

DESCRIPTION

Title of Invention: SATELLITE TIME DISTRIBUTION SYSTEM

Technical Field

[0001]

The present invention relates to a technology for distributing time information using a geostationary satellite.

Background Art

[0002]

Lately the importance of a time authentication service is increasing because of the spread of the Internet and the digitization of information. The time authentication service is called a "time business", and is used as a time stamp to prove the accuracy and reliability (effectiveness) of time when electronic data is created and the transaction time on the net. In a system which issues such a time stamp, a clock of the system itself must record an accurate time (that is, time synchronizing with the standard time) in order to ensure the reliability of the time stamp. A clock built into a standard computer system, however, is not very reliable, and it is inevitable that time starts to shift during use over a period of time. Therefore it is necessary to obtain accurate and highly reliable time information from an external time distribution service, and set the time (calibrate the internal clock) regularly based

on this information. Recently it is common that various apparatuses used in companies and homes are networked and mutually operated by digital controls, and to implement such synchronous control, accurate time setting of each apparatus is desired.

[0003]

For the time distribution service, a standard wave (long wave JJY) distribution service, and a service using such a bi-directional network as an NTP (Network Time Protocol) server have been used. A method of setting time using a GPS satellite signal is also known. However a problem of using the method of using a standard wave is the propagation delay of radio waves, which is generated according to the distance from the transmitting station. In the case of using a GPS satellite signal, the radio wave could fluctuate due to the distance from the satellite, due to weather and the like. In the case of an NTP server as well, a propagation delay is generated in the network, and the delay time fluctuates considerably depending on the network load. A method of eliminating error and fluctuation by averaging the time information is available, but the accuracy to be obtained is limited. Furthermore, time setting cannot be performed for many clients at the same time, since this is a client/server system.

[0004]

There once were TV receivers and video recorders which use the time signal of NHK during analog broadcasting for

the time setting of the internal clock. However as analog broadcasting shifts to terrestrial digital broadcasting, a broadcast signal could no longer be used to synchronize time. Theoretically, in terrestrial digital broadcasting, information cannot be distributed in real-time, and about a one to several second delay is inevitable due to a delay by transmission/relay lines, delay by encoding at the transmission side and decoding at the reception side, delay by a multiplexing apparatus, and the like. According to the standards of terrestrial digital broadcasting, broadcasting companies are required to transmit time information called TOT (Time Offset Table) multiplexed with the broadcast waves. However TOT guarantees only a degree of accuracy within "a $\pm$ 500 msec. error range from JST (Japanese Standard Time) when time is input to a standard receiver". Further, the error disperses depending on the broadcasting company, performance of the receiver, and a number of relays (typically a distance from Tokyo). As a consequence, it is difficult to use TOT for time information for which high reliability is required.

[0005]

In PTL 1, a system which distributes time information using a geostationary satellite is proposed. According to this system, a control station transmits a system timing signal to a satellite and receives a returned signal thereof, whereby a path delay from the transmission to the reception is measured, and the delay time is transmitted to

each receiving apparatus as a time correction coefficient signal. Then each receiving apparatus corrects the clock based on the time correction coefficient signal and the system timing signal reception time in the local station. The propagation time from the satellite to the receiving apparatus may differ depending on the position of the receiving apparatus, but this problem is solved in this system by storing the distance correction coefficient for each receiving apparatus. With this method, however, the distance correction coefficient must be set for each receiving apparatus, and professional skill is required for this installation and setting operation, and the operation itself is complicated. This problem becomes more serious as the number of receiving apparatuses increases, and could inhibit the widespread use of the system. Another problem of this method is that highly accurate time information cannot be distributed to an indefinite number of receiving apparatuses (receiving apparatuses in which the distance correction coefficient is not set).

Citation List

Patent Literature

[0006]

PTL1: Japanese Patent Application Laid-Open No. 2004-7418

Summary of Invention

Technical Problem

[0007]

With the foregoing in view, it is an object of the present invention to provide a technology for distributing accurate and highly reliable time information via a geostationary satellite. It is another object of the present invention to provide a convenient and highly flexible time distribution system which can simplify installation and setting operations of a receiving apparatus.

Solution to Problem

[0008]

To achieve the above object, a satellite time distribution system according to the present invention adopts the following configuration. That is, the present invention is a satellite time distribution system for distributing time information to receiving apparatuses via a geostationary satellite, including: a reference clock which generates time to be a reference; transmitting means for generating time information by adding an ID to a time obtained from the reference clock, encrypting the time information and transmitting the encrypted time information via the geostationary satellite; receiving means for receiving the time information returned from the geostationary satellite; delay calculating means for measuring a reception time of the time information based on

a time of the reference clock, and determining a difference between the time included in the time information and the measured reception time as delay time; and delay time information transmitting means for generating delay time information by adding, to the delay time, a same ID as the ID included in the time information, and transmitting the delay time information to the receiving apparatuses.

[0009]

According to this configuration, time required from a point when the reference clock generated time to a point when the receiving means receives the information via the satellite (delay time) can be measured accurately. The delay time measured here includes all the factors related to path delays, such as time required for such signal processing as ID addition and encryption, time required for transmitting signals in the system, propagation time from the transmitting means to the satellite, time required for relaying in the satellite, and propagation time from the satellite to the receiving means. According to this configuration, even if the reference time source, which generates a time to be a reference, and the transmitting means are geographically distant and a terrestrial line is used, the delay time, including the fluctuation in the line, can be measured in real-time.

[0010]

Therefore only if each of the receiving apparatuses can receive delay time information immediately after the

time information and add the delay time to the time included in the time information, then an accurate reception time (that is, reception time in the time system of the reference clock) can be calculated, considering all the above mentioned various path delays. If a difference is detected between the reception time calculated here and a reception time measured by the time system of the internal clock of the receiving apparatus, the internal clock of the receiving apparatus can be adjusted so as to cancel the difference to zero. As a result, time of the receiving apparatus can be set at high precision.

[0011]

Here if the difference between the distance from the satellite to this system and the distance from the satellite to a receiving apparatus is extremely small, the delay time differences can be regarded as the same. However as the difference between these distance values increases, the difference of the delay time values can no longer be ignored, and this difference could drop the accuracy of the time setting.

[0012]

Therefore it is preferable that the satellite time distribution system further has correction information transmitting means for transmitting, via the geostationary satellite, correction information for correcting a delay time difference generated by a difference in geographical position between the receiving apparatuses. The difference

in geographical position may include not only a difference in two-dimensional (plane) position, but also a difference in three-dimensional (altitude) position.

[0013]

According to this configuration, the receiving apparatus can correct the delay time difference due to the difference in geographical position using the received correction information, and can set time more accurately. Further, according to the present invention, the correction information is distributed from the system side, hence this information need not be set in the receiving apparatus in advance. As a consequence, the installation and setting operation of the receiving apparatus can be simplified.

[0014]

It is preferable that the correction information transmitting means obtains the correction information for each of the receiving apparatuses, or for each area where each of the receiving apparatuses is installed, and transmits the correction information along with limiting information to limit receiving apparatuses capable of accessing the correction information or areas where the correction information can be used.

[0015]

Due to this, highly accurate distance correction according to the geographical position of each receiving apparatus or each area can be performed, and accuracy of time setting can be further improved. In the case of the

present invention, the correction information, to which limiting information is attached, is distributed, therefore individual control for each receiving apparatus or for each area is implemented, while utilizing the advantage of broadcasting based on satellite distribution.

[0016]

In order to individually control for each receiving apparatus as mentioned above, the system must know the installed location of each receiving apparatus, but this can be implemented by registering the installation address of the receiving apparatus when a procedure to subscribe to the time distribution service is performed, and managing the apparatus ID and address (or such information as an area code) for each receiving apparatus in a data base inside the system. It is for certain preferable to store the values of the correction information for each receiving apparatus in this data base.

[0017]

It is preferable that the time information and the delay time information are multiplexed in a data communication area of satellite broadcasting and then distributed, and each of the receiving apparatuses is a broadcasting receiver which can receive satellite broadcasting, and sets the time of an internal clock using the time information and the delay time information.

[0018]

By this configuration, highly accurate time setting

can be implemented for an internal clock of a broadcasting receiver (e.g. tuner, video recorder, TV set), and the start and end control of program watch reservation, recording reservation and the like can be performed accurately.

[0019]

The present invention can be seen as a satellite time distribution system that includes at least a part of the above mentioned configuration, or a satellite time distribution method that includes at least a part of the above mentioned processing. The present invention can also be seen as a program for having a computer execute at least a part of the above mentioned processing, or a computer-readable recording medium in which this program is recorded.

Advantageous Effects of Invention

[0020]

According to the present invention, accurate and highly reliable time information can be distributed via a geostationary satellite. Since correction information is distributed from the system, the installation and setting operation of the receiving apparatus is simple, and a convenient and highly flexible time distribution system can be provided.

Brief Description of Drawings

[0021]

[Fig. 1] A block diagram depicting a configuration of a satellite time distribution system according to a first embodiment

[Fig. 2] A flow chart depicting the processing flow of a time distribution service

[Fig. 3] A flow chart depicting the processing flow of a time audit service

[Fig. 4] A block diagram depicting a configuration of a satellite time distribution system according to a second embodiment

[Fig. 5] A block diagram depicting a configuration of a satellite time distribution system according to a third embodiment

Description of Embodiments

[0022]

A satellite time distribution system according to an embodiment of the present invention will now be described in detail with reference to the drawings.

[0023]

<First embodiment>

Fig. 1 is a block diagram depicting a configuration of the satellite time distribution system. The satellite time distribution system 1 of the present embodiment is a system which is used as a TA (Time Authority), which provides a time distribution service and a time audit service for a receiving apparatus 2, which is a TSA (Time Stamping

Authority).

[0024]

The satellite time distribution system 1 is comprised of an atomic clock (reference clock) 10 which generates a reference time, a time distribution audit server 11, an encryption server 12, an IP encapsulator 13, a transmission antenna 14, a receiver 15, a receiving antenna 16 and a time authentication server 17. A receiving apparatus 2, on the other hand, is comprised of a receiving antenna 20, a receiver 21 and a time authentication server 22. The time distribution audit server 11 of the satellite time distribution system 1 and the receiving apparatus 2 are connected by a terrestrial line, such as the Internet. Security of communication via the geostationary satellite 3 is assured by encryption based on scrambled communication, and security of communication via the terrestrial line is assured by a TSA signature.

[0025]

(Time distribution)

A processing flow of the time distribution service will be described first with reference to Fig. 2.

[0026]

A PPS (pulse per second) signal, which is output from the atomic clock 10, is input to the time distribution audit server 11. The time distribution audit server 11 generates time information by adding a transmission ID using a random value to the time (distribution time T1)

obtained from the atomic clock 10 (step S10). This time information is encrypted by the encryption server 12, and is then encapsulated by the IP encapsulator 13, and is transmitted (uplinked) from the transmitting antenna 14 to the geostationary satellite 3 (step S11). The time information is returned from the geostationary satellite 3 and distributed to the receiving apparatus 2, which is a TSA.

[0027]

When the time information is received via the receiving antenna 20 and the receiver 21, the receiving apparatus 2 inputs the time information to the time authentication server (step S20). The time authentication server 22 decodes the encrypted time information and confirms that this is the time information distributed from the TA, and clocks the reception time T3 based on the time system of the internal clock of the time authentication server 22 itself. The time information (including the distribution time T1 and the transmission ID) and the reception time T3 are stored in a memory of the time authentication server 22 (step S21).

[0028]

In the case of distributing the time information in the above system, about several hundred msec. of a path delay is generated from the point when the system 1 generates the time information to the point when the receiving apparatus receives the time information.

Therefore in order to accurately set the time of the internal clock of the receiving apparatus 2, it is necessary to perform correction considering the path delay. However the path delay is influenced by many factors, including time required for such signal processing as an ID addition, encryption and IP encapsulation, time required for signal transmission in the system, propagation time from the transmitting antenna 14 to the geostationary satellite 3, time required for relaying in the geostationary satellite 3, propagation time from the geostationary satellite 3 to the receiving antenna 16, and time required for signal processing and decoding processing in the reception side, and could also be influenced by environmental fluctuations (e.g. change of propagation time due to weather and temperature, fluctuation of position of satellite, load of signal line), which are generated along these paths. This means that the delay time changes in each time distribution, hence accuracy cannot be expected if a method of correcting the path delay using a fixed correction value is adopted. Therefore in the satellite time distribution system 1 of the present embodiment, an actual delay time is measured at every time distribution, and this delay time information is notified to the receiving apparatus 2, whereby highly accurate correction of the path delay is implemented.

[0029]

In concrete terms, the satellite time distribution

system 1 as well receives the time information, which was returned from the geostationary satellite 3, using the receiving antenna 16, the receiver 15 and the time authentication server 17 (step S12). The time authentication server 17 decodes the time information, and records the reception time T2 based on the time system of the atomic clock 10 (step S13). Then the time authentication server 17 determines the delay time $\Delta t1$ ($= T2 - T1$), by calculating the difference between the recorded reception time T2 and the distribution time T1 included in the time information (step S14), and transmits the determined delay time $\Delta t1$ to the time distribution audit server 11. The delay time $\Delta t1$ measured like this includes all the above mentioned factors related to path delay. It is preferable that the receiving antenna 16, the receiver 15 and the time authentication server 17 have the same configuration as the receiving antenna 20, the receiver 21 and the time authentication server 22 constituting the receiving apparatus 2 respectively. Then the time from the antenna receiving the signal to decoding and recording the reception time can be matched between the system 1 and the receiving apparatus 2, and the delay time $\Delta t1$ can be measured even more accurately.

[0030]

Then the time distribution audit server 11 generates the delay time information by adding a transmission ID, the same as the transmission ID included in the above mentioned

time information, to the delay time Δt_1 (step S15). The delay time information is encrypted by the encryption server 12, then is encapsulated by the IP encapsulator 13, and is transmitted from the transmitting antenna 14 to the geostationary satellite 3, and is distributed to the receiving apparatus 2 (step S16). The distributed time information and delay time information are stored in a memory of the time distribution audit server 11 for a predetermined period.

[0031]

When the delay time information is received via the receiving antenna 20 and the receiver 21, the receiving apparatus 2 inputs this delay time information to the time authentication server 22 (step S22). The time authentication server 22 decodes the delay time information and extracts the transmission ID and the delay time Δt_1 , and then specifies time information having the same transmission ID out of the time information stored in the memory (step S23). If the time information having the same transmission ID is detected, the time authentication server 22 adds the delay time Δt_1 to the distribution time T_1 included in this time information, so as to calculate the time $T_1 + \Delta t_1$ (step S24). The time $T_1 + \Delta t_1$ corresponds to the reception time in the reference time system of the atomic clock 10 (correct reception time).

[0032]

The time authentication server 22 compares the time T_1

+ Δt_1 and the reception time T_3 clocked by the internal clock, and determines the difference thereof (step S25). This difference corresponds to the shift between the internal clock and the reference clock system. If the difference is not zero (or if the difference is greater than a predetermined tolerance), the time authentication server 22 sets the time of the internal clock of the receiving apparatus (step S26). Thereby highly accurate time setting considering the path delay can be implemented. A distribution frequency of the time information and the delay time information is arbitrary, but in order to perform time synchronization of TSA without fail, distribution is executed preferably with a several tens of seconds to several minutes interval.

[0033]

(Time Audit)

Now a processing flow of a time audit service will be described with reference to Fig. 3. The time audit service is a system for auditing whether the time system of the receiving apparatus 2, which is TSA, is accurate for assuring accuracy.

[0034]

In the receiving apparatus 2, which became a target of the time audit, the time authentication server 22 attaches a signature for a TSA certificate in the time audit certificate request information first (step S40). The time audit certificate request information includes at least the

distribution time $T1$ and the transmission ID included in the time information received from the satellite time distribution system 1, and the reception time $T3$ when this time information was received. The time authentication server 22 transmits the time audit certificate request information with the signature to the time distribution audit server 11 of the satellite time distribution system 1 via the terrestrial line.

[0035]

The time distribution audit server 11 records the arrival time of the time audit certificate request information and verifies the signature value, so as to confirm that the time authentication server 22, which transmitted this request, is a terminal registered in the time distribution audit server 11 (step S30). Then the time distribution audit server 11 confirms that the combination of the distribution time $T1$ and the transmission ID included in the time audit certificate request information is the same as those of the time information which the time distribution audit server 11 distributed in the past (step S31). If these confirmations are successful, the time distribution audit server 11 reads the delay time $\Delta t1$ corresponding to the transmission ID from the memory, and adds the delay time $\Delta t1$ to the distribution time $T1$. Then the time distribution audit server 11 compares the time $T1 + \Delta t1$ and the time $T3$, and generates a time audit certificate, attaches the signature

and transmits this time audit certificate with the signature to the time authentication server 22 via the terrestrial line if this difference (deviation of the internal clock of the receiving apparatus 2 and the reference time system) is within a predetermined tolerance (steps S32, S33). If the time difference exceeds the tolerance, the time distribution audit server 11 may return a warning without issuing the time audit certificate, or may transmit a control signal to force-stop the TSA function of the receiving apparatus 2.

[0036]

When a time audit certificate reception completion notice is received from the time authentication server 22 (step S34), the time distribution audit server 11 closes connection with the time authentication server 22. The time authentication server 22, on the other hand, verifies the signature of the issued time audit certificate (steps S42, S43), then stores the information written in the time audit certificate in the memory, and performs appropriate processing (step S44). If the receiving apparatus 2 has a plurality of TSA certificates, the above processing is repeated, and a time audit certificate is issued for each TSA certificate.

[0037]

According to the above described embodiment, the delay time is actually measured and distributed every time the time information is distributed, therefore the path delay

can be accurately corrected, and accurate and highly reliable time synchronization can be implemented. Since a same transmission ID is added to the time information and the delay time information, correspondence of the time information and the delay time information can be easily discerned merely by comparing the transmission IDs. Furthermore, according to this system, the time information is encrypted and distributed, so alteration of the time information can be prevented, and reliability of the distribution time can be improved.

[0038]

<Second Embodiment>

Fig. 4 shows a configuration of a satellite time distribution system according to a second embodiment of the present invention. The second embodiment is characterized in that the system has a redundant configuration as a precaution against troubles and failure of the system.

[0039]

As Fig. 4 shows, the system of the present embodiment is comprised of a first system 1a and a second system 1b. The respective configuration of these systems 1a and 1b is approximately the same as the system of the first embodiment (see Fig. 1), but a difference is that the second system 1b does not have equipment for transmitting information to the geostationary satellite 3 (e.g. transmitting antenna, IP encapsulator, encryption server). Hence the time information and the delay time information

generated in the second system 1b are transmitted to the first system 1a via a terrestrial line, such as the Internet, and are transmitted to the geostationary satellite 3 using the transmission equipment of the first system 1a. By two systems sharing the transmission equipment like this, equipment cost and operation cost can be reduced considerably.

[0040]

The delay time of the terrestrial line, such as the Internet, could fluctuate greatly depending on the load of the network, but the delay time including a path delay on the terrestrial line can be accurately measured by determining the difference between the time when the second system 1b generated the time information (distribution time) and the time when the receiving antenna of the second system 1b received the time information, just like the first embodiment. As a consequence, highly accurate time setting considering the path delay can be implemented, just like the case of the first embodiment.

[0041]

In the present embodiment, the first system 1a and the second system 1b normally execute the time distribution service and the time audit service alternately, but if trouble occurs to one of the systems, this system is shutdown, and the service is continued by the other system alone. Due to this configuration, highly reliable service can be implemented.

[0042]

<Third Embodiment>

Fig. 5 shows a configuration of a satellite time distribution system according to a third embodiment of the present invention. In the first and second embodiments, a case of applying the present invention to TA, which performs time distribution and time audit, was described, but in the third embodiment, a case of applying the present invention to setting the time of the internal clock of a broadcasting receiver is described.

[0043]

A broadcasting receiver (tuner) 4 for receiving a satellite broadcasting is installed on a site of a contractor of a satellite broadcasting. Some broadcasting receivers 4 have a recording reservation function using EPG (Electronic Program Guide), but this function operates depending on the internal clock of the receiver 4, so if the time of the internal clock is not accurate, the beginning or ending of a program could be missed during recording. Therefore in the present embodiment, a method for automatically setting time for many broadcasting receivers, utilizing the simultaneous addressing characteristic of satellite broadcasting, is proposed.

[0044]

As Fig. 5 shows, a broadcasting receiver 4 is installed in various locations throughout Japan. If the geographical position of each receiver is greatly different

like this, a propagation distance from the geostationary satellite 3 to the receiver 4 differs, and the difference of the delay time cannot be ignored. Therefore a satellite time distribution system 1c has a function to transmit correction information for correcting the delay time difference due to the difference in geographical position between the receivers. The rest of the configuration is approximately the same as the system according to the first embodiment, hence mainly the correction information transmission function will be described hereinbelow. Information on time distribution of the time information, delay time information, correction information and the like are multiplexed in the data communication area of the satellite broadcasting and then distributed.

[0045]

In the satellite time distribution system 1c, a data base for storing information on the broadcasting receiver 4 of each contractor is constructed. This data base stores the apparatus ID of the broadcasting receiver 4, installation location information, correction information, and the like. For the installation location, any information can be used if the geographical position of the broadcasting receiver can be specified, such as an area code (code assigned to each area sectioned in advance, such as Minato-Ku Tokyo, or Yokohama City Kanagawa), the address, and latitude/longitude. The apparatus ID and the installation location information can be obtained from the

contractor information received in the satellite broadcasting subscription procedure. The correction information is a parameter for correcting the delay time difference. The correction information (delay time difference) can be theoretically calculated using a standard radio wave propagation speed, if the positional relationship of the system 1c, the broadcasting receiver 4 and the geostationary satellite 3 is known. Strictly speaking, the correction information should be different depending on the receiver, but the correction information may be set in area units if the delay time difference is confined within a tolerance. In the case of Fig. 5, the correction information is calculated for each receiver 4 and is stored in a data base in advance, but the system 1c may calculate the correction information based on the installation location information upon distributing the correction information.

[0046]

The system 1c can transmit the correction information by attaching it to the time information or the delay time information, or can also transmit only the correction information separately from the time information and the delay time information. As mentioned above, the values of the correction information are different depending on the receiver or the area, hence the receiver or the area which can access the correction information must be specified when the correction information is transmitted. In

concrete terms, as Fig. 5 shows, the system 1c attaches an apparatus ID or an area code to the correction information, and transmits. When the correction information is received, the receiver 4 refers to the apparatus ID or the area code to determine if this receiver 4 can access this information, and chooses the information. Since the range where the correction information can be accessed is limited in this way, individual control for each receiver (or for each area) can be implemented.

[0047]

If the delay time difference included in the correction information is Δt_2 , the receiver 4 can determine the reception time (reception time in the reference time system) by the following expression, using the distribution time T_1 included in the time information, the delay time Δt_1 included in the delay time information, and the delay time difference Δt_2 included in the correction information.

$$\text{Reception time} = T_1 + \Delta t_1 + \Delta t_2$$

[0048]

Then just like the first embodiment, the receiver 4 compares the reception time T_3 in the time system of the internal clock with the time $T_1 + \Delta t_1 + \Delta t_2$, and sets the time of the internal clock based on this difference.

[0049]

According to the method of the present embodiment, the path delay can be corrected in real-time considering the delay time difference generated due to the difference in

geographical position between the broadcasting receivers 4 as well, therefore an even more accurate time setting than the previously mentioned embodiment can be implemented. Furthermore, according to the present embodiment, the correction information is distributed from the system, which means that the broadcasting receiver 4 need not set the correction information in advance. Since the complicated operation to calculate and set the correction information (delay time difference) is unnecessary when the broadcasting receiver 4 is installed, the installation and setting operation of the broadcasting receiver 4 is simplified.

[0050]

<Other application fields>

The application range of the present invention is not limited to the above embodiments, but can include application to various systems which require accurate and highly reliable time information. For example, the present invention can be applied to the synchronization control of traffic lights in a traffic system. By synchronizing time in an ETC system or N system, reliability of the time when a vehicle is passing by and time to capture an image can be improved. Also by synchronizing time in a train and subway system, accurate operation can be expected. The present invention can also be applied to systems that distribute time to ships and submarines at sea, or to synchronize time among ships. The present invention can also be applied to

a system for synchronizing time information and managing time of crime prevention cameras installed in a town, and a time synchronization system of a mobile base station. Application to a smart grid is also possible. For example, by synchronizing time in a system which reads and manages power meters and gas meters, automatic reading based on accurate time becomes possible, and automatic audit at a desired date and time, in the case of moving to a new address, for example, also can be handled. In the case of mutually synchronizing systems of power companies in order to supply power stably, the time synchronization according to the present invention can be suitably applied. In the third embodiment, the time setting of the broadcasting receiver was described, but the present invention can also be applied to the time setting of other apparatuses used in companies and homes. It is also preferable that after the time setting based on the present invention, the time synchronization of other apparatuses in a company or home is performed using DLNA (Digital Living Network Alliance) or FM waves.

Reference Signs List

[0051]

- 1, 1a, 1b, 1c SATELLITE TIME DISTRIBUTION SYSTEM
- 2 RECEIVING APPARATUS
- 3 GEOSTATIONARY SATELLITE
- 4 BROADCASTING RECEIVER

- 10 ATOMIC CLOCK
- 11 TIME DISTRIBUTION AUDIT SERVER
- 12 ENCRYPTION SERVER
- 13 IP ENCAPSULATOR
- 14 TRANSMISSION ANTENNA
- 15 RECEIVER
- 16 RECEIVING ANTENNA
- 17 TIME AUTHENTICATION SERVER
- 20 RECEIVING ANTENNA
- 21 RECEIVER
- 22 TIME AUTHENTICATION SERVER

CLAIMS

[Claim 1]

A satellite time distribution system for distributing time information to receiving apparatuses via a geostationary satellite, comprising:

a reference clock which generates time to be a reference;

transmitting means for generating time information by adding an ID to a time obtained from the reference clock, encrypting the time information and transmitting the encrypted time information via the geostationary satellite;

receiving means for receiving the time information returned from the geostationary satellite;

delay calculating means for measuring a reception time of the time information based on a time of the reference clock, and determining a difference between the time included in the time information and the measured reception time as delay time; and

delay time information transmitting means for generating delay time information by adding, to the delay time, a same ID as the ID included in the time information, and transmitting the delay time information to the receiving apparatuses.

[Claim 2]

The satellite time distribution system according to

Claim 1, further comprising correction information transmitting means for transmitting, via the geostationary satellite, correction information for correcting a delay time difference generated by a difference in geographical position between the receiving apparatuses.

[Claim 3]

The satellite time distribution system according to Claim 2, wherein

the correction information transmitting means obtains the correction information for each of the receiving apparatuses, or for each area where each of the receiving apparatuses is installed, and

transmits the correction information only to a receiving apparatus capable of accessing the correction information, or to an area where the correction information can be accessed.

[Claim 4]

The satellite time distribution system according to one of Claims 1 to 3, wherein

the time information and the delay time information are multiplexed in a data communication area of satellite broadcasting and then distributed, and

each of the receiving apparatuses is a broadcasting receiver which can receive satellite broadcasting, and sets the time of an internal clock using the time information

and the delay time information.