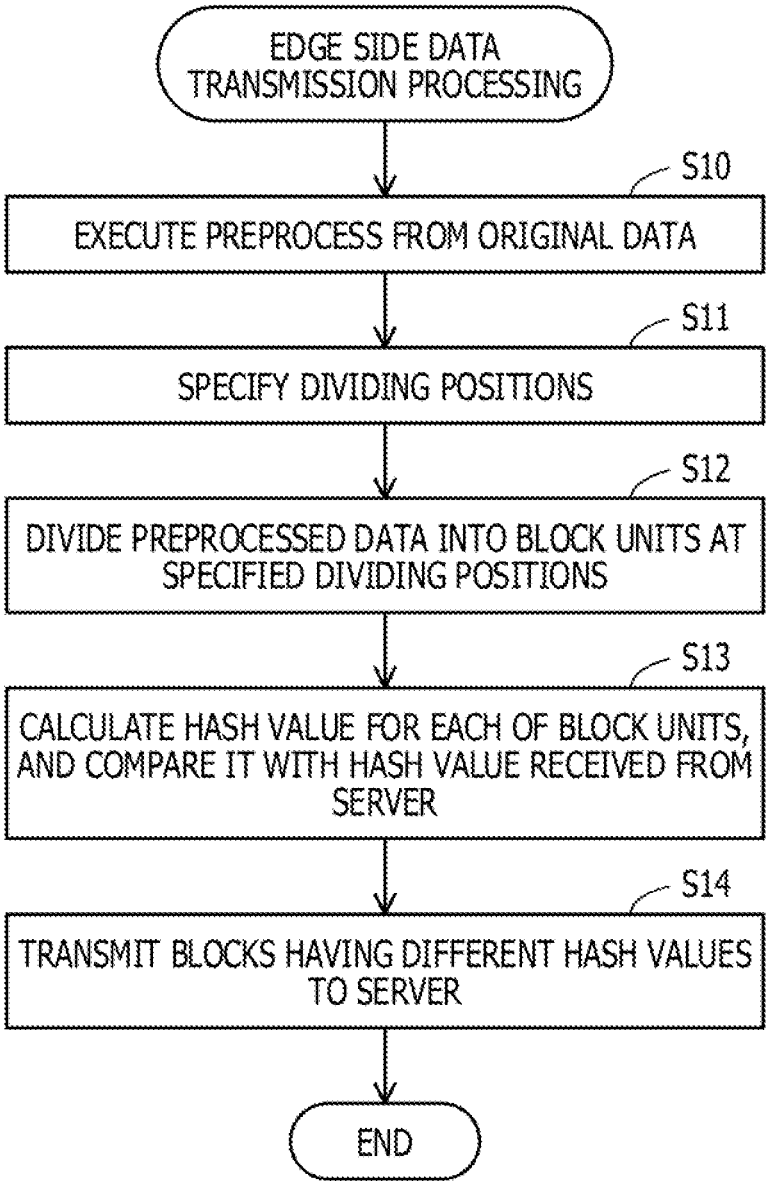

EDGE SIDE DATA TRANSMISSION PROCESSING
S10
EXECUTE PREPROCESS FROM ORIGINAL DATA
S11
SPECIFY DIVIDING POSITIONS
S12
DIVIDE PREPROCESSED DATA INTO BLOCK UNITS AT SPECIFIED DIVIDING POSITIONS
S13
CALCULATE HASH VALUE FOR EACH OF BLOCK UNITS, AND COMPARE IT WITH HASH VALUE RECEIVED FROM SERVER
S14
TRANSMIT BLOCKS HAVING DIFFERENT HASH VALUES TO SERVER
END

FIG. 12

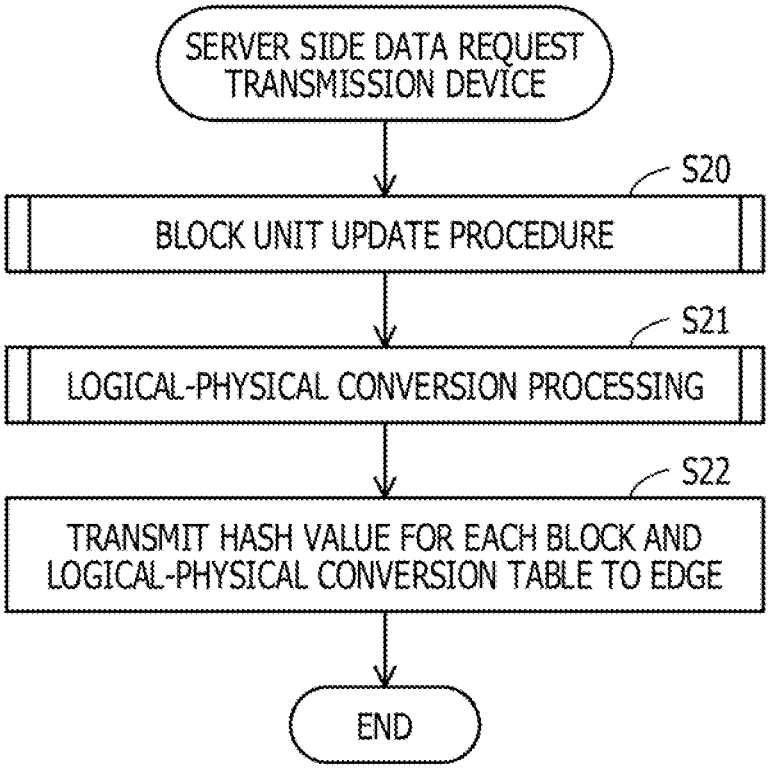

SERVER SIDE DATA REQUEST TRANSMISSION DEVICE
S20
BLOCK UNIT UPDATE PROCEDURE
S21
LOGICAL-PHYSICAL CONVERSION PROCESSING
S22
TRANSMIT HASH VALUE FOR EACH BLOCK AND LOGICAL-PHYSICAL CONVERSION TABLE TO EDGE
END

FIG. 13

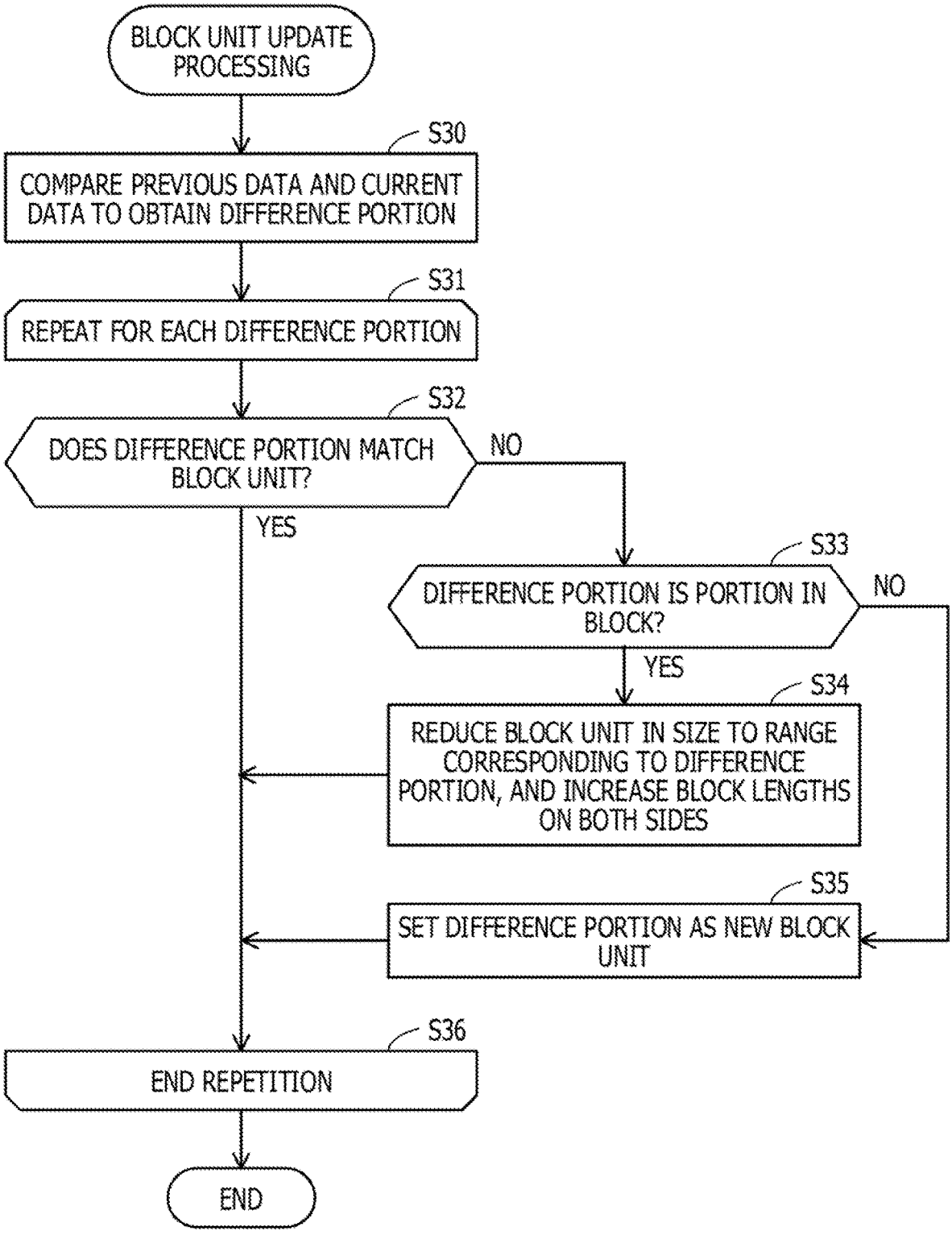

BLOCK UNIT UPDATE PROCESSING
S30
COMPARE PREVIOUS DATA AND CURRENT DATA TO OBTAIN DIFFERENCE PORTION
S31
REPEAT FOR EACH DIFFERENCE PORTION
S32
DOES DIFFERENCE PORTION MATCH BLOCK UNIT?
NO
YES
S33
DIFFERENCE PORTION IS PORTION IN BLOCK?
NO
YES
S34
REDUCE BLOCK UNIT IN SIZE TO RANGE CORRESPONDING TO DIFFERENCE PORTION, AND INCREASE BLOCK LENGTHS ON BOTH SIDES
S35
SET DIFFERENCE PORTION AS NEW BLOCK UNIT
S36
END REPETITION
END

FIG. 14

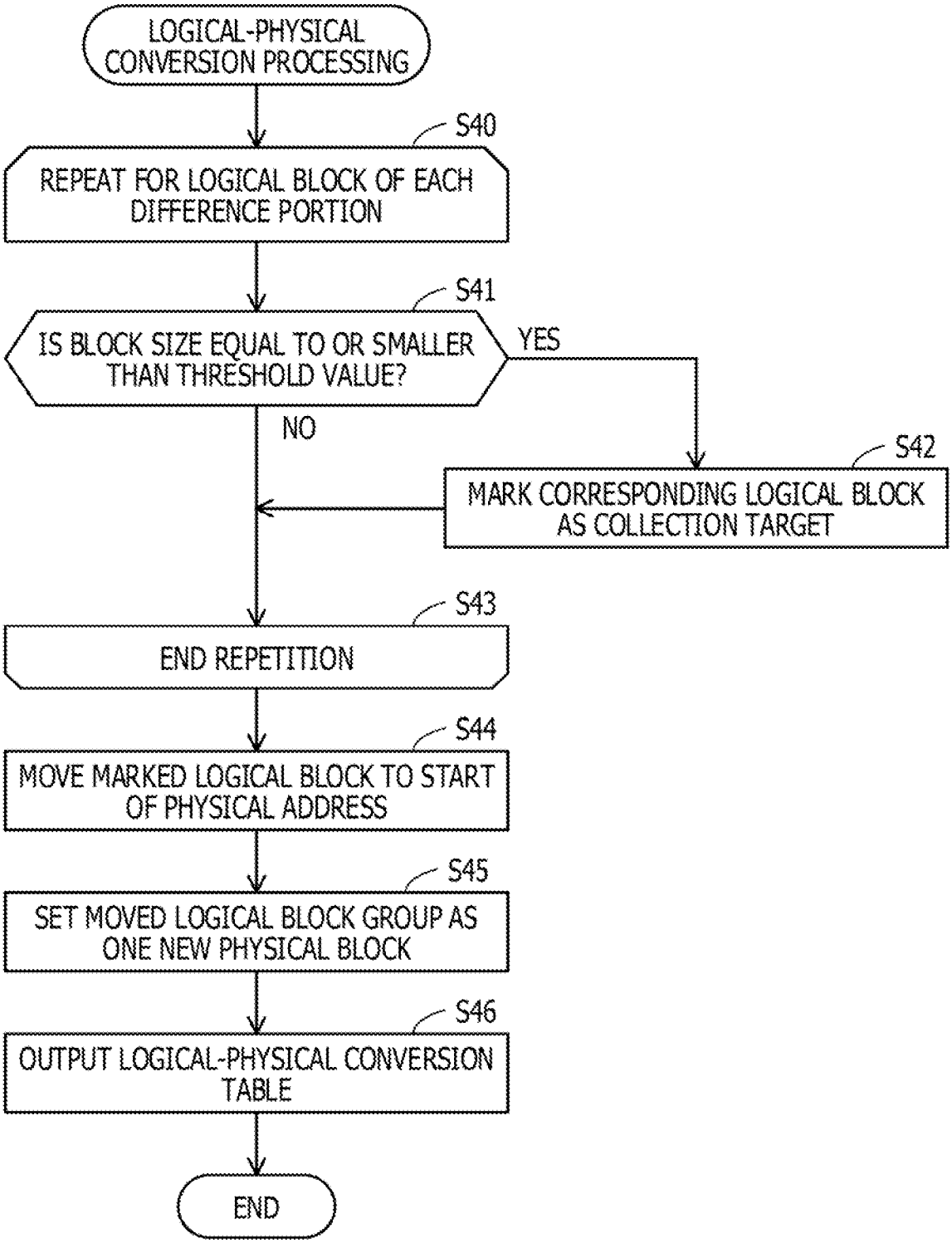
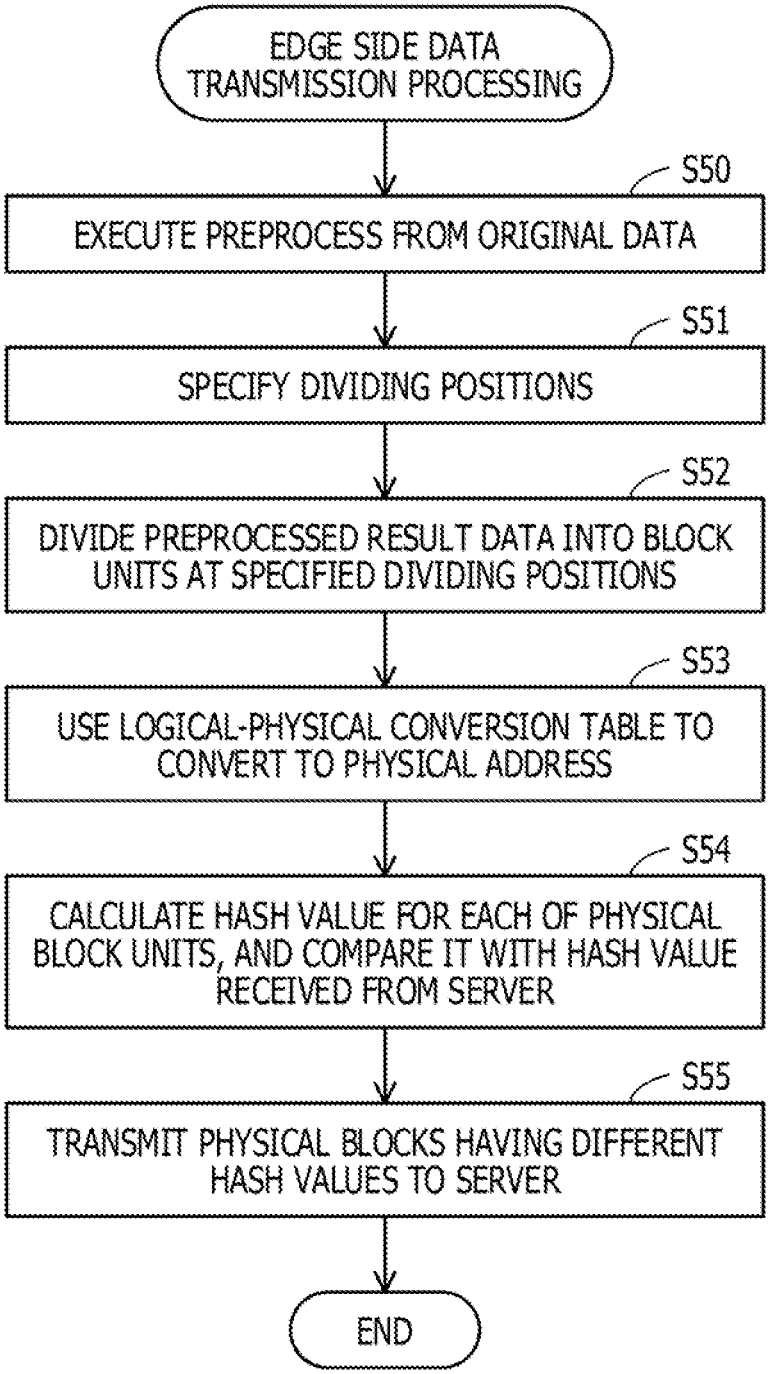

LOGICAL-PHYSICAL CONVERSION PROCESSING
S40
REPEAT FOR LOGICAL BLOCK OF EACH DIFFERENCE PORTION
S41
IS BLOCK SIZE EQUAL TO OR SMALLER THAN THRESHOLD VALUE?
YES
NO
S42
MARK CORRESPONDING LOGICAL BLOCK AS COLLECTION TARGET
S43
END REPETITION
S44
MOVE MARKED LOGICAL BLOCK TO START OF PHYSICAL ADDRESS
S45
SET MOVED LOGICAL BLOCK GROUP AS ONE NEW PHYSICAL BLOCK
S46
OUTPUT LOGICAL-PHYSICAL CONVERSION TABLE
END

FIG. 15


EDGE SIDE DATA TRANSMISSION PROCESSING
S50
EXECUTE PREPROCESS FROM ORIGINAL DATA
S51
SPECIFY DIVIDING POSITIONS
S52
DIVIDE PREPROCESSED RESULT DATA INTO BLOCK UNITS AT SPECIFIED DIVIDING POSITIONS
S53
USE LOGICAL-PHYSICAL CONVERSION TABLE TO CONVERT TO PHYSICAL ADDRESS
S54
CALCULATE HASH VALUE FOR EACH OF PHYSICAL BLOCK UNITS, AND COMPARE IT WITH HASH VALUE RECEIVED FROM SERVER
S55
TRANSMIT PHYSICAL BLOCKS HAVING DIFFERENT HASH VALUES TO SERVER
END

RECORDING MEDIUM, DATA COLLECTION DEVICE, AND DATA COLLECTION METHOD

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application is based upon and claims the benefit of priority of the prior Japanese Patent Application No. 2019-2414, filed on Jan. 10, 2019, the entire contents of which are incorporated herein by reference.

FIELD

[0002] The embodiments discussed herein are related to a recording medium, a data collection device, and a data collection method.

BACKGROUND

[0003] A system is used which transmits data accumulated in a data transmission source device from the device to a host device. For example, there is a proposal of an information management method in which, when expanding the storage capacity of a file server using an online storage service, the file server divides the file into block files to be managed. In the proposed information management method, the file server does not upload to the online storage service a block which overlaps a block file group that has already been registered/stored, but only changes the file configuration information.

[0004] There is a proposal of a file transfer method in which the receiving computer divides the old file into segments, calculates the hash number for each segment, and transfers these hash numbers to the transmitting computer. In the proposed file transfer method, the transmitting computer examines each segment of the new file and determines which segment has a hash number that matches the hash number received from the receiving computer. The transmitting computer notifies the receiving computer of matching segments which match the new file. The receiving computer then constructs a copy of the new file from the matching segments of the old file.

[0005] Related techniques are disclosed in, for example, Japanese Laid-open Patent Publication No. 2012441738 and Japanese National Publication of International Patent Application No. 9-510559.

[0006] It is conceivable that, when the data transmission source device divides data into blocks and opts not to transmit to the host device the blocks that overlap the blocks stored in the host device, it is possible to suppress the transfer of the overlapping blocks. For example, when the host device requests data from the transmission source device, sending the past data enables the transmission source device to send only a difference block from the past data.

[0007] Here, in order to further reduce the data transfer volume, it is conceivable to calculate in the host device the hash value for each predetermined block unit, and transmit the calculated block-unit hash value from the host device to the transmission source device. The transmission source device obtains a block-unit hash value for the accumulated data, and is capable of specifying data to be transmitted according to the difference from the hash value transmitted from the host device.

[0008] However, in this case, the unit of the data size transmitted from the transmission source device is a block unit, which is a calculation unit of the hash value. Therefore, even when there is a difference in part of a block, the transmission source device transmits the entire block, and there is a problem that the data transfer volume may not be sufficiently reduced. In view of the above, it is desirable to be able to provide a data collection program, a data collection device, and a data collection method which make it possible to reduce data transfer volume.

SUMMARY

[0009] According to an aspect of the embodiments, a non-transitory computer-readable recording medium storing a program that causes a computer to execute a process, the process includes comparing first data previously acquired from a data transmission source device and second data currently acquired from the data transmission source device to specify a difference portion of the second data as compared with the first data; determining a dividing position of the second data so that the difference portion is made into a single block; dividing the second data into a plurality of first blocks at the determined dividing position; transmitting, to the data transmission source device, a first hash value for each of the plurality of first blocks and information on the dividing position; and receiving, from the data transmission source device, the second block corresponding to a second hash value different from the first hash value for each of the plurality of first blocks, among second blocks obtained by dividing third data held by the device based on the information on the dividing position.

[0010] 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.

[0011] 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

[0012] FIG. **1** is a diagram illustrating a data collection device according to a first embodiment;

[0013] FIG. **2** is a diagram illustrating a data collection system according to a second embodiment;

[0014] FIG. **3** is a diagram illustrating an example of hardware of a server;

[0015] FIG. **4** is a diagram illustrating an example of hardware of an edge;

[0016] FIG. **5** is a diagram illustrating a function example of the server;

[0017] FIG. **6** is a diagram illustrating a function example of the edge;

[0018] FIGS. **7**A and **7**B are each a diagram illustrating an example of a difference portion;

[0019] FIGS. **8**A and **8**B are each a diagram lustrating an example of dividing position update;

[0020] FIG. **9** is a diagram illustrating an example of logical-physical conversion;

[0021] FIG. **10** is a diagram illustrating an example of a logical-physical conversion table;

[0022] FIG. **11** is a flowchart illustrating an example (part **1**) of edge side data transmission processing;

[0023] FIG. **12** is a flowchart illustrating an example of server side data request transmission processing;

[0024] FIG. **13** is a flowchart illustrating an example of block unit update processing;

[0025] FIG. **14** is a flowchart illustrating an example of logical-physical conversion processing; and

[0026] FIG. **15** is a flowchart illustrating an example (part **2**) of the edge side data transmission process.

DESCRIPTION OF EMBODIMENTS

[0027] Hereinafter, the present embodiments will be described with reference to the drawings.

First Embodiment

[0028] A first embodiment will be described.

[0029] FIG. **1** is a diagram illustrating a data collection device according to a first embodiment.

[0030] A data collection device **10** communicates with a device **20** via a network and collects data held by the device **20**. The device **20** is, for example, an information processing device such as a computer, a sensor device, or a device equipped with a sensor device (for example, a moving body such as an automobile equipped with a sensor device). The device **20** includes a memory for storing data to be transmitted to the data collection device **10**.

[0031] The data collection device **10** includes a storage unit **11** and a processing unit **12**. The storage unit **11** may be a volatile storage device such as a random-access memory (RAM), or a nonvolatile storage device such as a hard disk drive (HDD) or a flash memory. The processing unit **12** may include a central processing unit (CPU), a digital signal processor (DSP), an application specific integrated circuit (ASIC), a field-programmable gate array (FPGA), or the like. The processing unit **12** may be a processor which executes a program. The "processor" referred to herein may include a set of a plurality of processors (a multiprocessor).

[0032] The storage unit **11** stores data collected from the device **20**. For example, the storage unit **11** stores first data D**1** which the processing unit **12** previously acquired from the device **20**. The first data D**1** is divided into units of a predetermined size called blocks. For example, the first data D**1** includes blocks B**11**, B**12**, B**13**, and B**14** obtained by dividing the first data D**1** from the start to the end at dividing positions a**1**, a**2**, and a**3**. The dividing positions are indicated by an address from the start of the data (for example, when a**1**, a**2**, and a**3** indicate addresses, the starting address<a**1**<a**2**<a**3**<the ending address). The information on the dividing positions is determined in advance for the data collection device **10** and is notified from the data collection device **10** to the device **20** in advance.

[0033] The processing unit **12** acquires data from the device **20**. For example, the processing unit **12** here acquires second data D**2** from the device **20**. The size of the second data D**2** is the same as the size of the first data D**1**. The processing unit **12** may calculate the hash values (sometimes referred to as summary values) of the blocks B**11**, B**12**, B**13**, and B**14**, and transmit the calculated hash values to the device **20**.

[0034] The device **20** receives the hash values, and among the new data held by the device **20**, sends the device **20** the blocks having different hash values from the received hash values and identification information such as an address indicating the block positions of the blocks in the new data. Among the blocks of new data, the blocks corresponding to the same hash values as the hash values received from the data collection device **10** have been transmitted to the data collection device **10** and are already held by the data collection device **10**. On the other hand, among the blocks of new data, the blocks corresponding to the hash values different from the hash values received from the data collection device **10** are yet to be transmitted to the data collection device **10**. Therefore, the device **20** is allowed to avoid transmitting overlapping data to the data collection device **10** by transmitting only the blocks having different hash values.

[0035] The second data D**2** includes blocks B**11**, B**12**, **821**, and **614** obtained by dividing the second data D**2** from the start to the end at dividing positions a**1**, a**2**, and a**3**. In the second data D**2**, the blocks **611**, **812**, and B**14** are common to the first data **01**, and the block B**21** is not common. Therefore, in this case, the device **20** may transmit only the block **821** of the second data D**2** to the data collection device **10**.

[0036] When receiving the block B**21** and the block position identification information on the block B**21** in the second data D**2** from the device **20**, the processing unit **12** determines that the block B**21** is an update section for the block B**13**. For this reason, the data collection device **10** obtains the second data D**2** by replacing the block B**13** of the first data D**1** with the block B**21**. In this way, the data collection device **10** may appropriately acquire the second data D**2** by reducing the data collection for the overlapping blocks.

[0037] The processing unit **12** further compares the first data D**1** and the second data D**2**, and according to the comparison, specifies a difference portion of the second data D**2** as compared with the first data D**1**, and determines the dividing positions of the blocks of the second data D**2** so that the difference portion made into a single block B**22**. For example, assume that, in the second data D**2**, the range from the dividing position a**2** to the address a**4** (where a**4** is an address greater than the dividing position a**2** and less than the dividing position a**3**) is a section different in content from the same range of the first data D**1**, and the other sections have the same content as the first data D**1**. Then, for example, the processing unit **12** determines the dividing positions a**1**, a**2**, and a**4** as the dividing positions of the blocks of the second data D**2**.

[0038] The processing unit **12** divides the second data D**2** into blocks B**11**, B**12**, B**22**, and B**23** (multiple first blocks) at the determined dividing positions a**1**, a**2**, and a**4**. The processing unit **12** transmits to the device **20** the hash value (first hash value) for each of the blocks B**11**, B**12**, B**22**, and B**23** and the information on the dividing positions a**1**, a**2**, and a**4**, The hash values of the blocks B**11**, **812**, B**22**, and **823** are hash values h**1**, h**2**, h**3**, and h**4**.

[0039] The device **20** receives the hash value for each of the blocks B**11**, B**12**, B**22**, and B**23** and the information on the dividing positions a**1**, a**2**, and a**4**. The memory of the device **20** stores third data D**3** which is yet to be transmitted to the data collection device **10** and is the next transmission target. The size of the third data D**3** is the same as the size of the second data D**2**. The device **20** divides the third data D**3** into blocks B**11**, B**12**, B**31**, and B**23** (multiple second blocks) based on the information on the dividing positions a**1**, a**2**, and a**4**. The device **20** obtains the hash value (second hash value) for each of the blocks B**11**, B**12**,**1331**, and B**23**. The hash values of the blocks B**11**, **812**, B**31**, and **823** are hash values hi, h**2**, h**5**, and h**4**, respectively. The device **20**

transmits to the data collection device **10** the block **831** corresponding to the hash value h**5** different from the received hash values h**1**, h**2**, h**3**, and h**4** among the hash values h**1**, h**2**, h**5**, and h**4**. Here, for example, the device **20** transmits to the data collection device **10** the identification information on the block position of the block B**31** in the third data D**3**.

[0040] For example, among the blocks B**11**, B**12**, B**31**, and B**23**, the processing unit **12** receives from the device **20** only the block B**31** corresponding to the hash value h**5** different from the hash values h**1**, h**2**, h**3**, and h**4** transmitted to the device **20**. For example, the processing unit **12** receives the block position identification information on the third data D**3** from the device **20** together with the block B**31**, and obtains, based on the identification information, the third data D**3** by changing the block B**22**, among the blocks B**11**, B**12**, B**22**, and B**23**, to the block B**31**.

[0041] As above, by changing the data dividing positions, the data collection device **10** may reduce the data transfer volume.

[0042] For example, it is conceivable not to change the dividing positions a**2**, a**2**, and a**3** of the original transmission target data. However, in the case of the example of FIG. **1**, when the data of the dividing positions a**2** to a**3** of the third data D**3** is transmitted to the device **20** even though the difference of the third data D**3** as compared with the second data D**2** is a section of the dividing positions a**2** to a**4**, redundant data transmission is performed for the section from the address a**4** to the dividing position a**3**.

[0043] On the other hand, for example, the data collection device **10** updates the dividing positions a**1**, a**2**, and a**3** to the dividing positions a**1**, a**2**, and a**4** according to the comparison between the first data D**1** and the second data D**2**. For this reason, in the example of FIG. **1**, it is possible to avoid transmitting to the device **20** the section of the dividing positions a**4** to a**3** in the third data D**3**. In the device **20**, when the change in the update positions in the data in a certain period is relatively small, or when the update positions in the data in a certain period do not change, the data collection method by the data collection device **10** increases the effect of reducing the transfer volume.

Second Embodiment

[0044] Next, a second embodiment will be described.

[0045] FIG. **2** is a diagram illustrating a data collection system according to a second embodiment.

[0046] The data collection system according to the second embodiment includes a server **100** and edges **200**, **300**, **400**, The server **100** is coupled to a network **50**. The network **50** is, for example, a wide area network (WAN). The network **50** is coupled with base stations **51**, **52**, Each of the base stations **51**, **52**, . . . wirelessly communicates with the edges existing in the area to which the base station belongs. The server **100** and each edge may communicate with each other via the network **50** and a base station in any area.

[0047] The server **100** is a server computer which collects and analyzes data acquired by the edges **200**, **300**, **400**, . . . from the edges **200**, **300**, **400**, ... The server **100** specifies a period and area for which data is to be collected in response to a user analysis request, and collects data related to the specified period and area from the edges **200**, **300**, **400**, ... In the second embodiment, as data acquired by the edges **200**, **300**, **400**, . . . , rainfall data is exemplified. Based on the rainfall data collected from the edges **200**, **300**, **400**, . . . , the server **100** analyzes the rainfall in the areas where the edges **200**, **300**, **400**, . . . exist.

[0048] However, the type of data to be collected may be other than rainfall, and it is possible to consider, for example, various types such as temperature, humidity, wind flow, amount of vibration, atmospheric substance concentration, radiation dose, electromagnetic waves (for example, information converted into an image), or sound. The server **100** is an example of the data collection device **10** according to the first embodiment.

[0049] The edges **200**, **300**, **400**, . . . are moving bodies or devices mounted on the moving bodies. The moving body is a vehicle, an animal, a ship, a flying body, a robot, or the like. Each of the edges **200**, **300**, **400**, . . . includes a raindrop sensor, and acquires rainfall data using the raindrop sensor. The edges **200**, **300**, **400**, . . . have a wireless communication function, and wirelessly communicate with the base stations in the areas where they exist. The edges **200**, **300**, **400**, . . . transmit the acquired rainfall data to the server **100** in response to a request from the server **100**.

[0050] Each of the edges **200**, **300**, **400**, is an example of the device **20** of the first embodiment.

[0051] FIG. **3** is a diagram illustrating an example of hardware of a server.

[0052] The server **100** includes a CPU **101**, a RAM **102**, an HDD **103**, an image signal processing unit **104**, an input signal processing unit **105**, a medium reader **106**, and a network interface card (NIC) **107**. Note that the CPU **101** corresponds to the processing unit **12** of the first embodiment. The RAM **102** or the HDD **103** corresponds to the storage unit **11** of the first embodiment.

[0053] The CPU **101** is a processor that executes program instructions. The CPU **101** loads at least part of the program or data stored in the HDD **103** into the RAM **102** and executes the program. The CPU **101** may include a plurality of processor cores. Alternatively, the server **100** may include a plurality of processors. Processing to be described below may be performed in parallel using a plurality of processors or processor cores. A set of a plurality of processors may be referred to as a "multiprocessor" or simply a "processor".

[0054] The RAM **102** is a volatile semiconductor memory that temporarily stores a program to be executed by the CPU **101** and data to be used for computation by the CPU **101**. The server **100** may include a type of memory other than the RAM, and may include a plurality of memories.

[0055] The HDD **103** is a nonvolatile storage device for storing a software program such as an operating system (OS), middleware, or application software, and data. The server **100** may include a storage device of another type such as a flash memory or a solid state drive (SSD) or may include a plurality of nonvolatile storage devices,

[0056] The image signal processing unit **104** outputs an image to a display **111** coupled to the server **100** in accordance with an instruction from the CPU **101**. As the display **111**, any type of display such as a cathode ray tube (CRT) display, a liquid crystal display (LCD), a plasma display, or an organic electro-luminescence (OIL) display may be used.

[0057] The input signal processing unit **105** acquires an input signal from an input device **112** coupled to the server **100**, and outputs the input signal to the CPU **101**. As the input device **112**, a pointing device such as a mouse, a touch panel, a touchpad, or a trackball, a keyboard, a remote

controller, a button switch, or the like may be used. A plurality of types of input devices may be coupled to the server **100**.

[0058] The medium reader **106** is a reading device that reads programs and data recorded in a recording medium **113**. As the recording medium **113**, for example, a magnetic disk, an optical disk, a magneto-optical disk (MO), a semiconductor memory, or the like may be used. The magnetic disk includes a flexible disk (FD) or a hard disk drive (HDD). The optical disc includes a compact disc (CD) or a digital versatile disc (DVD).

[0059] The medium reader **106** copies a program or data read from the recording medium **113** to another recording medium such as the RAM **102** or the HDD **103**. The read program is executed by, for example, the CPU **101**. The recording medium **113** may be a portable recording medium, or may be used to distribute programs or data. The recording medium **113** or the HDD **103** may be referred to as a computer-readable recording medium.

[0060] The NIC **107** is coupled to a network **50** and is an interface that communicates with another computer via the network **50**. The NIC **107** is coupled to a communication device such as a switch or a router belonging to the network **50**, by a cable, for example.

[0061] FIG. **4** is a diagram illustrating an exampleof hardware of an edge.

[0062] The edge **200** Includes a CPU **201**, a RAM **202**, a flash memory **203**, a raindrop sensor **204**, and a wireless unit **205**.

[0063] The CPU **201** is a processor that executes program instructions. The CPU **201** loads at least part of the program or data stored in the flash memory **203** into the RAM **202** and executes the program. The CPU **201** may include a plurality of processor cores. The edge **200** may have a plurality of processors.

[0064] The RAM **202** is a volatile semiconductor memory that temporarily stores a program to be executed by the CPU **201** and data to be used for computation by the CPU **201**.

[0065] The flash memory **203** is a non-volatile memory device that stores a program of software such as firmware, and data.

[0066] The raindrop sensor **204** is a sensor that detects the rainfall around the edge **200**. The raindrop sensor **204** stores the detected rainfall data in the RAM **202** or the flash memory **203**.

[0067] The wireless unit **205** is a wireless communication interface that may be wirelessly coupled to the base stations **51**, **52**, ... The wireless unit **205** communicates with the server **100** via a base station that covers an area where the edge **200** exists.

[0068] When the edge **200** itself moves, the edge **200** has a moving mechanism such as a motor or an engine, which is not illustrated in FIG. **4**.

[0069] The edges **300**, **400**, are also achieved by the same hardware as the edge **200**.

[0070] FIG. **5** is a diagram illustrating a function example of the server.

[0071] The server **100** includes a storage unit **120**, a block division unit **130**, a block update unit **140**, a logical-physical conversion unit **150**, a hash value generation unit **160**, and a data receiving unit **170**. The storage unit **120** is achieved by using a storage area of the RAM **102** or the HDD **103**. The block division unit **130**, the block update unit **140**, the logical-physical conversion unit **150**, the hash value generation unit **160**, and the data receiving unit **170** are achieved by the CPU **101** executing a program stored in the RAM **102**.

[0072] Processing by these functions of the server **100** is executed for each edge. In the following, the processing for the edge **200** is exemplified, but the same processing is performed for the edges **300**, **400**, ...

[0073] The storage unit **120** stores data collected from the edges **200**, **300**, **400**, ...

[0074] The block division unit **130** divides the data stored in the storage unit **120** into a plurality of sections. One section is referred to as a block. The block division unit **130** divides the data into blocks based on the data dividing position information stored in the storage unit **120**.

[0075] The block update unit **140** updates the dividing position information stored in the storage unit **120**. The block size may vary from block to block.

[0076] The logical-physical conversion unit **150** performs conversion from a logical block group to a physical block group. The logical block group is a block group immediately after the data is divided based on the information on the dividing positions (result of division by the block division unit **130**). The physical block group is a block group in which a block group having a difference from the previous data is arranged at the start among the block groups immediately after being divided based on the information on the dividing positions. The logical-physical conversion unit **150** generates a logical-physical conversion table indicating a logical-physical conversion method according to the logical-physical conversion results, and transmits the logical-physical conversion table to the edge **200**. The logical-physical conversion table includes information on the dividing positions.

[0077] The hash value generation unit **160** generates a hash value for each block. The hash value generation unit **160** transmits the generated hash values to the corresponding edge **200**. The edge **200** transmits to the server **100** a block corresponding to a hash value different from the hash value received from the server **100** among the new data to be transmitted, and does not transmit the other blocks of the new data. Together with the block to be transmitted, the edge **200** transmits to the server **100** the block position identification information on the block in the new data.

[0078] The data receiving unit **170** receives the block transmitted by the edge **200**. The data receiving unit **170** obtains new data of the edge **200** by applying the block currently received from the edge **200** to the previously received data. "Applying" indicates that, regarding the block position of the block received this time, the block at the block position of the previous data is replaced with the block received this time.

[0079] The server **100** executes such processing for each edge, and collects data from the edges **200**, **300**, **400**, ...

[0080] FIG. **6** is a diagram illustrating a function example of the edge.

[0081] The edge **200** includes a storage unit **220**, a preprocessing unit **230**, a block division unit **240**, a logical-physical conversion unit **250**, a hash value generation unit **260**, and a sending processing unit **270**. The storage unit **220** is achieved by using a storage area of the RAM **202** or the flash memory **203**. The preprocessing unit **230**, the block division unit **240**, the logical-physical conversion unit **250**, the hash value generation unit **260**, and the sending pro-

cessing unit **270** are achieved by the CPU **201** executing a program stored in the RAM **202**.

[0082] The storage unit **220** stores original data, preprocessed data, and a logical-physical conversion table including information on dividing positions received from the server **100**, and the like. The original data is data to be subjected to a predetermined preprocess at the edge **200**, and is, for example, rainfall data acquired at one-second intervals. The preprocess is a process that is performed on the original data before data transmission to the server **100**, and is, for example, processing for obtaining the average rainfall at one-minute intervals from the rainfall data acquired at one-second intervals. The preprocessed data is data generated by the preprocess.

[0083] The preprocessing unit **230** performs a preprocess on the original data stored in the storage unit **220**. The preprocessing unit **230** stores the preprocessed data in a predetermined area of the storage unit **220** or the RAM **202**.

[0084] The block division unit **240** divides the preprocessed data into a plurality of blocks based on the information on the dividing positions. The result of division by the block division unit **240** is a logical block group.

[0085] The logical-physical conversion unit **250** performs conversion from the logical block group to the physical block group based on the logical-physical conversion table,

[0086] The hash value generation unit **260** generates a hash value for each physical block included in the physical block group.

[0087] The sending processing unit **270** collates the hash value generated by the hash value generation unit **260** with the hash value received from the server **100**, and transmits a physical block having a different hash value to the server **100**.

[0088] The edges **300**, **400**, . . . have the sam e function as the edge **200**.

[0089] FIGS. **7**A and **7**B are each a diagram illustrating an example of a difference portion.

[0090] FIG. **7**A illustrates an example in which a difference portion exists at the boundary of a block dividing position between the previous data transmitted by the edge **200** and the current data. In the example of FIG. **7**A, a difference portion exists at the boundary between the blocks **502** and **503** among the four blocks **501**, **502**, **503**, and **504**.

[0091] When the block size is not changed, the whole of each of the blocks **502** and **503** is transmitted from the edge **200** to the server **100** in the example of FIG. **7**A. However, the blocks **502** and **503** each include a portion already acquired by the server **100** other than the difference portion. Transmission of the portion acquired by the server **100** is redundant data transmission.

[0092] FIG. **75** illustrates an example in which a difference portion exists at a portion inside a single block between the previous data transmitted by the edge **200** and the current data. In the example of FIG. **7**B, a difference portion exists at a portion inside the block **512** among the three blocks **511**, **512**, and **513**.

[0093] When the block size is not changed, the block **512** is transmitted from the edge **200** to the server **100** in the example of FIG. **7**B. However, the block **512** includes a portion acquired by the server **100** other than the difference portion. Transmission of the portion acquired by the server **100** is redundant data transmission.

[0094] In light of the above, the server **100** changes the data dividing positions.

[0095] FIGS. **8**A and **85** are each a diagram illustrating an example of dividing position update.

[0096] FIG. **8**A illustrates an example of dividing position update when a difference portion exists at a portion inside a single block. In the example of FIG. **8**A, a difference portion exists at a portion inside the block **523** among the blocks **521**, **522**, **523**, and **524** corresponding to the data dividing positions b**1**, b**2**, and b**3**. In this case, the block update unit **140** updates the dividing positions of the data to dividing positions b**1**, b**4**, and b**5**. The data is divided into blocks **531**, **532**, **533**, and **534** at the dividing positions b**1**, b**4**, and b**5**. Among these, the block **533** for the dividing positions b**4** to b**5** is a block corresponding to the difference portion inside the block **523**.

[0097] FIG. **8**B illustrates an example of dividing position update when a difference portion exists at the boundary between two blocks. In the example of FIG. **85**, a difference portion exists at the boundary between the blocks **542** and **543** among the blocks **541**, **542**, **543**, and **544** corresponding to the data dividing positions b**6**, b**7**, and b**8**. In this case, the block update unit **140** updates the dividing positions of the data to, for example, dividing positions b**9** and b**10**. The data is divided into blocks **551**, **552**, and **553** at the dividing positions b**9** and b**10**. Among these, the block **552** for the dividing positions b**9** to b**10** is a block corresponding to the difference portion at the boundary between the blocks **542** and **543**.

[0098] There may be a plurality of relatively small difference portions in one dataset as a transmission target In this case, when each of the plurality of small difference portions is made into a block, the number of collations of hash values for the blocks on the edge side increases, or the number of transmissions of the transmission target blocks is easily performed, and data collection by the server **100** is delayed. Thus, the server **100** executes logical-physical conversion processing that combines the relatively small difference portions into one.

[0099] FIG. **9** is a diagram illustrating an example of logical-physical conversion.

[0100] The server **100** receives data corresponding to a logical block group **601** from the edge **200**. The logical block group **601** is a logical block group before the dividing positions are changed. FIG. **9** illustrates addresses p**1** to p**13** for the logical block group **601** and the physical block group **602**. Among these, the data is divided into four logical blocks according to three dividing positions of addresses p**4**, p**7**, and p**10**. The logical block group **601** includes these four logical blocks.

[0101] The sections of the addresses p**2** to p**3** is the first difference portion of the data currently acquired as compared with the data acquired previously from the edge **200**. The section of the addresses p**5** to p**6** is the second difference portion of the data currently acquired as compared with the data acquired previously from the edge **200**. The section of the addresses p**8** to p**9** is the third difference portion of the data currently acquired as compared with the data acquired previously from the edge **200**. The section of the addresses p**11** to p**12** is the fourth difference portion of the data currently acquired as compared with the data acquired previously from the edge **200**.

[0102] The physical block group **602** is a physical block group before the dividing positions are changed, and is the same block group as the logical block group **601**.

[0103] The server **100** changes the logical block group **601** to the logical block group **603** by changing the dividing positions so that the above four difference portions are made into a single logical block. Here, a logical block having a logical block ID (IDentifier) "x" is expressed as "logical block x". A physical block having the same content as the logical block x may be expressed as "physical block x".

[0104] The logical block group **603** has nine logical blocks of logical blocks a, b, c, d, e, f, g, h, and i in the order of addresses. The logical block a corresponds to the section of the addresses p**1** to p**2**. The logical block b corresponds to the difference portion of the addresses p**2** to p**3**. The logical block c corresponds to the section of the addresses p**3** to p**5**. The logical block d corresponds to the difference portion of the addresses p**5** to p**6**. The logical block e corresponds to the section of the addresses p**6** to p**8**. The logical block f corresponds to the difference portion of the addresses p**8** to p**9**, The logical block g corresponds to the section of the addresses p**9** to p**11** The logical block h corresponds to the difference portion of the addresses p**11** to p**12**.

[0105] For example, assume that the size of each of the logical blocks b, d, f, and h is less than a predetermined threshold value. In this case, the server **100** generates a logical-physical conversion table T**1** so as to generate a physical block group **604** in which the logical blocks b, d, f, and h are aggregated at the start of the data to form a single block. The physical block group **604** has a total of six physical blocks including the start physical block obtained by gathering the logical blocks b, d, f, and h into a single block, and the subsequent physical blocks a, c, e, g, and i. The server **100** generates a logical-physical conversion table T**1** that specifies a method of conversion from the logical block group **603** to the physical block group **604**.

[0106] Moreover, the server **100** inputs the physical blocks included in the physical block group **604** to a predetermined hash function, and obtains a hash value group **605**. The hash value group **605** includes hash values hs, ha, hc, he, hg, and hi.

[0107] The hash value hs is a hash value of the physical block obtained by gathering the logical blocks b, d, f, and h into a single block. The hash value ha is a hash value of the physical block a. The hash value hc is a hash value of the physical block c. The hash value he is a hash value of the physical block e. The hash value hg is a hash value of the physical block g. The hash value hi is a hash value of the physical block i.

[0108] The server **100** transmits the hash value group **605** and the logical-physical conversion table T**1** to the edge **200**. The edge **200** receives the hash value group **605** and the logical-physical conversion table T**1**.

[0109] The edge **200** holds preprocessed data **701**. The edge **200** divides the preprocessed data **701** into a logical block group based on the logical-physical conversion table T**1**. The logical block group includes logical blocks a, b, c, j, e, k, g, h, and i in the order of addresses. The logical block j is a logical block corresponding to the block position of the logical block d. The logical block k is a logical block corresponding to the block position of the logical block f.

[0110] The edge **200** performs logical-physical conversion on the logical blocks a, b, c, j, e, k, g, h, and i based on the logical-physical conversion table T**1**, and generates a physical block group **702**. The physical block group **702** has a total of six physical blocks including the start physical block obtained by gathering the logical blocks b, j, k, and h into a single block, and the subsequent physical blocks a, c, e, g, and i.

[0111] The edge **200** inputs the physical blocks included in the physical block group **702** to the same hash function as the hash function that the server **100** has, and obtains a hash value group **703**. The hash value group **703** includes hash values ht, ha, hc, he, hg, and hi. The hash value ht is a hash value of the physical block obtained by gathering the logical blocks b, j, k, and h into a single block.

[0112] The edge **200** compares the hash values of the hash value group **703** with the hash values of the hash value group **605**. The hash values ha, hc, he, hg, and hi are included in both the hash value groups **605** and **703**. The hash value ht is not included in the hash value group **605**. Therefore, the edge **200** transmits to the server **100** the physical block (physical block **702***a*) obtained by gathering the logical blocks b, j, k, and h into a single block, and does not transmit the physical blocks a, c, e, g, and i to the server **100**.

[0113] As described above, by executing the logical-physical conversion processing that combines relatively small difference portions into one, the server **100** may reduce the number of comparisons of hash values and the number of transmissions of data, suppress delay in data collection by the server **100**, and improve data collection efficiency.

[0114] FIG. **10** is a diagram illustrating an example of a logical-physical conversion table.

[0115] The logical-physical conversion table T**1** is generated by the logical-physical conversion unit **150** and stored in the storage unit **120**. A duplicate of the logical-physical conversion table T**1** is provided from the server **100** to the edge **200** and stored in the storage unit **220**. The logical-physical conversion table T**1** includes items of physical block ID, logical block ID, logical address, physical address, and size.

[0116] A physical block ID is registered in the item of physical block ID. A logical block ID is registered in the item of logical block ID. In the item of logical address, a logical address indicating the start position of the corresponding logical block in the data (logical block group) is registered. In the item of physical address, a physical address indicating the start position of the corresponding physical block in the data (physical block group) after logical-physical conversion is registered. In the item of size, the size of the corresponding logical block is registered. The unit of size is, for example, bytes (bytes).

[0117] For example, in the logical-physical conversion table T**1**, a record is registered having a physical block ID "**0**", a logical block ID "b", a logical address "0xaaaabbbb", a physical address "0x00000000", and a size "**16**". This record indicates that a logical block with the logical block ID "b" (logical block b) belongs to the physical block with the physical block ID "**0**", the logical address of the logical block b is "0xaaaabbbb", the physical address after logical-physical conversion is "0x00000000", and the size is 16 bytes.

[0118] In the logical-physical conversion table. T**1**, for other blocks as well, records indicating the correspondence between logical blocks and physical blocks are registered. According to the example of the logical-physical conversion table T**1**, the logical blocks b, j, k, and h belong to the physical block with the physical block ID "**0**". The logical block a belongs to the physical block with the physical block

ID "1". The logical block c belongs to the physical block with the physical block ID "2".

[0119] Immediately before the server **100** starts collecting data from the edge **200**, the setting values of the items of physical block ID and physical address may be the same as the setting values (initial values) of the items of logical block ID and logical address. The items of logical block ID and logical address correspond to the information on the dividing position of the blocks (logical blocks).

[0120] Next, processing procedures of the server **100** and the edge **200** according to the second embodiment will be described. The edges **300**, **400**, . . . perform the same procedures as the edge **200**. The server **100** executes the same procedures as those for the edge **200** also for the edges **300**, **400**, ...

[0121] FIG. **11** is a flowchart illustrating an example (part **1**) of edge side data transmission processing.

[0122] Assume that the edge **200** holds information on the initial block dividing positions in the storage unit **220**. When receiving the first data from the edge **200**, due to the absence of previous data, the server **100** divides the first data into logical blocks based on the information on the initial block dividing positions, calculates the hash value for each logical block, and transmits the hash values to the edge **200**. The procedures of FIG. **11** are started when the server **100** receives the first data from the edge **200** and then the edge **200** receives the hash value for each logical block in the first data from the server **100**.

[0123] (S**10**) The preprocessing unit **230** performs a preprocess on the current original preprocess target data stored in the storage unit **220**, and generates preprocessed data.

[0124] (s**11**) The block division unit **240** specifies the dividing positions for the preprocessed data based on the block dividing position information of the logical-physical conversion table stored in the storage unit **220**.

[0125] (S**12**) The block division unit **240** divides the preprocessed data into block units at the specified dividing positions. Initially, as the physical block ID and the physical address, the logical-physical conversion table has the same setting values as the logical block ID and the logical address. For this reason, the logical-physical conversion unit **250** does not have to perform logical-physical conversion. However, the logical-physical conversion unit **250** may perform logical-physical conversion. Even when logical-physical conversion is performed, the logical block group and the physical block group after logical-physical conversion are the same.

[0126] (S**13**) The hash value generation unit **260** calculates a hash value for each of the block units divided in step S**12**, and compares it with the hash value received from the server **100**.

[0127] (S**14**) The sending processing unit **270** transmits blocks having different hash values (logical block =physical block in the example of FIG. **11**) to the server **100**. Here,. the sending processing unit **270** also transmits the logical block IDs of the corresponding logical blocks (logical block ID =physical block ID in the example of FIG. **11**) to the server **100**, The edge **200** ends the above data transmission processing.

[0128] FIG. **12** is a flowchart illustrating an example of server side data request transmission processing.

[0129] When the server **100** receives a block from the edge **200**, the server **100** starts the following procedures.

[0130] (S**20**) The block update unit **140** executes block unit update processing based on the previous data acquired from the edge **200** and the current data. Details of the block unit update processing will be described later.

[0131] Based on the logical-physical conversion table and the physical block ID received from the edge **200**, the block update unit **140** specifies the block position of the difference portions as compared with the previous data. The block update unit **140** obtains the current data regarding the edge **200** by replacing the block position with the block currently acquired (the block currently acquired from the edge **200**).

[0132] (S**21**) The logical-physical conversion unit **150** executes logical-physical conversion processing. The logical-physical conversion unit **150** generates a logical-physical conversion table T**1** by logical-physical conversion processing. Details of the logical-physical conversion process will be described later.

[0133] (S**22**) The hash value generation unit **160** transmits the hash value for each physical block and the logical-physical conversion table T**1** to the edge **200**. The hash value generation unit **160** then ends the data request transmission processing.

[0134] As exemplified in step S**20**, when receiving a block, the server **100** receives from the edge **200** identification information (for example, a physical block ID or a logical block ID) indicating the position of the block in the current data held by the edge **200**. Based on the identification information, the server **100** obtains the current data by replacing some blocks of the previous data with the blocks currently received.

[0135] FIG. **13** is a flowchart illustrating an example of block unit update processing.

[0136] The block unit update processing corresponds to step **521**,

[0137] (S**30**) The block update unit **140** compares the previous data acquired from the edge **200** with the current data, and acquires a difference portion (logical address range).

[0138] (S**31**) The block update unit **140** repeatedly executes step S**32**, steps S**32** to S**34**, or steps S**32**, S**33**, and S**35** for each difference portion.

[0139] (S**32**) The block update unit **140** determines whether or not the difference portion matches the current block unit in the logical-physical conversion table. When they match, the processing proceeds to step S**36**. When they do not match, the processing proceeds to step S**33**, The current block unit is represented by a logical address range indicated by the logical address and size set in the current logical-physical conversion table.

[0140] (S**33**) The block update unit **140** determines whether or not the difference portion is a portion in a logical block. When the difference portion is a portion in the logical block, the processing proceeds to step S**34**. When the difference portion is not a portion of the logical block, the processing proceeds to step S**35**. Step S**33** No corresponds to the case where the difference portion straddles two logical blocks.

[0141] (S**34**) The block update unit **140** reduces the block unit in size to a range corresponding to the difference portion, and increases the block lengths on both sides. The details are as illustrated in FIG. **8**A. The processing proceeds to step S**36**.

[0142] (S**35**) The block update unit **140** sets the difference portion as a new block unit. In this case, for example, the

block lengths of the adjacent blocks (the blocks adjacent to the portions obtained by subtracting the difference portion from the corresponding blocks) are increased. The details are as illustrated in FIG. **8**B. The processing proceeds to step S**36**.

[0143] (S**36**) The block update unit **140** completes the repetition when the processing for all the difference portions acquired in step S**30** is completed. The block update unit **140** then ends the block unit update processing.

[0144] FIG. **14** is a flowchart illustrating an example of logical-physical conversion processing.

[0145] (S**40**) The logical-physical conversion unit **150** repeatedly executes Step S**41** or Steps S**41** and S**42** for the logical blocks of each difference portion.

[0146] (S**41**) The logical-physical conversion unit **150** determines whether or not the block size of the corresponding logical block is equal to or less than a threshold value. When the block size is equal to or less than the threshold value, the processing proceeds to step S**42**. When the block size is greater than the threshold value, the processing proceeds to step S**43**. The threshold value for block size is preset in the storage unit **120** or the like. The block size threshold value is, for example, about **5** to **10**% of the size of data to be transmitted by the edge **200**. Note that any size may be set as the threshold value for block size,

[0147] (S**42**) The logical-physical conversion unit **150** marks the corresponding logical block as a collection target. For example, the logical-physical conversion unit **150** records the logical block ID of that logical block as a collection target logical block in an area other than the logical-physical conversion table in the storage unit **120**. Alternatively, the logical-physical conversion unit **150** may provide a setting item for a flag in the logical-physical conversion table, and mark the flag with "True" (collection target) and "False" (not collection target). The processing proceeds to step S**43**.

[0148] (S**43**) When the processing for all the logical blocks in a difference portion is finished, the logical-physical conversion unit **150** completes the repetition, and the processing proceeds to step S**44**,

[0149] (S**44**) The logical-physical conversion unit **150** moves the logical block marked in step S**42** to the start of the physical address.

[0150] (S**45**) The logical-physical conversion unit **150** sets the moved logical block group as one new physical block.

[0151] (S**46**) The logical-physical conversion unit **150** generates a logical-physical conversion table T**1** in which the physical block ID and the physical block address are set so that the unmarked logical blocks follow the physical block created in step S**45** in the order of logical addresses. The logical-physical conversion unit **150** outputs the generated logical-physical conversion table T**1** to the storage unit **120**. The logical-physical conversion unit **150** then ends the logical-physical conversion processing.

[0152] As described above, the server **100** divides the acquired data into a plurality of logical blocks when there are difference portions having a size less than the threshold value, and then generates, from the plurality of logical blocks, a plurality of physical blocks (a plurality of additional blocks) including one block obtained by gathering the difference portions (logical blocks) having a size less than the threshold value at the start. The server **100** transmits to the edge **200** the hash value for each block included in the plurality of physical blocks, the information on the dividing positions, and the conversion information used for conversion from a plurality of logical blocks to a plurality of physical blocks (information on the correspondence between logical addresses and physical addresses).

[0153] FIG. **15** is a flowchart illustrating an example (part **2**) of the edge side data transmission process.

[0154] The procedures of FIG. **15** are executed when the logical block. ID and the physical block ID are different in the logical-physical conversion table T**1** currently received by the edge **200** from the server **100** together with the hash values.

[0155] (S**50**) The preprocessing unit **230** performs a preprocess on the current original preprocess target data stored in the storage unit **220**, and generates preprocessed data.

[0156] (S**51**) The block division unit **240** specifies the dividing positions for the preprocessed data based on the logical-physical conversion table T**1** stored in the storage unit **220**.

[0157] (S**52**) The block division unit **240** divides the preprocessed data into block units at the specified dividing positions. This generates a logical block group corresponding to the preprocessed data.

[0158] (S**53**) The logical-physical conversion unit **250** uses the logical-physical conversion table T**1** to convert the logical address of each logical block in the logical block group generated in step S**52** into a physical address.

[0159] (S**54**) The hash value generation unit **260** calculates the hash value for each of the physical block units indicated by the logical-physical conversion table T and compares it with the hash value received from he server **100**.

[0160] (S**55**) The sending processing unit **270** transmits physical blocks having different hash values to the server **100**. Here, the sending processing unit **270** also transmits the physical block IDs of the corresponding physical blocks to the server **100**. The edge **200** ends the above data transmission processing.

[0161] The server **100** refers to the logical-physical conversion table Ti, and converts the physical block IDs of the received physical blocks into one or more logical block IDs. The server **100** acquires current data related to the edge **200** by replacing the logical block with the corresponding logical block. ID in the logical block group previously acquired from the edge **200** with the logical block currently acquired from the edge **200** (converted from the physical block).

[0162] As above, by changing the data dividing positions, the server **100** may reduce the data transfer volume.

[0163] For example, it is also conceivable not to change the initially determined block dividing positions. However, in this case, the edge transmits a whole block even when there is a difference in a portion of the block, and it is impossible to sufficiently reduce the data transfer volume.

[0164] In light of the above, the server **100** dynamically updates the block dividing positions according to the comparison between the data previously acquired from the edge **200** and the data currently acquired. For this reason, when there is a relatively high possibility of an update in a portion of a block, it is possible to suppress redundant transfer of data other than the updated portion. For example, it is possible to improve the efficiency of difference detection by physically gathering relatively small blocks with a high possibility of update to obtain a hash value, In the edge, when the change in the update positions in the data in a certain period is relatively small, or when the update positions in the data in a certain period do not change, the data

collection method by the server **100** increases the effect of reducing the transfer volume.

[0165] Even when each edge has relatively low performance (for example, the memory capacity on the edge side is small and capable of holding only the data for next transmission), or when the communication band between the base stations **51**, **52** and each edge is narrow, it is possible to suppress the data transfer volume from the edge and efficiently collect data.

[0166] The information processing according to the first embodiment may be achieved by causing the processing unit **12** to execute a program. The information processing according to the second embodiment may be achieved by causing the CPU **101** to execute a program. The program may be recorded in the recording medium **113** that is computer-readable.

[0167] For example, the program may be delivered by distributing the recording medium **113** having the program recorded thereon. Alternatively, the program may be stored in another computer and distributed via a network. For example, the computer stores (installs) a program recorded on the recording medium **113** or a program received from another computer in a storage device such as the RAM **102** or the HDD **103**, and reads and executes the program from the storage device.

[0168] All examples and conditional language provided herein are intended for the 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 one or more 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 non-transitory computer-readable recording medium storing a program that causes a computer to execute a process, the process comprising:

comparing first data previously acquired from a data transmission source device and second data currently acquired from the data transmission source device to specify a difference portion of the second data as compared with the first data;

determining a dividing position of the second data so that the difference portion is made into a single block;

dividing the second data into a plurality of first blocks at the determined dividing position;

transmitting, to the data transmission source device, a first hash value for each of the plurality of first blocks and information on the dividing position; and

receiving, from the data transmission source device, the second block corresponding to a second hash value different from the first hash value for each of the plurality of first blocks, among second blocks obtained by dividing third data held by the device based on the information on the dividing position.

2. The recording medium according to claim **1**, wherein the third data is acquired by

when receiving the second blocks, receiving from the data transmission source device identification information indicating positions of the second blocks in the third data, and

replacing a block at a position in the second data indicated by the identification information with a corresponding one of the second blocks.

3. The recording medium according to claim **1**, wherein the transmitting includes:

dividing the second data into the plurality of first blocks when there are difference portions having a size less than a threshold value;

generating, from the plurality of first blocks, a plurality of additional blocks including one block obtained by gathering difference portions having a size less than the threshold value at a start; and

transmitting, to the data transmission source device, a third hash value for each of the blocks included in the plurality of additional blocks, the information on the dividing position, and conversion information used for conversion from the plurality of first blocks to the plurality of additional blocks.

4. The computer-readable recording medium according to claim **1**, wherein the acquiring the second data includes:

transmitting, to the data transmission source device, a hash value of each of a plurality of third blocks included in the first data;

receiving, from the data transmission source device, a fourth block corresponding to a hash value different from the hash value of each third block, among a plurality of fourth blocks included in the second data; and

applying the received fourth block to the first data.

5. A data collection device comprising:

a memory; and

a processor coupled to the memory and configured to;

compare first data previously acquired from a data transmission source device and second data currently acquired from the data transmission source device to specify a difference portion of the second data as compared with the first data,

determine a dividing position of the second data so that the difference portion is made into a single block,

divide the second data into a plurality of first blocks at he determined dividing position,

transmit, to the data transmission source device, a first hash value for each of the plurality of first blocks and information on the dividing position, and

receive, from the data transmission source device, the second block corresponding to a second hash value different from the first hash value for each of the plurality of first blocks, among second blocks obtained by dividing third data held by the device based on the information on the dividing position.

6. A data collection method executed by a processor included in a computer, the data collection method comprising;

comparing first data previously acquired from a data transmission source device and second data currently acquired from the data transmission source device to specify a difference portion of the second data as compared with the first data;

determining a dividing position of the second data so that the difference portion is made into a single block;

dividing the second data into a plurality of first blocks at the determined dividing position;

transmitting, to the data transmission source device, a first hash value for each of the plurality of first blocks and information on the dividing position; and

receiving, from the data transmission source device, the second block corresponding to a second hash value different from the first hash value for each of the plurality of first blocks, among second blocks obtained by dividing third data held by the device based on the information on the dividing position.

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